Climate-Smart Landscapes:

Multifunctionality in Practice

Edited by
Peter A. Minang
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Olivia E. Freeman
Cheikh Mbow
Jan de Leeuw
Delia Catacutan

World Agroforestry Centre

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World Agroforestry Centre (ICRAF)
The World Agroforestry Centre (ICRAF) is one of the Centres of the CGIAR Consortium. Its vision is rural transformation in the developing world as smallholder households increase their use of trees in agricultural landscapes to improve food security, nutrition, income, health, shelter, social cohesion, energy resources and environmental sustainability. The Centre's mission is to generate science-based knowledge about the diverse roles that trees play in agricultural landscapes, and to use its research to advance policies and practices, and their implementation to benefit the poor and the environment. The organization conducts research in 34 countries in Africa, Asia and Latin America.

ASB Partnership for the Tropical Forest Margins (ASB)
The ASB Partnership for the Tropical Forest Margins is working to raise productivity and income of rural households in the humid tropics without increasing deforestation or undermining essential environmental services. ASB is a consortium of over 50 international and national-level partners with an eco-regional focus on the forest-agriculture margins in the humid tropics, with learning landscapes in the western Amazon of Brazil and Peru, the Congo basin in Cameroon and the Democratic Republic of Congo, southern Philippines, northern Thailand, northern Vietnam and the island of Sumatra in Indonesia.

Contents

List of Figures, Tables and Boxes vi

List of Abbreviations xii

Foreword xviii

Acknowledgements xx

List of Authors xxii

Summary xxxii

Global Landscapes Map xxxiv

Part 1: Introduction 1

1 **Introduction and basic propositions** 3
Peter A. Minang, Meine van Noordwijk, Olivia E. Freeman, Lalisa A. Duguma, Cheikh Mbow, Jan de Leeuw and Delia Catacutan

Part 2: Understanding Landscapes 19

2 **Whither landscapes? Compiling requirements of the landscape approach** 21
Emmanuel Torquebiau

3 **Characterising multifunctionality in climate-smart landscapes** 37
Olivia E. Freeman

4 **What can climate-smart agricultural landscapes learn from the *gestion de terroirs* approach?** 51
Florence Bernard

5 **Landscape restoration from a social-ecological system perspective?** 63
Lalisa A. Duguma, Peter A. Minang, Mathew Mpanda, Anthony Kimaro and Dieudonne Alemagi

6 **Climate Smart Territories (CST): An integrated approach to food security, ecosystem services, and climate change in rural areas** 75
Bastiaan Louman, José Joaquín Campos-Arce, Leida Mercado, Pablo Imbach, Claudia Bouroncle, Bryan Finegan, Claudia Martínez, César Mendoza, Roger Villalobos, Claudia Medellín, Cristobal Villanueva, Tatiana Mendoza, Amilcar Aguilar and Danilo Padilla

7 **Integrated landscape initiatives in practice: assessing experiences from 191 landscapes in Africa and Latin America** 89
Abigail K. Hart, Jeffrey C. Milder, Natalia Estrada-Carmona, Fabrice A. J. DeClerck, Celia A. Harvey and Philip Dobie

8 **How can an integrated landscape approach contribute to the implementation of the Sustainable Development Goals (SDGs) and advance climate-smart objectives?** 103
Cheikh Mbow, Constance Neely and Philip Dobie

Part 3: From Concepts to Inducing Change 119

9 **Scale considerations in landscape approaches** 121
Peter A. Minang, Lalisa A. Duguma, Dieudonne Alemagi and Meine van Noordwijk

10 **Leveraging landscapes: A systems approach to drivers of change** 135
Lalisa A. Duguma and Peter A. Minang

11 **Landcare - a landscape approach at scale** 151
Delia Catacutan, Clinton Muller, Mary Johnson and Dennis Garrity

12 **Landscape-level constraints and opportunities for sustainable intensification in smallholder systems in the tropics** 163
Ingrid Öborn, Shem Kuyah, Mattias Jonsson, A. Sigrun Dahlin, Hosea Mwangi and Jan de Leeuw

13 **Water-focused landscape management** 179
Meine van Noordwijk, Beria Leimona, Ma Xing, Lisa Tanika, Sara Namirembe and Didik Suprayogo

14 **Opportunities and challenges of landscape approaches for sustainable charcoal production and use** 195
Miyuki Iiyama, Henry Neufeldt, Philip Dobie, Roy Hagen, Mary Njenga, Geoffrey Ndegwa, Jeremias Gasper Mowo, Philip Kisoyan and Ramni Jamnadass

15 **Gender-specific spatial perspectives and scenario building approaches for understanding gender equity and sustainability in climate-smart landscapes** 211
Grace B. Villamor, P. Afiavi Dah-gbeto, Andrew Bell, Ujjwal Pradhan and Meine van Noordwijk

16 **The opportunity costs of emission reduction: a methodology and application to support land use planning for low emission development** 227
S Suyanto, Andree Ekadinata, Rachmat Mulia, Feri Johana and Atiek Widayati

17 **Negotiation support tools to enhance multifunctioning landscapes** 243
Sonya Dewi, Andree Ekadinata, Dony Indiarto, Alfa Nugraha and Meine van Noordwijk

18 **Institutional arrangements for climate-smart landscapes** 257
Susan W. Wambugu, Susan W. Chomba and Joanes Atela

Part 4: Involving the Private Sector 275

19 **Private sector investment in landscape approaches: the role of production standards and certification** 277
Gabrielle Kissinger, Mark Moroge and Martin Noponen

20 **Landscape approaches to sustainable supply chain management: the role of agribusinesses** 295
Amos Gyau, Judith Oduol, Mercy Mbugua, Divine Foundjem-Tita, Djalal Ademonla Arinloye and Christophe Kouame

21 **Private sector engagement in landscape-based approaches - lessons from cases in East Africa** 307
Sara Namirembe and Florence Bernard

Part 5: Contextualized Experience 317

22 **Operationalizing climate-smart agricultural landscapes: the case of a tea- producing landscape in Kericho, Kenya** 319
Jeffrey C. Milder, Mark Moroge and Seth Shames

23 **Institutional dynamics and landscape change – a case study of Southern Cameroon** 335
Divine Foundjem-Tita, Stijn Speelman, Peter A. Minang, Peter Mbile, Samuel N. Ndobe and Zac Tchoundjeu

24 **Pathways for sustainable intensification and diversification of cocoa agroforestry landscapes in Cameroon** 347
Dieudonne Alemagi, Peter A. Minang, Lalisa A. Duguma, Anderson Kehbila and Faith Ngum

25 **Landscape approaches in the Congo Basin: linking the Democratic Republic of Congo's Emission Reduction Program (ERP) and the Central Africa Regional Program for the Environment (CARPE)** 361
Kalame Fobissie

Part 6: Synthesis and Conclusions 373

26 **The future of landscape approaches: interacting theories of place and change** 375
Meine van Noordwijk, Peter A. Minang, Olivia E. Freeman, Cheikh Mbow and Jan de Leeuw

27 **Enhancing multifunctionality through system improvement and landscape democracy processes: a synthesis** 389
Peter A. Minang, Lalisa A. Duguma, Meine van Noordwijk, Ravi Prabhu and Olivia E. Freeman

Lists of Figures, Tables and Boxes

Figures

1.1	A landscape as the interaction between human actions, ecosystems and the abiotic factors that shape the physical environment	6
1.2	Visualization of an actual landscape as a member of a wider set of locally feasible landscape configurations, constrained by household decisions and national context	7
1.3	Visualization of climate change as part of the wider set of interacting global change influences and drivers of change at the landscape scale, modified by national development policy and its implementation	7
1.4	Examples of the multiple starting points for landscape approaches, that may have a common destination and all use an adaptive collaborative management learning loop approach	10
2.1	Spatial structure of an agricultural landscape	23
2.2	Landscape units' categories	25
2.3	Various types of landscape matrices (from Perfecto et al., 2009) that connect forest fragments	26
2.4	Landscape-level 'biodiversity-friendly' schemes	29
2.5	Possible protected areas across a landscape	29
3.1	Linkages and interactions including potential drivers and incentives across local, landscape, national and global scales	39
3.2	Different combinations of synergistic interventions addressing different combinations of primary objectives	43
4.1	Key steps for implementation of GT	53
5.1	Hypothetical degradation-restoration schematic in natural resources management at scales such as a landscape	66
5.2	Schematic showing elements that characterized the gradual changes in the Shinyanga Region, Tanzania	68
6.1	Diagram of the relationship between landscapes and territories	78
7.1	Proportion of the respondents who reported their initiative as including each of the 33 specific investments and activities (left panel) and as achieving each of the 22 specific outcomes (right panel) across the four domains of landscape multifunctionality	95
8.1	The evolution of approaches within the scientific and development contexts	107
8.2	An interpretation of the various principles of a landscape approach (based on Sayer et al., 2013; see Box 8.1) described in three categories: prerequisites, action items and aims	109

9.1 Hierarchical representations of scale and scale interactions 124

10.1 Understanding the processes that led to ecosystem degradation in the Shinyanga Region 142

11.1 Countries where there is an interest in Landcare and where Landcare initiatives currently exist 153

11.2 Community members working through a Landcare project to repair the erosion of Mafidhi gully with gabion walls in Chivi District, Masvingo Province in Zimbabwe 154

12.1 Trees in and around coffee plantations in Costa Rica have significantly reduced coffee berry borer infestations via different mechanisms, e.g., hosting predators such as birds 168

12.2 Establishment of forest gardens in Cam My Commune, Central Vietnam, contributes to sustainable livelihoods of local, smallholder farmers 170

12.3 West Pokot in semi-arid area of Kenya: degraded landscape (left), restored landscaped with enclosures in (centre), livestock grazing in enclosure (right) 171

13.1 Schematic representation of the hydrological cycle between oceans and land with twelve targets and intervention points that have over time been included in ‘integrated water management’ discussions 188

14.1 Charcoal economics 198

14.2 A LA for sustainable charcoal 205

14.3 Top: Urbanization has led to increasing demand for charcoal as a preferred, affordable fuel (Photo credit: Miyuki Iiyama) Bottom: Charcoal production targets mature hardwood species with significant degradation impacts (Photo credit: Geoffrey Ndegwa) 206

15.1 Gender specific spatial organization of households' farm management 214

15.2 Patterns of land-use change under variable precipitation conditions created by the women-only group (1; a and b) and the men-only group (2; c and d) 219

15.3 Land use change patterns based on the RPGs of women-only (a) and men-only (b) groups 220

15.4 Land-use change pattern using a 2005 land use map as a baseline 220

16.1 Schematic diagram of opportunity cost estimation 230

16.2 Conceptual figure of the opportunity cost curve 232

16.3 The four core modules of the FALLOW model described in Lusiana et al. (2012) 233

16.4 Location of Tanjabar District in Jambi Province, Sumatra, Indonesia and the different land uses within the landscape area 234

16.5 Opportunity cost curve of emission reductions from land use change in Tanjabar 236
16.6 Potential emission reductions at 5 USD/tCO_2e and 10 USD/tCO_2e thresholds 236
17.1 Land Use Planning for Multiple Environmental Services (LUMENS): process and components 246
17.2 Merangin working group conducting planning unit reconciliation (left); mosaic of cropland and agroforests in river valley of Merangin (right) 249
17.3 Planning Unit map resulting from the reconciliation process 250
17.4 Projections of land use/cover maps to 2025 under the three different scenarios 251
17.5 Changes over time (due to actual land use/cover changes until 2010, and scenario-based projection of land use/cover changes from 2015-2025) 252
18.1 Institutional arrangements, i.e., actors and their interactions at various levels, governed by laws, rules and regulations in shaping landscapes (developed from multi-level governance perspectives and social dimensions of climate change) 258
20.1 Vision for Change project 301
22.1 Map of the Kericho landscape 321
22.2 View of the Kericho landscape, which consists of a mosaic of tea production areas, annual crop parcels, eucalyptus woodlots, forest conservation areas, and human settlements 322
25.1 Location of CARPE landscapes within the Congo Basin forest area 361
26.1 Combination of Figures 1.2 and 1.3, showing the overall complexity of the way landscapes as socio-ecological systems interact with wider national and global system scales, as well as with households and (gender and wealth differentiated) individual livelihood strategies 376
26.2 The relationship between ToP and ToC at the landscape scale are reflected through the answers to six main groups of questions 380
26.3 Generic ToC for global progress towards the SDGs, by combining six roles for agents of change (see text) and three knowledge value chains 381
27.1 An Illustration showing both adaptive collaborative management (ACM) and system improvement process (SIP) 391
27.2 The Landscape Process Wheel showing main landscape processes 393
27.3 A suggested good governance framework for assessing landscape negotiation processes 398

Tables

3.1 Descriptions and examples of additive and superadditive synergies 42

4.1 Key similarities and differences between the GT and climate-smart landscape approaches 55

7.1 Summary of selected characteristics of surveyed initiatives in Africa (87) and Latin America and the Caribbean (104) 93

8.1 The SDGs and the potential contribution of the landscape approach to these goals 110

9.1 Summary of scale interpretations in landscapes 125

10.1 Meadows (1999)'s recommendation for leverage points in a system with corresponding examples of leveraging options at the landscape level 139

10.2 Leveraging areas and preliminary diagnostic questions to identify the levers in a landscape 143

13.1 Six questions that in combination lead to a basic understanding of water management at the landscape scale and the interactions with other ecosystem services 181

13.2 Methods for various stages of negotiating integrated water management at the landscape scale, referring to the six questions of Table 13.1 181

13.3 Four key dimensions to understand the spectrum of governance instruments for enhancing watershed functions of landscapes in ways that are both efficient and fair 185

14.1 Application of Sayer et al. (2013)'s ten principles for LAs in different woodfuel interventions 202

16.1 Time-averaged carbon stock and profitability of land use systems in Tanjabar 235

16.2 Potential loss of annual income per tCO_2e of each scenario compared to the BAU in the Tanjabar District, calculated by the FALLOW model 238

18.1 Comparative matrix for the three case projects aiming to achieve climate-smart outcomes in various landscapes 265

19.1 Case study summary: production standards and ILM 283

22.1 Highlights of results of the climate-smart landscape assessment process in each of the six activity domains 325

24.1 Tradeoffs in sustainable intensification and diversification pathways of CALs in Cameroon 351

24.2 Examples of different direct and indirect incentive mechanisms 354

25.1 Some of the differences between CARPE and the ERPs, focusing mainly on the DRC context 366

27.1 Summary of how chapters in this book address various dimensions of landscape processes 394

Boxes

4.1	Mali's Decentralization Programme and GT approach	57
6.1	Multi-thematic farmer field schools for CST implementation	80
8.1	Ten principles from Sayer et al. (2013)	108
9.1	Water management in the Nile river basin: multiple scales and multiple actors	123
9.2	Nested scales in REDD+	129
11.1	Kapchorwa District Landcare Chapter: managing the landscape for livelihoods	157
12.1	Landscape management of coffee berry borer to sustain productivity on smallholder farms	168
12.2	Forest gardens sustain livelihoods when variable weather hits intensified crop cultivation in Central Vietnam	170
12.3	Enclosures contribute to sustainable intensification of livestock production in semi-arid West Pokot, Kenya	171
13.1	Buffering of river flow: combining local and hydrological understanding?	183
13.2	River Care	185
14.1	Sustainable charcoal production and Sayer et al. (2013)'s ten principles	204
15.1	Outsourcing, landscapes and gender	215
17.1	Steps in the LUMENS tool	247
17.2	LUMENS Application in Merangin, Jambi, Indonesia	250
18.1	Brief histories and backgrounds of the three case study landscapes	263
20.1	Case study: Vision for Change project between Mars Inc. and the World Agroforestry Centre (ICRAF)	301
21.1	Developing private-financed PES in Sasumua watershed, Kenya: a strong business case challenged by the national institutional framework	310
21.2	Imarisha Naivasha Partnership for Sustainable Development: a government-led landscape initiative with strong involvement of the private sector	311
21.3	Vision-based planning for Kasyoha-Kitomi and Kakasi Forests, Uganda: unclear entry points for the private sector	312
22.1	Sustainable agriculture certification in the tea sector	323
23.1	Evolution in the implementation of the concept community forestry in Cameroon	339

25.1 Activities of Salonga-Lukenie-Sankuru (SLS) CARPE landscape program 364
26.1 New directions for international agricultural research 377
26.2 Working definitions for theories of place and change 377
26.3 Proposition A: Current landscapes are a suboptimal member of a set of locally feasible landscape configurations 378
26.4 Proposition B: Actors and interactions can nudge landscapes towards better managed tradeoffs within a set of feasible configurations, through engagement, investment and interventions 382
26.5 Proposition C: Climate is one of many boundary conditions for landscape functioning 383
26.6 Proposition D: Theories of change must be built within a theories of place for effective location-specific engagement 385
27.1 Landscape Democracy 397

Abbreviations

A/R	Afforestation/Reforestation
AAG	American Association of Geographers
AASD	Action d'Aide Sanitaire et de Développement
ABM	Agent-Based Model
ABMS	Activity Baseline Monitoring System
ACM	Adaptive Collaborative Management
AFOLU	Agriculture, Forestry, and Other Land Uses
AHP	Analytic Hierarchy Process
ALN	African Landcare Network
ALUCT	Analysis of Land Use and Cover Trajectory
AMSA	Agroindustrias Unidas de Mexico
ANOVA	Analysis of Variance
ASB	Alternatives to Slash-and-Burn Partnership for the Tropical Forest Margins
BAU	Business As Usual
BROA	Biodiversity Risk and Opportunity Assessment
BTNP	Bukit tiga Puluh National Park
CAFEC	Central Africa Forest Ecosystems Conservation
CAL	Cocoa Agroforestry Landscape
CAM	Regional Autonomous Corporation of the upper Magdalena
CARPE	Central Africa Regional Program for the Environment
CATIE	Tropical Agricultural Research and Higher Education Centre
CATIE/MAP	CATIE's Mesoamerican Agroenvironmental Program
CBD	Convention on Biological Diversity
CBNRM	Community-Based Natural Resource Management
CBO	Community-Based Organization
CCBA	Climate Community and Biodiversity Alliance
CF	Carbon Fund
CFA	Community Forest Association
CFM	Community Forest Management
CGF	Consumer Goods Forum
CGIAR	Consultative Group on International Agricultural Research
CI	Conservation International
CIFOR	Center for International Forestry Research
COMIFAC	Central African Forest Commission
Con$erv	Conservation Auction and Environmental Services Enhancement
COOPAFI	Cooperative Central Association of Family Farmers
COP	Conference of Parties
CSA	Climate-Smart Agriculture
CSLA	Climate-Smart Landscape Approach

CSO	Civil Society Organization
CSR	Corporate Social Responsibility
CST	Climate Smart Territories
CVC	Cocoa Village Center
DPSIR	Driver-Pressure-State-Impact-Response
DRC	Democratic Republic of Congo
E3	Eclogia, Economia y Etica
ECOM	Ecom Agroindustrial Corp
ERP	Emission Reduction Program
ERPA	Emission Reduction Purchasing Agreement
ER-PIN	Emission Reduction Program Idea Note
ETP	Ethical Tea Partnership
EU-RED	European Commission's Renewable Energy Directive
FALLOW	Forest, Agroforest, Low-Value or Waste Model
FAO	Food and Agriculture Organization of the United Nations
FCFA	CFA Franc
FCMC	Forest, Carbon, Markets and Communities
FCPF	Forest Carbon Partnership Facility
FFS	Farmer Field Schools
FIMAC	Investment Fund for Agricultural and Communal Micro Projects
FIP	Forest Investment Program
FlowPer	Flow Persistence Analysis
FMNR	Farmer-Managed Natural Regeneration
FPIC	Free and Prior Informed Consent
FSC	Forest Stewardship Council
GAC	Global Action Coalition
GBM	Green Belt Movement
GEF	Global Environment Facility
GenRiver	Generic River Flow Model
GHG	Greenhouse Gas
GIS	Geographical Information System
GLF	Global Landscapes Forum
GT	Gestion de Terroirs
Ha	Hectare
HASHI	Hifadhi Ardhi Shiyanga - Shinyanga Soil Conservation
HCV	High Conservation Value
HLF	Heritage Lottery Fund
HLG	Hutan Lahan Gambut
HTI	Hutan Tanaman Industri
IBAT	Integrated Biodiversity Assessment Tool
IBP	Incentive-Based Program
ICCN	Institut Congolaise pour la Conservation de la Nature

ICDPs	Integrated Conservation and Development Projects
ICRAF	World Agroforestry Centre
IITA	International Institute for Tropical Agriculture
ILA	Integrated Landscape Approach
ILM	Integrated Landscape Management
INADES	Institut Africain pour le Développement Economique et Social
INCEF	International Conservation and Education Fund
INRM	Integrated Natural Resource Management
IPCC	Intergovernmental Panel on Climate Change
IP	Innovation Platform
IRDPs	Integrated Rural Development Programmes
ISO	International Standards Organization
ITK	Indigenous Technical Knowledge
IUCN	International Union for Conservation of Nature
KACP	Kenya Agricultural Carbon Project
KADLACC	Kapchorwa District Landcare Chapter
KFS	Kenya Forest Service
KKK	Kasyoha-Kitomi and Kakasi
Km	Kilometer
KTDA	Kenya Development Tea Agency
LAC	Latin America and the Caribbean
LA	Landscape Approach
LB-LUDAS	Lubuk Beringin - Land Use DynAmic Stimulator
LCCs	Location Carbon Committees
LFK	Local Ecological Knowledge
LPFN	Landscapes for People, Food and Nature Initiative
LPG	Liquid Petroleum Gas
LULCC	Land Use and Land Cover Change
LUMENS	Land Use Planning for Multiple Environmental Services
LUP	Land Use Planning
LUWES	Land-Use Planning for loW-Emissions development Strategies
MDGs	Millennium Development Goals
MEA	Millennium Ecosystem Assessment
MICCA	FAO Mitigation of Climate Change in Agriculture Programme
MINADER	Ministry of Agriculture and Development
MRV	Measurement, Reporting and Verification
MuScaPES	Multi-scale Payments for Environmental Service Paradigms
N_2	Di-Nitrogen
NAFRAC	Natural Forest Resources and Agroforestry Management Centre
NAMA	Nationally Appropriate Mitigation Actions
NAPA	National Adaptation Programmes of Action
NGO	Non-Governmental Organization

NICFI	Norway's International Climate and Forest Initiative
NLP	National Landcare Programme
NORAD	Norwegian Agency for Development Cooperation
NOVACEL	Nouvelle Société d'Agriculture et Elevage
NPK	Nitrogen-Phosphorus-Potassium Fertilizer
NPV	Net Present Value
NRM	Natural Resource Management
NTFP	Non-Timber Forest Products
NWSC	Nairobi City Water and Sewerage Company
OM	Outcome Mapping
PACT	Private Agencies Collaborating Together
PaLA	Participatory Landscape Appraisal
PA	Protected Area
PaWaMo	Participatory Water Quality Monitoring
PEMA	Participatory Environment Management
PES	Payments for Environmental Services
PIREDD	Integrated REDD+ Sub-Project in the Plateau District
PPP	Public-Private Partnership
PTLA	Way Besai Hydroelectricity Power Company
PU	Planning Units
PUR	Planning Unit Reconciliation
RalMA	Rapid Landslide Mitigation Appraisal
RAPAC	Network of Central African Protected Areas
REALU	Reducing Emissions from All Land Use
REDD	Reducing Emissions from Deforestation and forest Degradation
REDD+	Reducing Emissions from Deforestation and forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks
RHA	Rapid Hydrological Appraisal
R-PAN	REDD+ for People and Nature
RoC	Republic of Congo
RPG	Role Playing Games
RSPO	Roundtable on Sustainable Palm Oil
RTRS	Round Table for Responsible Soy
RUPES	Rewarding Upland Poor for Environmental Services
SAI	Sustainable Agriculture Initiative
SAN	Sustainable Agriculture Network
SDGs	Sustainable Development Goals
SES	Social-Ecological System
SESF	Social-Ecological Systems Framework
SIP	Systems Improvement Process
SL	Sustainable Livelihoods

SLS	Salonga-Lukenie-Sankuru
SODECAO	Société de Développement du Cacao
SODEFOR	La Société de Développement Forestière
SSA	Sub-Saharan Africa
STCP	Sustainable Tree Crops Program
SWAT	Soil and Water Assessment Tool
tCO_2e	Ton Carbon Dioxide Equivalent
TFA	Tropical Forest Alliance
ToC	Theory of Change
ToP	Theory of Place
UNCCD	United Nations Convention to Combat Desertification
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USD	United States Dollar
USDA	United States Department of Agriculture
V4C	Vision for Change
VCS	Verified Carbon Standard
WCS	Wildlife Conservation Society
WRI	World Resources Institute
WRUA	Water Resource Users Association
WWC	Wildlife Works Carbon
WWF	World Wildlife Foundation
ZSM	Zoological Society of Milwaukee

Foreword

The debate on climate change focuses on global carbon flows and on broad-brush generalisations about how societies may adapt to predicted future conditions. However, the actual decisions on how and where to sequester carbon and how to adapt to very uncertain futures will need to take place at more local levels. Although global and national policies will provide the context, the actual outcomes will be determined by the decisions of millions of stakeholders all seeking to improve their own condition. Somehow these individual decisions must build a 'whole' that is greater than the sum of their parts. This book argues persuasively that a realistic 'whole' is the climate-smart landscape.

Landscapes yield multiple benefits, they support biodiversity, mitigate natural disasters, sequester carbon, but most importantly they provide for sustainable commercial activity. The landscape approach considers how interconnected components of the landscape can be managed to reap multiple benefits and balance commercial, social and environmental concerns. Recognition of these 'emergent properties' of landscapes has led to a proliferation of initiatives to address natural resource management problems at a landscape scale. The landscape concept has become attractive to funders of aid programmes because it promises win-win solutions – it claims to deliver on multiple social, economic and environmental objectives – delivering all things to all people. The result is that many development assistance agencies and conservation non-governmental organizations now use the term rather loosely to describe well-intentioned but rather fuzzy programmes whose outcomes and impacts are hard to measure. There is also a lot of uncertainty about how one actually operates a landscape approach[1]. The present volume is therefore very welcome – it breaks new ground in terms of establishing a case record of landscape initiatives and building a community of practice amongst those who have actually pursued landscape initiatives in a scientifically rigorous way.

The World Agroforestry Centre has led the way in the emergence of the 'landscape' concept as the organising framework for operationalising climate change measures on the ground. This book and other studies[2] show that numerous initiatives are recognising that the landscape scale is appropriate for balancing the multiple interests of people with diverse livelihoods and interests in sequestering carbon and adapting to climate change. The World Agroforestry Centre has several decades of experience in promoting the benefits of trees in landscapes for their multiple contributions to human well-being. Now the centre has mobilised many scientists from a range of institutions who have expertise in optimising the contribution of trees in the landscape in dealing with climate change.

Achieving climate-smart landscapes requires the application of inter-disciplinary science and the chapters in this book bear testament to the diversity of the scientific resources that the World Agroforestry Centre has been able to mobilize. The authors have many decades of combined experience in dealing with the complexity of tropical landscapes and the multiple interests of their inhabitants. The book is rooted in both pragmatism and wisdom and will provide valuable guidance and insights to those who will be seeking to make their landscapes more climate-smart.

No single recipe will enable landscapes to be made climate-smart and the needs for climate-smartness will constantly change as climate change itself unfolds. Practitioners will find in this volume much that will enrich their attempts to influence and adapt landscapes. Landscapes will be learning laboratories where the impacts of climate and other social and economic changes will be felt and the responses tested.

The climate-smartness of a landscape will be a function of its assets – human, social, natural and physical – and managing these assets will be the challenge of those who seek to influence the evolution of landscapes. Again in this book the broad sweep of knowledge needed to understand and strengthen landscape assets is comprehensively reviewed.

I commend this book to the scientists, local and national government officials, civil society organisations and land managers who will be entrusted with ensuring that our landscapes are climate-smart as we navigate into our uncertain future. I hope and believe that this volume will contribute to transforming what is now a rather vague but attractive concept into rigorous processes that will make the world's landscapes 'climate-smart'.

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1 Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J. L., Sheil, D., Meijaard, E., ... Buck, L. E. (2013). Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. *Proceedings of the national academy of sciences, 110*(21), 8349-8356.

2 Milder, J. C., Buck, L. E., DeClerck, F., & Scherr, S. J. (2012). *Landscape approaches to achieving food production, natural resource conservation, and the millennium development goals.* In Integrating Ecology and Poverty Reduction, 77-108. New York: Springer.

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Summary

Landscape approaches present opportunities for sustainable development by enhancing opportunities for synergy between multiple objectives in landscapes (i.e., social, economic and environmental). They challenge the 'one-place-one-function' concept of specialization that sees agriculture, forest and urban spheres as 'silos'. Drawing on a large range of case studies from predominantly the humid, sub-humid and dry tropics across the world, this book provides directly applicable knowledge, while also highlighting key issues requiring further work. Written for researchers, practitioners and policymakers alike, this book links theory to practice.

Building on earlier concepts laid out in earlier volumes[1, 2], this book explores four central propositions on climate-smart and multifunctional landscape approaches:

A. Current landscapes are a suboptimal member of a set of locally feasible landscape configurations;
B. Actors and interactions can nudge landscapes towards better managed tradeoffs within the set of feasible configurations, through engagement, investment and interventions;
C. Climate is one of many boundary conditions for landscape functioning;
D. Theories of change must be built within theories of place for effective location-specific engagement.

The current knowledge base on these propositions is summarized as aspects where we know enough to act, and issues that represent critical uncertainties (see table below). Each of the propositions has counterpoints. Views on optimality and desirable directions of change differ between stakeholders. The way external and internal stakeholders build trust and interact is critical for success. Climate and climate change interact with other drivers and boundary conditions. A process-level generic theory of change can help articulate location-specific ones.

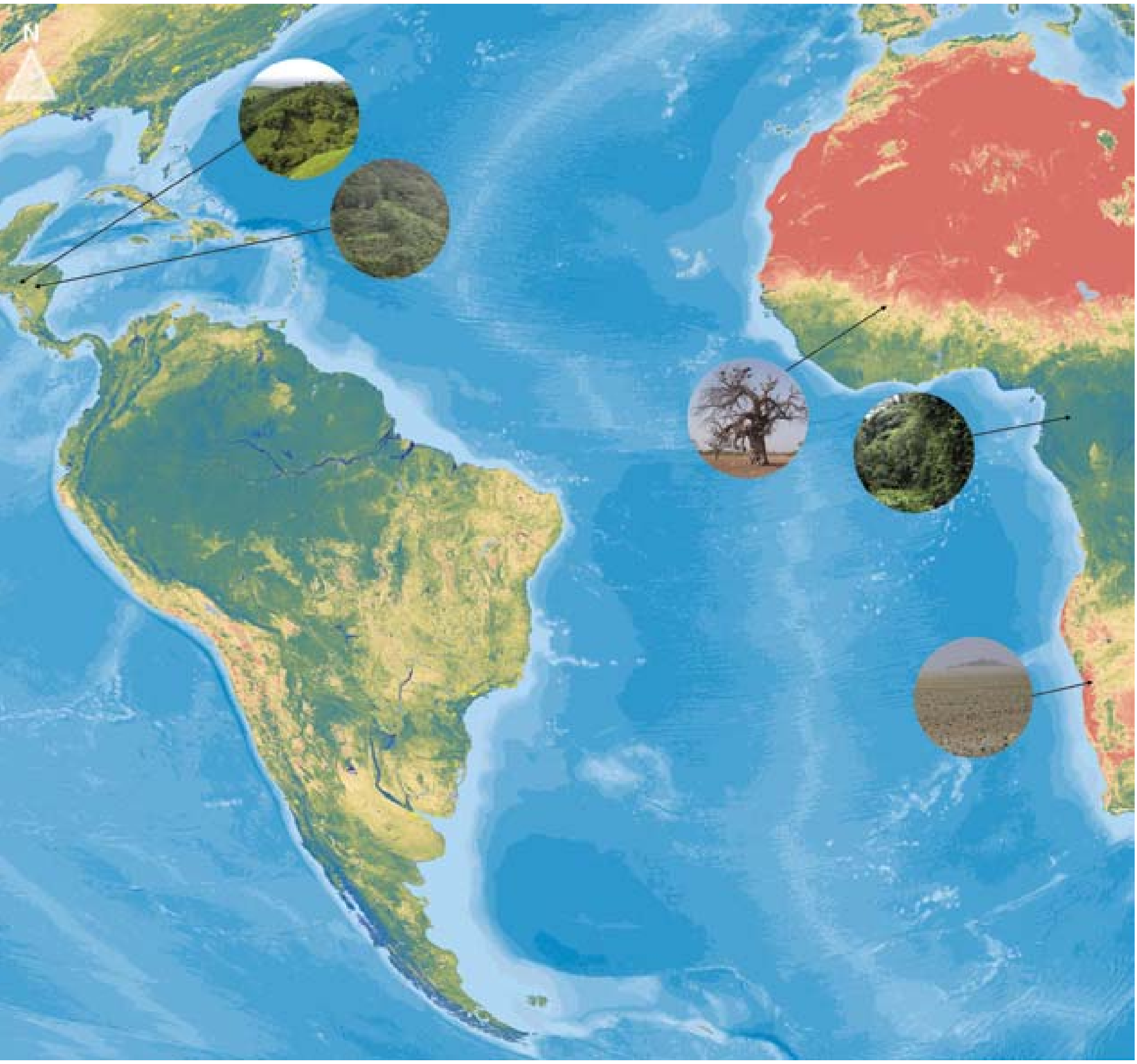
Guided by these propositions and their counterpoints, the 27 chapters of this book, prepared by 86 authors from 44 institutions, are presented in six parts. After an overall introduction (Part 1), basic concepts that help understand landscapes (Part 2), precede tools and concepts for inducing change (Part 3). Specific attention to involving the private sector (Part 4) and contextualized examples (Part 5) contribute to the synthesis and conclusions (Part 6).

Looking ahead from a policy perspective, policy approaches, instruments and incentives are needed. Having adopted landscape principles, the Convention on Biological Diversity (CBD) and the European Landscape Convention are hopefully two trendsetters in this area. In the climate change arena a holistic land-based approach to pursuing synergies between mitigation and adaptation is at least now under discussion (United Nations Framework Convention on Climate Change (UNFCCC)). Nesting landscapes to green economy policies requires existing policy streams for forests (Reducing Emissions from Deforestation and forest Degradation (REDD+)), nationally appropriate mitigation actions (NAMAs) and adaptation policies to interract with other aspects of the sustainable development goals (SDGs). Mechanisms that allow co-investments of public and private interests and resources are needed to catalyze actions in landscapes, guided by landscape democracy and transparency.

Aspects on which we know enough to act	Critical uncertainties
A. Bottom-up collective action supported by jurisdictional reform is key to success for multi-stakeholder, multiple-objective, contested-rights landscapes.	Legal pluralism in multilevel governance needs attention; further metrics (operational indicators) for multifunctionality are needed.
B. As incentive systems for better landscape management, 'co-investment in stewardship' may be more effective than direct performance-based payments. Polycentric governance can use multiple, nested incentive paradigms with attention for transparency requirements.	Integrative planning tools at the community level need to more effectively link diverse knowledge systems; proximate and ultimate motivation for individuals to engage in collective action needs to shape effective use of various types of incentives.
C. Operational synergy is feasible at the landscape scale between climate change adaptation and mitigation, enhancing effective ecological and socio-economic buffer functions.	Better metrics are needed for loss and gain of buffering of livelihoods, combining climate and other boundary conditions. There is need to pay attention to the way public-private partnerships and integrative policies can achieve mitigation co-benefits from adaptation.
D. Theories of place, including issues of identity and rights, will inform theories of change where there is early and strong involvement of local voices in any change process.	Domains of similarity that include modes of decision-making need to be recognized to facilitate cross-site learning. Existing ecological stratification needs social counterparts.

For practitioners, two complementary angles are important: landscape analysis and landscape facilitation. Landscape analysis, combining the best of multiple disciplines, increases the evidence-base for decision-making and action. Landscape facilitation, often in action research for development, aims at effectiveness, efficiency and equity in decision-making processes. On the interface of the two, guidance on choice of methods, tools and incentives is needed. Combinations of methods and tools need to be sophisticated enough to accommodate complexity, embrace uncertainty and enable tradeoffs to be managed. At the same time, methods need to remain practical enough for implementation. System Improvement Process approaches, as articulated in industry, are a helpful way of structuring analysis and leveraging actions in landscapes especially when deployed as part of an adaptive management process. Approaching landscapes from a business case perspective can be a useful pathway to increased investments and greater efficiency. Landscape democracy, is emerging as a potentially useful framework for landscape facilitation. Novel concepts and tools need further exploration and testing. The work-in-progress contributions of this book are steps in a long journey of discovery across the diverse ways landscapes can be, and become more, multifunctional and climate-smart.

1 van Noordwijk et al. (2011). *How trees and people can co-adapt to climate change: reducing vulnerability through multifunctional agroforestry landscapes.* Nairobi, Kenya: ICRAF.
2 van Noordwijk et al. (2013). *Negotiation-support toolkit for learning landscapes*. Bogor, Indonesia: ICRAF.



A select set of geolocated landscapes in which the World Agroforestry Centre (ICRAF) is working within a global map displaying a surface wetness index at 500 m resolution, based on Moderate Resolution Imaging Spectroradiometer (MODIS) remote sensing data. Photo credits: Tor-G. Vågen

World Agroforestry Centre
GeoScience Lab
http://landscapesportal.org
Legend
Urban areas
Lakes and rivers
Wetness index
Very dry
Moderately dry
Moderately wet
Wet
Global landscapes
by Tor-G. Vågen (t.vagen@cgiar.org) and Thomas Gumbricht
0
1000
2000
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PART 1

Introduction

World Agroforestry Centre researchers in action as they begin their journey understanding and exploring this learning landscape in Vietnam.
Photo credit: Alba Saray Perez

CHAPTER 1

Introduction and basic propositions

Peter A. Minang, Meine van Noordwijk, Olivia E. Freeman, Lalisa A. Duguma, Cheikh Mbow, Jan de Leeuw and Delia Catacutan

This book is about how landscape approaches can address the challenges of sustainable development. It explores the opportunities and challenges for developing countries to simultaneously achieve social, environmental and economic objectives at the landscape level through multifunctionality. It challenges the 'one-place-one-function' concept of specialization. Current interest in reducing the negative impacts of climate change, and slowing down its progression, leads logically to landscape-level interventions, but in interaction with many ongoing processes and learning opportunities. More specifically, the book aims to review conceptual understandings of landscapes and landscape approaches, as well as synthesize knowledge and experiences largely from across the developing world. Looking at landscapes within the context of climate change, this book provides a set of concepts, tools, incentives, past experiences and practices to further operationalize the concepts of integrated landscape approaches, and climate-smart landscapes in practice. Written for researchers, professionals and policymakers alike, it moves from theory to practice providing a toolkit for implementation of multifunctional landscapes.

This introductory chapter builds up an appreciation of what the landscape scale of analysis and action can do and how it can add value to understanding the relationships between individual livelihood options and strategies, and global change. Landscapes are usefully interpreted as dynamic socio-ecological systems. This supports the perspective that the actual landscape in its current configuration is one out of many possible configurations, and potentially a suboptimal one. Once the wider range of options and the various perspectives on 'optimality' are understood, the opportunity of a 'landscape approach' by proponents of change opens up: it is possible to influence the complex system operating at the landscape scale to manage the various tradeoffs between functions and stakeholders in different, and potentially better ways.

1. Why landscape approaches? What problems might they solve?

Landscape approaches have been born out of the need to address multiple objectives simultaneously. The primary reason for this need is the growing competition for land, with increasing global population and a non-expanding-sized planet earth. Interconnected socio-economic systems at the landscape scale are expected to deal with the 'wicked' challenge of sustainable development. The latter requires environmental conservation (avoiding further damage and recovering from inflicted damage) plus socio-economic development (achieving a considerable increase in quality of life for many people). Climate change has added to this challenge, increasing the sense of urgency.

Addressing climate change is one of many challenges within the environmental and natural resource management fields, termed, 'wicked problems' due to their complex, interwoven nature, often demanding intricate behavioural and policy changes from multiple actors to address them (Balint et al., 2011). Due to their complexity, these problems are often hard to explicitly define and arrive at a clear solution. It may also not be evident when the problem has been adequately addressed (Rittel & Webber 1973; 1984; Weber & Khademian, 2008). Within a landscape there are many different forces driving the change trajectories of the landscape's current and future states. While being able to identify a specific problem (e.g., deforestation), it might be much more complex and challenging to first, identify the specific drivers causing the problem and second, determine the best intervention to address the problem. For example, in the case of deforestation it has been recognized that there exists a number of both direct (proximate) and underlying (ultimate) drivers that are usually interconnected (Geist & Lambin, 2002; Hosonuma et al., 2012; Bernard et al., 2013). This can require a complex set of interventions ranging from land tenure fixes, land use choice changes, incentives schemes, intensification of agriculture at the forest margins, accompanying policies to limit the expansion of agriculture, and much more (Geist & Lambin, 2002; Palm et al., 2005).

Competition for a limited land base for food, fibre, fuel and other land uses has increased, as the world's population has grown. To feed a projected population of more than 9 billion by 2050, food production is expected to grow by more than 50% (FAO, 2009). This will require both expansion of agricultural land and intensification of agricultural practices. In order to meet this demand, it is estimated that agricultural land will increase by approximately 107 million hectares (ha) by 2050 (about 51 million ha in Africa and 49 million ha in Latin America), on top of its previous increase of 176 million ha between 1963 to 2007 (Alexandratos & Bruinsma, 2012). The projected agricultural growth likely implies loss of biodiversity and ecosystem services. Agricultural growth since the 1960s has already caused a decline by approximately 30% of biodiversity; the trend being the most extreme in the tropics with a decline of almost 60% (Global Biodiversity Outlook, 2010). Growing competition over fixed land resources implies often that economically attractive land uses triumph over those that are more valuable from a societal perspective, but less profitable for a private land user. Tropical and sub-tropical developing country landscapes are at the heart of this competition for land, partly because they also represent areas of the highest population growth as well as of projected agricultural land increases. As a result, planning of land use can no longer be the business of single interests, but needs to involve all interested parties. Hence, the increasing requirement for a landscape approach.

The growing competition for land has created mosaic landscapes that simultaneously emit greenhouse-gases, thereby accentuating climate change. This has given birth to a set of actions that aim to reconcile actions to address climate change mitigation (efforts to reduce greenhouse gases) and climate change adaptation as well as food production and food security in the context of the United Nations Framework Convention on Climate Change (UNFCCC). These approaches have been increasingly referred to as 'climate-smart' with multiple variants such as climate-smart agriculture, climate-smart landscapes and climate-smart development (Scherr et al., 2012; Harvey et al., 2013). In this context a landscape approach identifies opportunities to create sustainable landscape pathways by capitalizing on synergies to facilitate multifunctionality while reducing tradeoffs. This book builds on this increasing body of experience with integrated landscape approaches.

These kinds of holistic approaches are not entirely new. They have been advocated for in international forums including the Convention on Biological Diversity (CBD), which promotes the ecosystems approach, the Bern Convention and the World Heritage Convention, which also recommend landscape actions (WWF, 2002). A growing community of professionals in the area is also emerging[1].

Multifunctionality is about seeking to achieve multiple objectives simultaneously. Multifunctional landscapes in this context then refers to landscapes that effectively provide, as best as possible (relative to their potential), ecosystem functions (i.e., supporting, provisioning, regulatory and cultural)[2] that underpin social and economic functioning.

Therefore in this book we draw from, and build on, current experiences providing knowledge, tools, methods and lessons learned to promote achieving multiple objectives relating to economic, social and environmental functions in practice, framed specifically around 'climate-smart' opportunities.

2. Landscapes and landscape approaches

2.1 Landscapes

From the emergence of the word landscape, derived in English from German and Dutch origins in the Middle Ages as "landschaft" and "landschap", it has been given several definitions and interpretations. In science, these are covered in many fields and disciplines including, but not limited to, geography, ecology, arts and anthropology (Meinig, 1979). Angelstam et al. (2013*a*) distinguishes four interpretations and aspects of landscapes: i) ecological - the interactions between biophysical components such as soil, water, biota and vegetation and resultant patterns and processes; ii) anthropogenic - landscapes as human phenomena with constructs such as infrastructure, land uses, electoral and political constituencies; iii) intangible - as cognitive representations of space, organization and systems; and iv) coupled socio-ecological systems with a combination of all three above and the interfaces between them.

In sum, landscapes are place-based systems that result from interactions between people, land, institutions (laws, rules and regulations) and values. These interactions shape the dimensions of peoples' lives and either produce the food, fuel, fibre they need, or generate the income to buy these from elsewhere. Landscapes shape ecological services and the social and economic relationships on which people depend (Frost et al., 2006). We distinguish three outstanding interactive aspects that define a landscape: functional interactions, negotiated spaces and multiple scales.

1. **Functional interactions:** Ecological, economic and social processes in a landscape interact. Landscapes can be seen as a mosaic of components, named land units by Zonneveld (1989), who defined these as ecologically homogenous areas of land with associated variation in land use. The management of the various land units is linked to multiple and different sectors of a national economy (including agriculture, forestry, water management, infrastructure, rural development), and also to actor interests and biophysical characteristics.

2. **Negotiated spaces:** Landscapes typically have a diverse set of stakeholders with different perspectives, interests, power and ambitions, which can often be conflicting. Hence, negotiations are needed for the different actors to accept and live within decisions shaping the landscape. Therefore, landscapes are negotiated spaces, differing in degree of achieving harmony.
3. **Multiple scales:** Landscapes often have households, farms and other institutions (e.g., community-based organizations or the private sector) as elements, potentially engaged in collective action. Landscapes are interacting with neighbouring landscapes and are nested in coarser-scale subnational units, watersheds/basins or eco-regions. A convenient landscape scale is one that is large enough to contain the heterogeneity of biophysical characteristics as well as social, economic, political and cultural dimensions, but small enough to be socially coherent.

The fact that landscapes have multiple dimensions suggest that iterative, complex processes and interactions take place within a given landscape unit (see Figures 1.1, 1.2 and 1.3). Such interactions are influenced or shaped by both internal and external factors.

Figure 1.2 puts the actual landscape and the individual livelihoods it supports at the centre of the graph. It suggests that the actual landscape is a subset of the set of feasible landscape configurations in a local context, constrained by national development policy and its implementation. Three key influences on the actual versus feasible landscape are the (sense of) identity of those living in and shaping the landscape, their knowledge and understanding of the current situation and its alternatives, and the continuously changing perspectives on opportunities to link in with the national economy - by people moving in and out of the landscape, by attracting public and private investment, by interacting with existing and emerging markets.

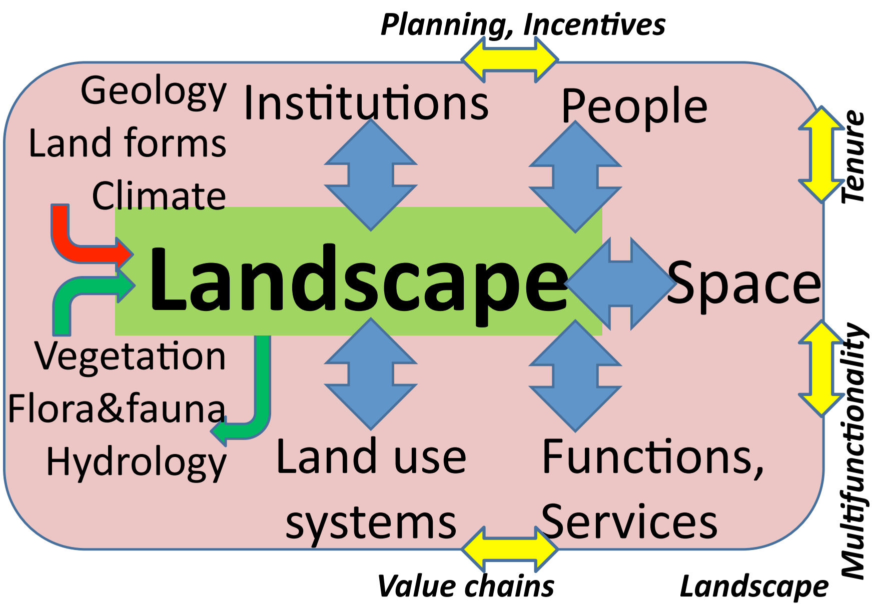


Figure 1.1 A landscape as the interaction between human actions, ecosystems and the abiotic factors that shape the physical environment.

Meanwhile the meso/macro-, micro- and pico[3]-economic dimensions of decision-making at the household level are influenced by the three basic instruments of public governance, shaping rights and rules, modifying incentives through taxes and subsidies, and influencing motivation (informally known as the 'sticks, carrots and sermons').

Figure 1.3 provides a wider context for the landscape of Figure 1.2, emphasizing that the national context interacts with a wider international set of global change dimensions that provide opportunities and constraints for national responses and development pathways.

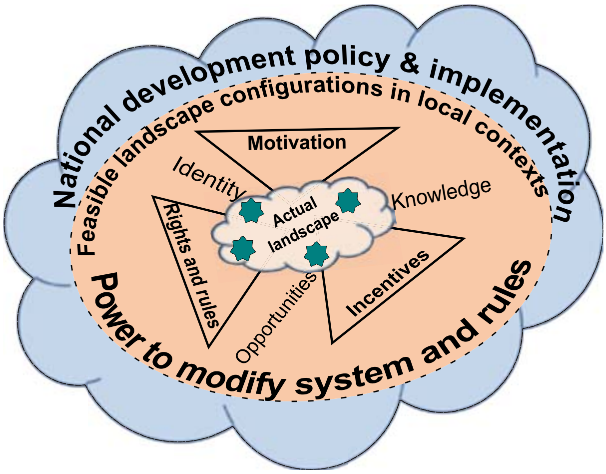


Figure 1.2 Visualization of an actual landscape as a member of a wider set of locally feasible landscape configurations, constrained by household decisions and national context.

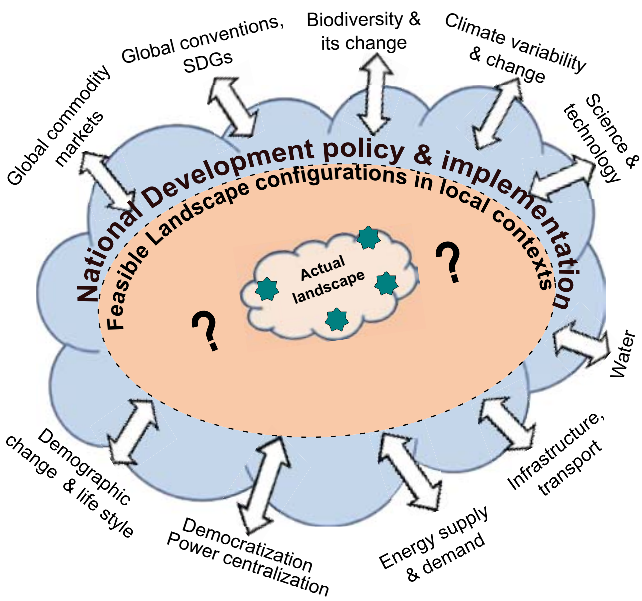


Figure 1.3 Visualization of climate change as part of the wider set of interacting global change influences and drivers of change at the landscape scale, modified by national development policy and its implementation.

Climate change is one of many such dimensions, and the current interest in the climate change community in 'landscape approaches' implies interactions, through the landscape system scale, with a wider agenda based on the sustainable development goals (SDGs), biodiversity, global trade, demographic change, global commodity markets, energy supply and demand, as well as water shortage due to increased demand, even without factoring in climate change.

2.2 The landscape approach

The term 'landscape approach' has been applied in many different contexts, often encompassing and representing different theories, ideas and processes. In this book, landscape approaches refer to a set of concepts, tools, methods and approaches deployed in landscapes in a bid to achieve multiple economic, social, environmental objectives (multifuntionality) through processes that recognize, reconcile and synergize interests, attitudes and actions of multiple actors. Therefore landscape approaches usually involve some form of multi-stakeholder processes.

As the approach may be defined by its process, rather than a well-defined end product, Sayer et al. (2013) has outlined a set of ten principles for landscape approaches adopted by the CBD. The ten principles include: continued learning and adaptation, common concern entry point, multiple scales, multifunctionality, multiple stakeholders, negotiated and transparent change logic, clarification of rights and responsibilities, participatory and user friendly monitoring, resilience, and strengthened stakeholder capacity. These principles are further discussed in many parts of the book.

In unpacking the term 'landscape approach' we may note that the term 'approach' suggests movement in the direction of, without necessarily getting there. For insiders, it may imply that the landscape is a target not yet reached, while for outsiders, who try to get closer to what is already a landscape, something that does not fully reflect their perception. In the way the term 'landscape approach' is often used, it indeed refers to a view from a given starting point (current state), benefitting from the distance that allows to see a bigger picture, and to consider alternative configurations of interests, goals and land use actions within a given space (the landscape), that might be better in achieving multiple bottom lines (i.e., a common desired multifunctional state). This distance demonstrates the benefits of using the landscape scale; it is where the local meets the global, accounting for both individual units within the landscape (both social and biophysical) and the emergent patterns and processes.

Still in taking a landscape approach there will usually need to be a set of enabling factors that will be partly context dependent. The concepts, incentives, methods and tools in a landscape approach will thus vary by context. Sayer et al. (2008) noted that in environments where institutions are strong, and where plenty of knowledge and ability to enforce agreements exist, a landscape approach to reconciling functions could rely on optimization algorithms used by experts who understand the agricultural production potential, conservation values and other needs. In developing countries where institutions are weak (e.g., where there is unclear or poorly enforced land tenure arrangements/laws) and relatively poor knowledge and weak enforcement capacity, a landscape approach will largely rely on "building constituencies, negotiating deals and muddling through" (Sayer et al., 2008). Sectoral and sometimes disparate objectives are encountered at the institutional level in landscapes. Land use sectors, such as agriculture, forestry, biofuel (energy) and other interests are often seen to be competing and conflicting. Dealing with such 'wicked' challenges often requires an inter-sectoral perspective and moving beyond decision-support to negotiation-support approaches within landscapes. Therefore landscape approaches represent a continuum of application, which can include weak-to-strong combinations of institutions, knowledge and enforcement capacity. Most places in the world would fall at some point along a continuum rather than be black or white situations.

3. Multiple starting points to approach a common destination

3.1 Diverse starting points

Landscape approaches can be interpreted as a journey with a given starting point depending on where you are (the current state of a given place in terms of functions and diverse interactions) moving towards a desired state (common desired multifunctionality). While you might have diverse starting points, the destination of sustainable multifunctional landscapes is a common destination. Figure 1.4 describes multiple possible starting points for a landscape approach that may converge if the multiple objectives can be reconciled and operational modalities allow for synergy.

3.2 Multifunctionality: the common desired destination

Many other integrated initiatives (e.g., Integrated Conservation Development Programmes (ICDP), integrated watershed management, climate-smart agriculture), are often framed in terms of sustainable land management in which there are synergies between multiple social, economic and environmental objectives (Angelstam et al., 2013*a*; Sayer et al., 2013). Therefore, regardless of the starting point, integrated approaches are essentially about achieving optimal potential for social, economic and environmental functions (i.e., sustainable multifunctional landscapes). Yet the actual application of such approaches in practice, have overall remained a significant challenge.

The articulation of an essential set of multiple ecosystem functions by the Millennium Ecosystem Assessment (MEA, 2005) (regulating, supporting, provisioning and cultural) could represent one way of looking at multifunctionality. The number of functions or sustainable development objectives targeted and/or prioritized is likely to vary by context as deemed relevant by actors. In this process tradeoffs will have to be made among functions.

Verchot et al. (2007) use the term 'sustainagility', implying not only the 'persistence' and 'resilience' of current systems as in sustainability, but the ability of such landscapes and its actors to self-adapt to future changes (e.g., climate). Sustainagility (shorthand for sustaining agility) is directly linked to maintaining and enhancing the resource base for future change, complementing and facilitating human adaptive capacity. The process of promoting climate-smart multifunctional landscapes is then also part of a process of creating climate-resilient pathways by promoting sustainagility.

3.3 Why climate-smart landscapes as a starting point for this book?

While 'climate-smart agriculture' is a term that is starting to be more widely used, 'climate-smart landscapes' are still fairly new with limited literature focusing specifically on this concept. Climate-smart landscapes can be defined as landscape actions and processes

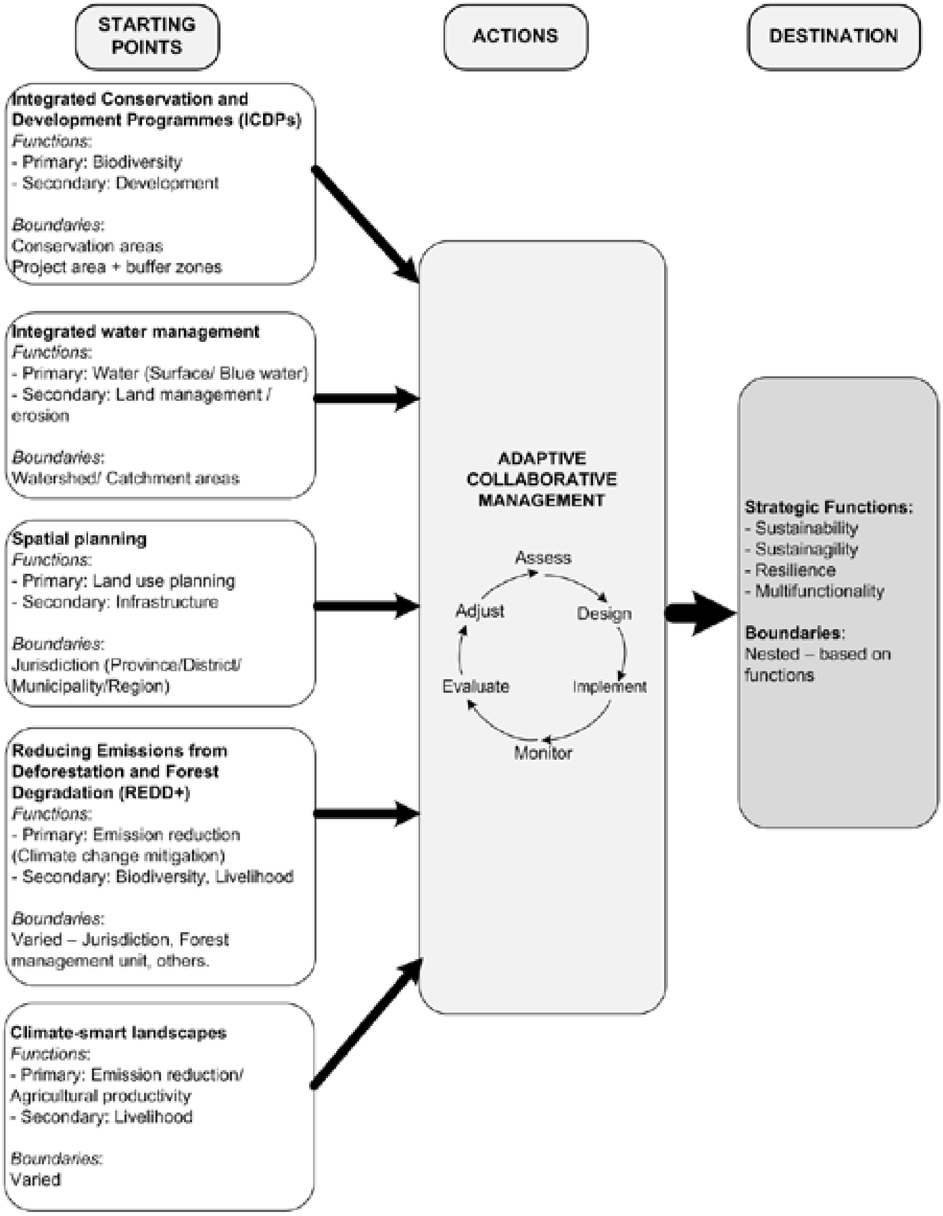


Figure 1.4 Examples of the multiple starting points for landscape approaches, that may have a common destination and all use an adaptive collaborative management learning loop approach.

that seek to integrate climate change mitigation and adaptation alongside multiple social, economic and environmental objectives (Harvey et al., 2013). Scherr et al. (2012) identify three features of climate-smart landscapes: 1) climate-smart practices at the field and farm scale, 2) diversity of land use across the landscape to provide resilience, and 3) management of land use interactions to achieve desired social, economic and ecological impacts.

Climate-smart landscapes were chosen as a starting point for this book for two main reasons. Firstly, that current climate change frameworks at the global level are providing unprecedented policy and financial support for landscape approaches, and secondly, that this support has provided a strong and growing portfolio of initiatives globally that urgently need support and guidance for implementation if they are to make a contribution to sustainability (DeFries & Rosenzweig, 2010; LPFN, 2012; Bernard et al., 2013).

Although the CBD has been most explicit in its support for ecosystems approaches, which have frequently been linked to or described as landscape approaches, its impact has been far less effective in triggering action compared to the UNFCCC. Reducing Emissions from Deforestation and forest Degradation (REDD+) and climate-smart agriculture are among growing initiatives that have emerged within the context of the UNFCCC. More than 70 countries worldwide are engaged in some form of REDD+ activity, with more than USD 7.2 billion pledged for REDD+ since 2008 (Creed & Nakooda, 2011). As integrated landscape approaches are needed for managing within complexity to address wicked problems, and climate change remains a significant wicked problem currently facing the world, application of climate-smart landscape approaches hold great potential to promote climate-resilient pathways, sustainagility and hence sustainable futures. This book therefore provides theories, tools, methods and lessons learned to assist in operationalizing climate-smart landscapes in practice, as an important dimension of multifunctional landscapes.

4. Guiding concepts for landscape approaches

This section briefly introduces a number of useful and recurrent underpinning concepts for landscape approaches that will be encountered throughout this book.

4.1 Systems thinking and positive and negative feedback loops

Landscapes can be fruitfully seen as coupled socio-ecological systems (Walker & Abel, 2002; Berkes & Folke, 2002). One example of a representation of socio-ecological systems is given by Ostrom (2009). She describes four core systems namely, resource systems (e.g., designated protected area with forests, wildlife and water systems), resource units (e.g., trees, shrubs, plants in forests, types of wildlife), users (e.g., individuals who use the park in multiple ways), and governance systems (e.g., institutions for management and rules). These four sub-systems are interacting with each other and are linked to political, social and economic settings as well as other related systems.

Feedback loops and non-linear dynamics are important pieces in the interactions between components and therefore can constitute important points for leveraging change in landscapes (Gunderson & Holling, 2002).

4.2 Leveraging, planning and emergence

A major dilemma in landscape approaches relates to how best to bring change needed to attain the desired state of a landscape. How much of a landscape can be fully designed, how much of landscape systems emerge from interactions and self-organization of system components and how much can be realistically expected from leveraging and strengthened feedback loops? Designing and re-designing landscapes comes from the planning perspective where sustainability and sustainagility, in a dynamic perspective of continued change, are the main objectives (Gallopin, 2002). While planning has a strong role to play, it is most helpful in places where governance, enforcement and implementation are strong (Sayer et al., 2008; Rudel & Meyfroidt, 2014). However, the main thrust of planning processes should be to foster negotiations towards common agreed objectives and actions towards sustainability.

With landscape systems being dynamic, some have underscored the role of leveraging as an important part of systems management (Meadows, 1999). Leveraging landscape systems would involve identifying leverage points and taking action to impact on system functioning and performance. Leverage points represent places in a complex system wherein a small change can generate bigger changes in the entire system. The paradigm/mindset out of which a system is developed, power distribution, the rules of the system (e.g., incentives, punishments), and information and material flow nodes are given as examples of leverage points that could be targeted (Meadows, 1999). Understanding the drivers of change in the system, changes in system inputs and/or processes are important. In essence, therefore, some degree of leveraging alongside planning and emergence from interactions are needed as main ingredients for successful landscape approaches.

4.3 Buffering

Where exposure to external sources of variability, in terms of weather, pest and disease outbreaks, economic supply-demand cycles, political context and social pressures, system properties that reduce exposure by buffering are crucially important for human wellbeing (van Noordwijk et al., 2011). Buffering across these different aspects and disciplinary traditions can be defined on the basis of reduction of variance between the outside and inside of a buffer. Buffers tend to have a limited absorption capacity, and their functionality can breakdown upon overexposure, leading to a sudden increase in human vulnerability. A key aspect of a landscape approach is to identify which environmental and social subsystems provide buffering, how buffering functions can be enhanced, and how loss of buffering can be avoided (van Noordwijk et al., 2013). Global change tends to be associated with loss of 'inefficient' and 'redundant' buffering and diversity, at a time that actually an increase in buffering is needed.

4.4 Multi-stakeholder governance

In the socio/human sub-systems in the landscape, players or stakeholders are key elements of the system and therefore need to be fully involved with planning, decision-making and incentives. These players have different, and often divergent interests, un-equal power distribution, and uneven resources at their disposal and therefore will impact landscape inputs, processes and outcomes differently and vice versa. Landscape processes are therefore expected to be multi-stakeholder processes that take into account heterogeneity in perspectives and in functions. But these interests may also mean that all players have to be watched in terms of compliance as free-ridership is often a challenge at the individual level.

4.5 Collaborative learning and action

A key feature of landscape approaches is active learning. Active learning takes place through actors that manage and make decisions in adaptive management loops that interact dynamically (Clark et al., 2011). Adaptive management has been defined as a systematic approach for improving management by learning from management outcomes. It recognizes that resource management in landscapes is dynamic, uncertain and complex, hence continued learning, reflection and adjustments are essential elements for success.

The process typically involves, assessing the problems, considering alternatives, predicting outcomes based on current knowledge, implementing alternatives, gaining new knowledge and using the new knowledge to adjust objectives and options (Holling, 1978; Lee, 1999).

Wicked development challenges being dealt with in landscapes often demand multi-disciplinary and multi-sectoral actions. Hence, only a collaborative approach that enables the joint generation of knowledge, learning and renewal can enable proper analysis, planning, decision-making and/or negotiations and actions (Gunderson et al., 2002). Angelstam et al. (2013*b*) suggest seven steps for collaborative knowledge generation and learning including: identify the landscape; study landscape history; map stakeholders use and non-use values, products and land use; analyse institutions, policies and governance systems; measure ecological, economic, social and cultural sustainability; asses sustainability dimensions and governance; and lastly, comparisons and synthesis.

4.6 Tradeoffs and synergies

Every landscape approach will have multiple and conflicting objectives – for example, conservation versus competing agriculture, emission reductions, biofuel production and many more. It is therefore important to understand the tradeoffs in reconciling these objectives in landscape implementation processes. Understanding opportunity costs of various land use options, their ecological productivity thresholds and their overall impacts are good examples of tradeoff considerations needed for decision-making or negotiations.

Even more important is the need to deliberately consider opportunities for synergies between these objectives in order to enhance efficiencies. Synergies relate to efficiency from a value addition (i.e., additive synergy) and/or reduced costs perspectives (i.e., non-additive synergy) (von Eye et al., 1998). Super-additive synergy has the essence "the whole is greater than the sum of the parts" (Corning, 1998; von Eye et al., 1998). In sub-additive synergy, the combined individual effects of the intervention is less than the effect obtained when the interventions act together. This form of synergy is useful when the main purpose of seeking synergy is to reduce costs or risks to the system (Duguma et al., 2014) (i.e., the combined cost of the individual interventions is often less when they are implemented together) (Tanriverdi, 2006).

5. In this book

This book is focused on four central propositions on climate-smart landscape approaches:

A. Current landscapes are a suboptimal member of a set of locally feasible landscape configurations;
B. Actors and interactions can nudge landscapes towards better managed tradeoffs within the set of feasible configurations, through engagement, investment and interventions;
C. Climate is one of many boundary conditions for landscape functioning;
D. Theories of change must be built within theories of place for effective location-specific engagement.

We use the four propositions to structure the book into six main parts comprising 27 chapters, including: Introduction (Part 1); Understanding Landscapes (Part 2); From Concepts to Inducing Change (Part 3); Involving the Private Sector (Part 4); Contextualized Experience (Part 5); and Synthesis and Conclusions (Part 6).

Understanding Landscapes (Part 2)

This part deals with Proposition A ("landscapes are meaningful units of analysis and for catalyzing change"; "the actual landscape is likely to be sub-optimal") and makes a start with Proposition B ("landscape approaches can have effect"; "they interact with complex socio-ecological systems, with internal and external feedbacks"). It is about concepts and frameworks that deepen understanding of landscapes as interactive socio-ecological systems. It opens up with a chapter exploring general features of landscapes (Chapter 2). A set of five chapters follow reviewing a selected number of conceptual framework examples applied to landscapes in the past decades including, looking at multifunctionality in climate-smart landscapes (Chapter 3), the *gestion de terroirs* concept (Chapter 4), socio-ecological systems (Chapter 5), climate smart territories (Chapter 6), and integrated landscape initiatives (Chapter 7). The section closes with a futuristic and policy-based perspective on how landscapes approaches connect with global level agenda's such as the SDGs and Future Earth (Chapter 8).

From Concepts to Inducing Change (Part 3)

Part 3 of the book deals with Proposition B ("landscape approaches can have effect"; "they interact with complex socio-ecological systems, with internal & external feedbacks") and Proposition C ("climate is a boundary condition for landscape functioning"). It ushers in a set of tools, methods and practices for analysing and facilitating change in landscapes for improved effectiveness, efficiency and equity. It begins with a chapter on scale considerations in landscape approaches (Chapter 9) and is followed by Chapter 10 which addresses the use of leverage points and levers in landscape restoration. Chapters 11, 12, 13 and 14 focus on land-care strategies, landscape attributes for supporting sustainable intensification, water-focused landscapes, and a landscape approach based around charcoal production for implementing landscape multifunctionality, respectively. Another set of three chapters focus on tools for analysing and understanding very specific landscape dimensions including varied modelling tools for gender-specific visioning (Chapter 15), opportunity cost analysis in the context of emission reductions (Chapter 16), and negotiation support tools for reaching common desired sustainable multifunctional goals (Chapter 17). The last chapter in this section addresses institutional pathways for reaching sustainable landscape objectives (Chapter 18).

Involving the Private Sector (Part 4)

In this part, Propositions B and C are further enriched by considering the interactions between private and public sectors in landscapes from three broad angles: investment (Chapter 19), value-chains (Chapter 20), and motivation (Chapter 21). All three chapters provide rich examples of private sector engagement in landscapes highlighting an area where this is a lot of potential for growth.

Contextualized Experience (Part 5)

This section addresses Proposition D ("interacting theories of place and change in landscapes") by presenting specific examples of 'what works' and/or does not work in various locations. Case studies unravel multiple dimensions of the issues discussed in preceding book sections under different contexts. The stories come largely from around Africa and demonstrate evolving and diverse situations. Chapter 22 dwells on an experience of operationalizing climate-smart agriculture in a landscape in western Kenya. Chapters 23 and 24 relay two experiences from Cameroon on how community forestry landscapes changed as a result of changes in institutional dynamics and how sustainable intensification can change cocoa dominated landscapes, respectively. And lastly in this section, Chapter 25 looks at potential of emission reduction programmes in the Democratic Republic of Congo.

Synthesis and Conclusions (Part 6)

In this final section, the first (Chapter 26) revisits the four propositions focusing especially the way theories of place and theories of change interact (Proposition D). The second, (Chapter 27) articulates a systems improvement and landscape democracy-based framework for enhancing effectiveness, efficiency and equity in landscape approaches with specific attention on the challenges ahead.

Endnotes

1 See Landscapes for People, Food and Nature (LPFN) initiative http://peoplefoodandnature.org/

2 According to the Millennium Ecosystem Assessment (2005), there are four main categories of ecosystem services: 1) provisioning (e.g., of resources and livelihood needs such as food, fuel and fibre), 2) regulating (e.g., basic ecological and natural processes such a climate), 3) cultural services (e.g., life fulfilling and development opportunities such as ecological-based education), and 4) supporting (e.g., regeneration of resources directly used).

3 Pico-economics or behavioural economics reflects the complement to micro-economic rationality in the way people make choices (van Noordwijk et al., 2012).

References

Alexandratos, N., & Bruinsma, J. (2012). *World agriculture towards 2030/2050: the 2012 revision,* 12-03. Rome, FAO: ESA Working paper.

Angelstam, P., Grodzynskyi, M., Andersson, K., Axelsson, R., Elbakidze, M., Khoroshev, A., ... Naumov, V. (2013*a*). Measurement, collaborative learning and research for sustainable use of ecosystem services: Landscape concepts and Europe as laboratory. *Ambio, 42*(2), 129-145.

Angelstam, P., Elbakidze, M., Axelsson, R., Dixelius, M., & Törnblom, J. (2013*b*). Knowledge production and learning for sustainable landscapes: Seven steps using social–ecological systems as laboratories. *Ambio, 42*(2), 116-128.

Balint, P. J., Stewart, R. E., Desai, A., & Walters, L. C. (2011). *Wicked environmental problems: managing uncertainty and conflict*. Washington DC (USA): Island Press

Berkes, F., & Folke, C. (2002). Back to the future: ecosystem dynamics and local knowledge. In Gunderson, L. H. & Holling, C. S. (Eds.) *Panarchy: Understanding transformations in human and natural systems,* 121-146. Washington DC, USA: Island Press.

Bernard, F., Minang, P. A., van Noordwijk, M., Freeman, O. E., & Duguma, L. A. (2013). *Towards a landscape approach for reducing emissions: substantive report of Reducing Emissions from All Land Uses (REALU) project.* Nairobi, Kenya: World Agroforestry Centre (ICRAF).

Clark, W. C., Tomich, T. P., van Noordwijk, M., Guston, D., Catacutan, D., Dickson, N. M., & McNie, E. (2011). Boundary work for sustainable development: Natural resource management at the Consultative Group on International Agricultural Research (CGIAR). *Proceedings of the National Academy of Sciences,* 200900231. doi: 10.1073/pnas.0900231108

Corning, P. A. (1998). “The synergism hypothesis”: On the concept of synergy and its role in the evolution of complex systems. *Journal of Social and Evolutionary Systems, 21*(2), 133-172.

Creed, A., & Nakhooda, S. (2011). *REDD+ finance delivery: Lessons from early experience (Carbon Finance Policy BriefSeries)*. London: Overseas Development Institute (ODI)/ Washington, DC: Henrich Boll Stiftung.

DeFries, R., & Rosenzweig, C. (2010.) Towards a whole-landscape approach for sustainable land use in the humid tropics. *Proceedings of the National Academy of Sciences,* 107, 19627- 19632.

Duguma, L. A., Minang, P. A., & van Noordwijk, M. (2014). Climate Change Mitigation and Adaptation in the Land Use Sector: From Complementarity to Synergy. *Environmental management, 54*(3), 420-432.

FAO (Food and Agriculture Organization of the United Nations). (2009). *Harvesting Agriculture’s Multiple Benefits: Mitigation, Adaptation, Development and Food Security: Policy Brief.* Rome: FAO.

Frost, P., Campbell, B., Medina, G., & Usongo, L. (2006). Landscape-scale approaches for integrated natural resource management in tropical forest landscapes. *Ecology and Society, 11*(2), 30. Retrieved from http://www.ecologyandsociety.org/vol11/iss2/art30/

Gallopin, G. G. (2002) Planning for resilience scenarios, surprises and branch points. In Gunderson, L.H. & Holling, C.S. (Eds.) *Panarchy. Understanding transformations in human and natural systems*, 361 – 394. Washington, DC: Island Press.

Geist, H. J., & Lambin, E. F. (2002). Proximate Causes and Underlying Driving Forces of Tropical Deforestation: Tropical forests are disappearing as the result of many pressures, both local and regional, acting in various combinations in different geographical locations. *BioScience, 52*(2), 143–150.

Global Biodiversity Outlook. (2010). *Global Biodiversity Outlook 3*. Retrieved from http://gbo3.cbd.int/

Gunderson, L . H., & Holling, C. S. (2002) *Panarchy. Understanding transformations in human and natural systems.* Washington DC: Island Press.

Gunderson, L. H., Holling, C. S., & Peterson, G. D. (2002). Surprises and sustainability: cycles of renewal in the Everglades. In *Panarchy: understanding transformations in human and natural systems*, 315-332. Washington, DC: Island Press.

Harvey, C. A., Chacón, M., Donatti, C. I., Garen, E., Hannah, L., Andrade, A., ... Wollenberg, E. (2013). Climate-Smart Landscapes: Opportunities and Challenges for Integrating Adaptation and Mitigation in Tropical Agriculture. *Conservation Letters, 7*(2), 77-90.

Holling, C. S. (Ed.). (1978). *Adaptive Environmental Assessment and Management*. New York: John Wiley & Sons.

Hosonuma, N., Herold, M., De Sy, V., De Fries, R. S., Brockhaus, M., Verchot, L., ... Romijn, E. (2012). An assessment of deforestation and forest degradation drivers in developing countries. *Environmental Research Letters, 7*(4), 044009.

LPFN (Landscapes for People, Food and Nature Initiative) (2012). *Landscapes for people, food and nature: The vision, the evidence and next steps.* Washington, DC: EcoAgriculture Partners.

Lee, K. N. (1999). Appraising adaptive management. *Conservation Ecology, 3*(2), 3.

Meadows, D. H. (1999) *Leverage points: places to intervene in a system.* Hartland, VT USA: The Sustainability Institute.

Meinig, D. W. (1979). The beholding eye: Ten versions of the same scene. *The interpretation of ordinary landscapes: Geographical essays*, 33-48.

MEA (Millennium Ecosystem Assessment). (2005). *Ecosystems and human well-being: Synthesis*. Washington, DC: Island Press.

Ostrom, E. (2009). A general framework for analyzing sustainability of socio-ecological systems. *Science*, 325, 419 – 422.

Palm, C. A., Vostu, S. A., Sanchez, P. A., & Ericksen, P. J. (2005). *Slash and Burn. The search for alternatives,* 41-63. New York: Columbia University Press.

Rittel, H. W., & Webber, M. M. (1984). Planning problems are wicked. In Cross, N. (Ed.) *Developments in Design Methodology*, 135-144. New York, USA: John Wiley and Sons Inc.

Rittel, H. W., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy sciences, 4*(2), 155-169.

Rudel, T., & Meyfroidt, P. (2014). The food security-biodiversity-climate crisis and the genesis of rural land use planning in the developing world. *Land Use Policy*, 36, 329 – 247.

Sayer, J., Buck, L., & Dudley, N. (2008). *What is a landscape approach? Learning from landscapes, arborvitae special issue.* Gland, Switzerland: IUCN. Retrieved from http://www.iucn.org/about/work/programmes/forest/?1544/arborvitae-special-issue-Learning-from-Landscapes

Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J. L., Sheil, D., Meijaard, E., ... Buck, L. E. (2013). Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. *Proceedings of the National Academy of Sciences, 110*(21), 8349-8356.

Scherr, S., Shames, S., & Friedman, R. (2012). From climate-smart agriculture to climate smart landscapes. *Agriculture and Food Security*, 1, 12.

Tanriverdi, H. (2006). Performance effects of information technology synergies in multibusiness firms. *MIS Quarterly*, 57-77.

van Noordwijk, M., Hoang, M. H., Neufeldt, H., Öborn, I., & Yatich, T. (Eds). (2011). *How trees and people can co-adapt to climate change: reducing vulnerability through multifunctional agroforestry landscapes*. Nairobi: World Agroforestry Centre (ICRAF).

van Noordwijk, M., Leimona, B., Jindal, R., Villamor, G. B., Vardhan, M., Namirembe, S., ... Tomich, T. P. (2012). Payments for environmental services: evolution toward efficient and fair incentives for multifunctional landscapes. *Annual Review of Environment and Resources*, 37, 389-420.

van Noordwijk, M., Lusiana, B., Leimona, B., Dewi, S., & Wulandari, D. (Eds.) (2013). *Negotiation-support toolkit for learning landscapes*. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Verchot, L. V., van Noordwijk, M., Kandji, S., Tomich, T., Ong, C., Albrecht, A., ... Palm, C. (2007). Climate change: linking adaptation and mitigation through agroforestry. *Mitigation and Adaptation Strategies for Global Change, 12*(5), 901-918.

von Eye, A., Schuster, C., & Rogers, W. M. (1998) Modelling synergy using manifest categorical variables. *International Journal of Behavioral Development, 22*(3), 537-557.

Walker, B., & Abel, N. (2002). Resilient Rangelands. Adaptation in complex systems. In Gunderson, L. H., & Holling, C. S. (Eds.) *Panarchy. Understanding transformations in human and natural systems,* 293 – 214. Washington DC: Island Press.

Weber, E. P., & Khademian, A. M. (2008). Wicked problems, knowledge challenges, and collaborative capacity builders in network settings. *Public Administration Review, 68*(2), 334–349.

WWF (World Wildlife Fund). (2002). *The Landscape Approach: a position paper*. Bern, Switzerland: World Wildlife Fund.

Zonneveld, I. S. (1989). The Land unit - a fundamental concept in landscape ecology, and its applications. *Landscape Ecology*, 3, 67-86.

PART 2

Understanding Landscapes

Landscape of Mount Halimun Salak National Park, West Java, Indonesia, shows a nearly perfect mosaic of cropland (irrigated rice), plantation crop (tea, in the foreground), forest, an agroforestry garden, a fish pond, clear water and dwellings. Photo credit: CIFOR Aulia Erlangga 2010

CHAPTER

2

Whither landscapes? Compiling requirements of the landscape approach

Emmanuel Torquebiau

Highlights

- Thinking at the landscape scale does not simply mean thinking over wider areas but mainly thinking in terms of heterogeneity
- For a heterogeneous landscape to function, linkages and interactions should exist between landscape units, leading to functional heterogeneity
- Different land-uses mean different functions, leading to the concept of landscape multifunctionality, or multipurpose landscapes
- Multifunctional mosaic landscapes offer better synergy between mitigation of climate change and adaptation to climate change than homogenous land areas
- Multifunctional landscapes promote effective forms of collective action and vice versa
- Simple methods for assessing the performance of multifunctional landscapes are required

1. Introduction

"An area of land that has a particular quality or appearance". "An expanse of scenery that can be seen in a single view". If we go by these common definitions of what is a landscape, we probably do not need to spend time writing erudite books about 'climate-smart landscapes'. Landscapes as defined above are all over the place. Just raise your eyes so that you see (possibly in a single view) the land which is in front of you, and if this land has a particular feature, e.g., it is beautiful or ugly, empty or full, uniform or diverse, green or red, call it landscape x, y or z, and voilà. The only thing that is implicit in the definition is that you ought to see 'an area of land', an 'expanse', i.e., a land which is large enough to… well, large enough to what? Difficult to say. Let's try a default description: an area of land which is not constrained by a physical barrier visible at close distance so that you would not see 'a large area of land', but 'a small piece of land'. Probably not a very conclusive definition. Yet it intuitively carries an element of size, an essential attribute of what is called landscape in common parlance: a landscape cannot be something small, like your garden or this insignificant field in front of you. It has to reach beyond.

However, if size were the only attribute to think about, the word landscape would have probably not reached the prominence it has today in the agriculture and forestry research circles under the somehow cryptic expression 'landscape approach'. To name but a few, the World Agroforestry Centre (ICRAF) has introduced the word landscape in its logo for a few years ("Transforming lives and landscapes"), and the Center for International Forestry Research (CIFOR), is now championing an approach were forestry and agriculture work together in landscapes. This includes the recent launch of a worldwide internet survey called t20q, for "Top 20 questions for forestry and landscapes"[1]. The Forest Day and the Agriculture and Rural Development Day, two important annual conferences organized under the auspices of the United Nations Framework Convention on Climate Change (UNFCCC), have been merged since Warsaw's COP 19 in 2013 into a single conference called "The Global Landscapes Forum"[2]. This forum advocates landscapes "for a new climate and development agenda", implicitly giving landscapes a key role in climate science and policy. The "Landscape for People, Food and Nature" (LPFN) initiative and Ecoagriculture Partners[3] have been able to attract large numbers of attendees at several international meetings and have abundantly published on the compatibility between agriculture and biodiversity at the landscape level (e.g., Scherr & McNeely, 2008; Milder et al., 2014). A search with the key-word 'landscape' in recent years' issues of major agronomy and forestry research journals regularly yields a high number of references.

Ten principles for a landscape approach, proposed by Sayer et al. (2013), have been adopted by the Subsidiary Body on Scientific, Technical and Technological Advice of the Convention on Biological Diversity (CBD), and submitted to the Conference of the Parties of the CBD in November 2012. These principles insist on the integration between agriculture and environmental priorities and are intended to "support implementation of the landscape approach" so that multiple stakeholders can negotiate effectively at the landscape level. The landscape approach is also gaining recognition for addressing climate change issues in a novel manner, by promoting synergies between climate change adaptation, mitigation, and/or other management objectives such as improving livelihoods.

Termed 'climate-smart landscapes' (Harvey et al., 2014), such approaches can draw on 'climate-smart agriculture' principles (see FAO, 2013) for achieving goals related to food security, adaptation and mitigation at the landscape scale. So what is it that makes the 'landscape approach' so unique? And more importantly, why has it become a catchphrase of the climate change research community?

While the ten principles for a landscape approach, quoted in Sayer et al. (2013), are mainly designed to assist for landscape management, this chapter tries to compile the characteristics of 'desired landscapes'. These characteristics can be seen as the basic 'requirements' of the landscape approach. They are discussed in terms of systems thinking, i.e., structure and function, namely the components of a system and the interactions between system components. This methodological choice leads to identifying elements constitutive of landscapes on the one hand and describing processes acting at the landscape level on the other hand. It also leads to the selection of a set of variables (presented below as 'highlights' of the landscape approach, for lack of a better word) which refer to either structure (i.e., components of the landscape) or function (i.e., interactions between those components) and hence may ignore variables which may be considered important in other landscape analyses (e.g., it does not address complexity or non-linear dynamics and does not delve into social dynamics).

2. Highlights of the landscape approach

2.1 Landscape aesthetics vs function

In the 'land-use sector' sciences (e.g., agriculture, forestry, natural areas), the word landscape is not used with any aesthetical consideration such as 'a magnificent landscape'. This should be stated right in front because in arts (painting) and everyday language, the word landscape is often used with an aesthetical meaning, even if the English language has 'scenery' as an alternative word. Some languages do not even have these two words and the aesthetic dimension of the word is the most common one, ignoring the functional dimension (e.g., French 'paysage'). Landscapes discussed by land-use debates are not necessarily beautiful (although they may be, of course!). The reason why they are research objects is the fact that they carry a function, i.e., they convey a meaning of cause-effect relationship on the land. This relationship can take many different forms, like when a given practice (e.g., farming) has led to the transformation of the land or if a natural phenomenon (e.g., ecological succession) modifies vegetation. A main criterion is often the fact that the resulting 'land area' is not uniform. Typically, if we stand in front of one of these large maize fields of industrial agriculture, we'll probably say: "it's a maize field". However, if we see a small valley, the same size as the huge maize field, but with different land uses neighbouring each other, we'll probably say: "it's a landscape" (e.g., see Figure 2.1), even if it has an ugly factory or a polluted lake in the middle.

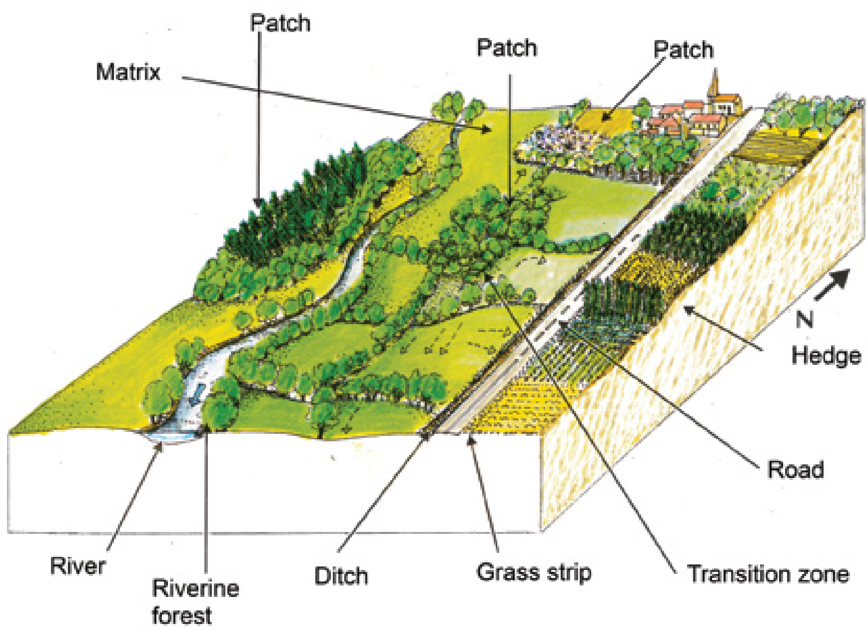


Figure 2.1 Spatial structure of an agricultural landscape (from Fischesser & Dupuis-Tate, 1996).

2.2 Landscape scale and heterogeneity

Thinking at the landscape scale does not simply mean thinking over wider areas (which is what most people think), but mainly thinking in terms of heterogeneity of land characteristics. This is the very essence of the science of landscape ecology, which is *de facto* the ecology of land heterogeneity and has strongly contributed to the emergence of the landscape approach in land-use related sciences (Wu & Hobbs, 2002). This structural heterogeneity feature of landscapes has two major consequences. The first one is that 'areas of land' considered under the landscape approach are composite, i.e., they are made of identifiable, different units (or 'patches') which often exist within a 'matrix' (e.g., see Cunningham et al., 2002). The term 'mosaic' is often used to convey this idea. Under this assumption, the terms 'agricultural landscape' or 'forestry landscape' are virtually contradictory in landscapes where both type of land uses exist. For this forest in front of me to be a 'forestry landscape' it would need to have several forest types side by side and visible at once. But if I see a mixture of agriculture and forest, or fields separated by tree hedges, the landscape mosaic becomes obvious. For example, when the Central Africa Regional Program for the Environment organized its programmes around 12 priority landscapes[4], it described working in different forest types and did not imply working under a 'landscape approach' as discussed here. Similarly, CIFOR's "Sentinel Landscapes"[5] are "geographic areas or set of areas bound by a common issue, in which a broad range of biophysical, social, economic and political data are monitored, collected with consistent methods and interpreted over the long term". Nothing here refers to a cause-effect relationship (i.e., function) leading to patches (i.e., structure) within a mosaic, although other works by CIFOR do use the mosaic principle, including through visuals[6].

The second consequence of the heterogeneity feature of landscapes lies in the nurturing of biodiversity. The more structural diversity, the more habitats for different flora and fauna and the more resilience of the area in front of perturbations, such as climate change (Tscharntke et al., 2005). Structural heterogeneity in turn leads to functional heterogeneity, e.g., competition or symbiosis between species, vegetation dynamics, predation by animals or pests, also named 'landscape interactions' (see next section). The list of different land-use units which can support biodiversity and agrobiodiversity in a heterogeneous landscape is virtually endless, e.g., fields, forests, woodlots, tree plantations, fallows, field borders, riparian areas, shelterbelts, grazing land, wetlands, rivers, ponds, reservoirs, constructions, dwellings and associated land, gardens, heritage sites, protected areas, natural (non-protected) areas, etc. Within a given land-use type, there can also be structural or functional differences such as different crops, presence or absence of a tree layer or a cover crop, different planting dates, etc. Structural heterogeneity can also be managed in a temporal fashion, with different crops in different years or seasons, fallows, relay planting, rotational harvesting in forests, etc. This heterogeneity feature of landscapes also leads to additional benefits such as diverse livelihoods or development outcomes and a range of products or potential enterprises.

2.3 Landscape interactions

For a heterogeneous landscape to function, linkages and interactions should exist between landscape units, leading to functional heterogeneity. Without these interactions, there is no landscape approach. There are simply contiguous areas, or large areas as opposed to small areas. These linkages and interactions have been widely studied by landscape ecologists through a series of landscape units' categories (see Figure 2.2). Common parameters used by landscape ecologists are spatial diversity (different units), heterogeneity and mosaic (organization of spatial units), complexity (number and type of interactions between spatial units) and connectivity (relations between units) (Burel & Baudry, 1999). As far back as 1947, the British plant ecologist A.S. Watt described patterns in vegetation in terms of 'patch dynamics' showing mosaics of patches at different successional stages (Watt, 1947). This linking of pattern, process and scale has since then become an important approach in plant ecology, used for example, to analyze the functioning of tropical rainforests in terms of ecological units' dynamics (e.g., Oldeman, 1990) and widely cited in plant ecology as the 'ecology of natural disturbance' (Pickett & White, 1985). The same approach has been used to show that heterogeneity in savanna vegetation varies as a function of scale, with plant-plant interactions being the main factor at micro-scale, disturbance-related plant recruitment mechanisms important at the local scale and a shifting mosaic of patches undergoing asynchronous transitions between grassland, wooded and intermediate phases at larger spatial scales (Gillson, 2005).

Taking into account this spatial-temporal patterning of patches is essential to design landscapes which mimic 'natural' ecosystems. Although people do not make a landscape to mimic a natural one, similarity with natural processes at the landscape scale is known to lead to improved sustainability and resilience (Tscharntke et al., 2005). The analysis of patch interactions, including under human influence, helps understanding whether adjacent land-use units share resources or rather compete for the same resources, whether a given unit can experience changes and transform into another unit and whether what is happening in one unit has positive or negative consequences in another one. The study of these interactions aids decision-making, identifying how to best combine different units and where to locate them in a production-oriented landscape. Typical positive interaction examples include tree-planted units harbouring bees next to annual crops which need to be pollinated, fields of pest-resistant varieties scattered within non-resistant varieties to decrease pest spreading, a wildlife corridor (or 'stepping stones') linking isolated habitat patches across a cultivated zone (e.g., see Figure 2.3), or the push-pull agricultural pest management where companion plants are used with crops to repel and attract pests hence reducing reliance on insecticides.

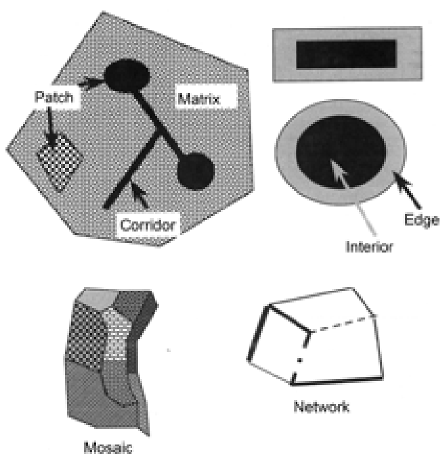
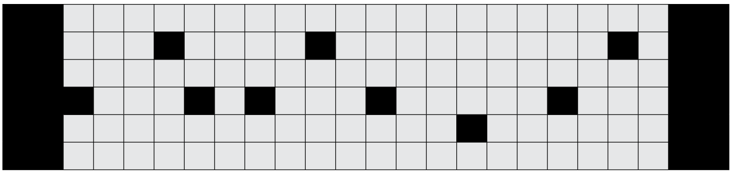


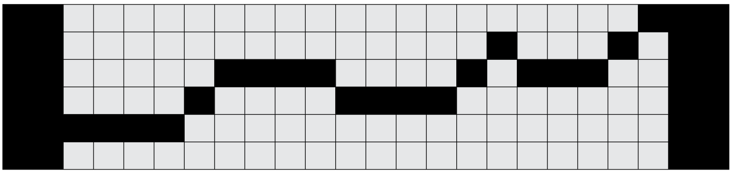
Figure 2.2 Landscape units' categories (from Burel & Baudry, 1999).

a.



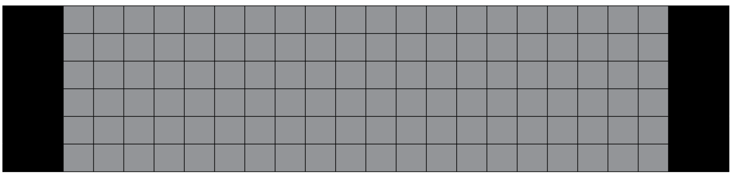
a) Stepping stones or trampolines, in which small patches of natural habitat dot the landscape. Some organisms are capable of jumping from one to the other eventually effecting a migration from one side to the other.

b.



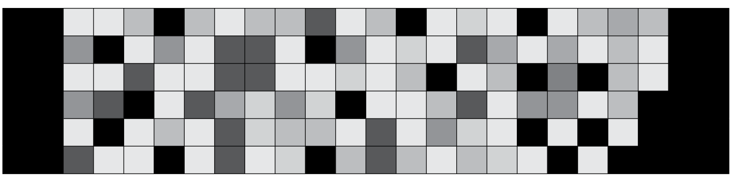
b) A classical corridor in which natural habitat patches are connected with one another to percolate seamlessly from one patch to the other.

c.



c) A uniform matrix of relatively high quality (relatively dark shading), corresponding to shaded coffee or cacao in agroforestry.

d.



d) A landscape mosaic in which different quality habitats are dispersed haphazardly throughout the matrix.

Figure 2.3 Various types of landscape matrices (from Perfecto et al., 2009) that connect forest fragments. Fragments of natural habitat are the black rectangles at the two ends of the figures. Shading indicates the quality of the habitat type: the darker the shading, the higher the quality.

Negative interaction examples comprise cases such as erosion prone tree plantation (e.g., teak) on top of a slope, the fragmentation of a wildlife area to a level where useful auxiliary fauna cannot successfully breed, or genetically modified crops planted nearby conventional crops (or wild relatives of the same species) so that crossbreeding occurs. Competition can also occur when plants or animals from neighbouring units share the same resources, e.g., tree roots from a woodlot invading a field. Such negative interactions also happen in natural environments, but may become a problem when they affect yields of cultivated species. The objective of the landscape approach should be, of course, to maximize positive interactions and minimize negative ones through the best possible arrangement of patches. It is also important that some form of integration (i.e., positive interactions) exists between components. For example, isolated fragments of natural vegetation surrounded by industrial farms may not lead to efficient biodiversity conservation (Perfecto et al., 2009).

An essential component fostering patch interaction is made of all the ecological infrastructures which maintain a 'network' (see Figure 2.1) in-between patches, such as hedges, drainage ditches, windbreaks, live fences, paths and roads, streams and rivers (and associated riparian 'forest'), isolated rocks, varied tree and shrub lines, grass strips, dikes, rock alignments, terraces and all sort of irregular topographies. Combined with the patches identified earlier, they contribute to resource flows and make the landscape mosaic an incredibly rich patchwork of habitats and microclimatic conditions, essential at the micro-scale. To 'kill' landscape heterogeneity, the fastest route is probably to use a big tractor to do away with these topographies and level the land before planting, a method often observed in industrial agriculture. As a consequence of the fact that structural heterogeneity can exist in time, ecological interactions at the landscape level also exist across temporal scales, like in a fallow having effect on the following planted crop or green manure fertilizing effects, through rotations, etc.

2.4 Multifunctionality

Different land-uses mean different functions, leading to the concept of landscape multifunctionality, or multipurpose landscapes. Typically, the first conjunction of functions which comes to mind is the combination of production (of a commodity) and protection (of the environment). The mainstreaming of biodiversity into production landscapes has become an important objective of today's 'land sharing' paradigm (Grau et al., 2013). It opposes the 'land sparing' assumption of the green revolution, which wrongly stated that by intensifying production in some areas, the rest of the land would be spared for nature conservation. This assumption is known as the 'Borlaug hypothesis' and, seeing how agricultural land is still expanding at the expanse of natural areas, it proved not to be confirmed. The landscape approach holds a totally different view and provides many examples where agricultural production and biodiversity conservation are not antagonistic thanks to the landscapes' heterogeneity features described above (Tscharntke et al., 2005). Beyond biodiversity protection itself, this protective function of multifunctional landscapes can actually be seen as a series of ecosystem services such as carbon sequestration, water conservation, soil erosion control, provision of raw materials and genetic or medicinal resources, sites of cultural value, all contributing to improved livelihoods.

The range of functions or, one could say, land objectives, that can be combined in multifunctional landscapes is wide, e.g., production and services, adaptation to - and attenuation of climate change, wood and food, subsistence and cash crops, biodiversity and commodities, ecosystem services and marketable goods, land sharing and land sparing, private vs public land, etc. Landscapes also allow for the concerted management of some public goods such as water or biodiversity. Communal infrastructures are relevant at this scale too, e.g., irrigation canals serving neighbouring farmers, locally managed conservation areas and communal gardens among private plots.

2.5 Landscape-level synergy between mitigation of climate change and adaptation to climate change

Climate change can also be addressed at the landscape level. While the last assessment from Intergovernmental Panel on Climate Change (IPCC)'s working group 3 on mitigation (IPCC, 2014) has shown that the land use sector (agriculture, forestry and other land uses, or AFOLU) accounts for nearly one quarter of all greenhouse gases emissions, it is striking to see that, beyond the classical rhetoric around reforestation programmes, little is being done in the land-use sector to curb emission rates. Most climate finance has so far been geared towards mitigation, but the Reducing Emissions from Deforestation and forest Degradation (REDD+) mechanism has virtually failed and is now further hindered by a very low price for carbon. The recent pledge by the Democratic Republic of Congo to log over its forest unless the international community pays US$ 1 billion is a demonstration of this failure[7]. The landscape approach can contribute to solving this dilemma through the design of land management principles which combine land units for mitigation and for adaptation respectively. This dual land use system can complement other land use systems were adaptation and mitigation are pursued on the same land unit such as in the ecosystem-based adaptation principle (Munang et al., 2013). An example of a 'climate-smart landscape' (Harvey et al., 2013) is a watershed where upper parts are kept for forest protection (focus on mitigation), middle parts for perennial crops (combined focus on mitigation and adaptation) and lower lands for annual crops or livestock (focus on adaptation). Figures 2.4 and 2.5 provide examples. A similar synergy can be achieved by landscapes where wildlife corridors or 'stepping stones' (mitigation, as a co-benefit of biodiversity conservation) are maintained in an otherwise agricultural matrix (adaptation) (see Figure 2.2). Agroforestry, where trees and crops (or animals) share the same land also provides an example. Here, synergy between adaptation and mitigation does not necessarily appear in terms of different patches in a landscape, but through different components (trees and crops) within a patch or between the edge and the interior of a patch (see Figure 2.1). This is the case in some agroforestry practices where trees and crops can be side-by-side (e.g., tree shelterbelts surrounding fields), clearly displaying a landscape mosaic structure. Some agroforestry practices (e.g., improved fallows, evergreen agriculture) can also lead to reduced fertilizer use. These examples indicate that 'climate smartness', which requires combining adaptation to and mitigation of climate change while maintaining production objectives, is easier to reach at the landscape scale than at the farm or plot scale.

2.6 Social and collective action dimensions

Different land-uses necessarily mean different practices and different people, sometimes many, with different views, all leading to different structure and functions within a landscape. This is because landscapes, as described above, typically spread beyond

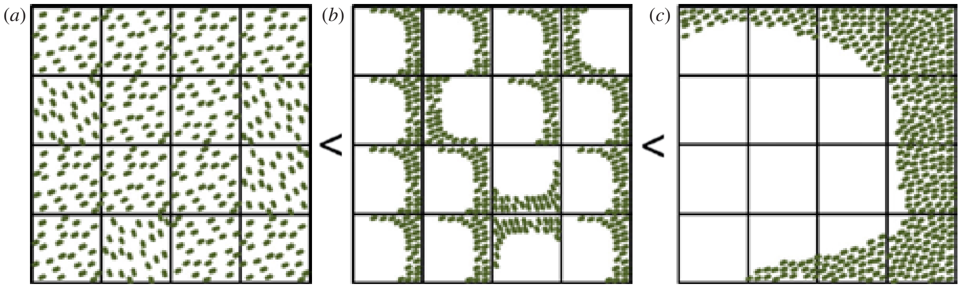


Figure 2.4 Landscape-level 'biodiversity-friendly' schemes (from Balmford et al., 2012) including: a) land sharing within farms, b) land sparing within farms, and c) land sparing across a group of farms. In each landscape, the same total area (denoted by the green shapes) is given over to wild nature.

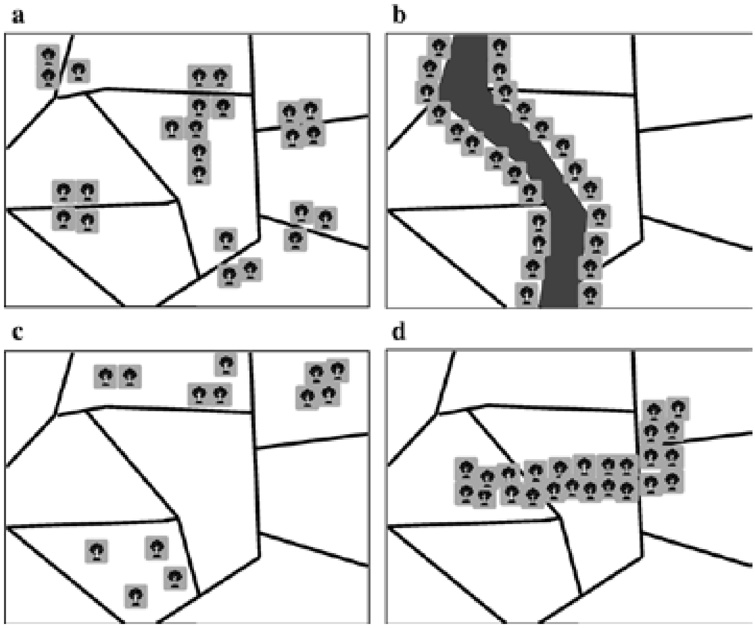


Figure 2.5 Possible protected areas across a landscape (from Goldman et al., 2007). **a** promotes local services such as pollination and **b** is appropriate for water purification and flood mitigation. In **c** critical mass rather than configuration is important, i.e., a certain number of landowners must participate and in d critical mass matters less but landscape configuration is important. Trees must be clustered together to form a large forest patch. Either **c** or **d** would be appropriate for global services such as carbon sequestration though **d** would be preferable for long-term ecosystem service provision.

the scale of a single farm (although a 'mosaic' of land use, and of course, a network of ecological infrastructures can perfectly exist within the boundary of a large farm). Heterogeneous landscapes cutting across farms are often managed by different people such as large vs small holders, different ethnic groups, natives or migrants. The social dimension of the landscape approach is thus essential. The word 'territory' has sometimes been used to describe those landscapes under a social construct, including under the expression 'climate-smart territories'[8] (see Louman et al., Chapter 6, this book). They are characterized by a series of common rules which apply to all. These rules have normally been decided through a negotiation process between stakeholders or are the application of traditional norms, formal or informal, maintained by a local authority or an informal jurisdiction such as a village council. Examples are provided by common harvesting or planting dates, simultaneous use of phytochemicals, bans on the collection of some forest products, for lighting fires at certain dates, etc. Many such examples are available, but water management and water sharing procedures probably provide the most convincing cases, up to a level where it can be said that water sharing has been central to the evolution of many civilizations (Delli Priscoli, 2000). This calls for the landscape approach to be cautious (but proactive) about water issues, especially under climate change constraints.

Multifunctional landscapes may be conducive to improved collective action. An example is provided by initiatives to develop the climate change mitigation potential in the agricultural sector. While quantifying carbon gains from mitigation activities carried out by smallholder farmers is difficult, landscape-scale quantification may enable farmers to pool resources and expertise to access carbon markets and other funding sources (Milne et al., 2012). Funding agencies, governments and non-governmental organizations (NGOs) are thus increasingly recognizing the benefits of taking a landscape approach to greenhouse gas quantification (Milne et al., 2012).

Because social landscapes require rules accepted by a majority of stakeholders, if not all, they often depend upon the presence of formal institutions, especially village or local government with their own policy, rules or by-laws which regulate interactions between people and consequently between landscapes units, especially when different land tenure regimes coexist. Landscape governance thus becomes essential. This does not necessarily mean that a multi-scalar, multi-actor form of governance needs to be created. That may be the case, and is very welcome, when bottom-up, participatory decision-making processes are present. But in the absence of such participatory mechanisms, what is at least required is a policy framework which acknowledges heterogeneity and multifunctionality principles in land management. Unfortunately, the existing policy context seldom, if ever, provides the necessary guidelines at the landscape level. In a recent study on the feasibility of developing landscape-level integration between agriculture and biodiversity in a transfrontier conservation area, none of the three countries surveyed (Mozambique, South Africa, Swaziland) had an explicit policy at the landscape level (Chitakira, 2012). One may then justifiably ask why is it that some people have historically built territories which function under common, negotiated rules while others have remained individualistic. There is no simple answer to this question, but following Boserup's Theory of Agricultural Change (Boserup, 2005) and Ostrom's Common Pool Resources Principles (Ostrom, 2008), a safe hypothesis can be that landscapes under a social construct have a high probability of emerging when pressure due to high population or lack of resources is addressed by collective choices based on trust. An additional requirement is the emergence of relevant institutions taking this collective action into account. Whether innovative governance rules can incorporate these parameters is another, difficult question.

Landscapes' social management is nevertheless dependent upon the perception people have of the landscape scale and interactions. Because of varied spatial and temporal patterns and processes behind landscape heterogeneity, this perception is neither easy nor spontaneous for many people, especially in developing countries. Results by Torquebiau et al. (submitted) in South Africa show that most people describe landscape units in terms of resources available (i.e., structure) rather than in terms of a combination of bio-physical and socio-cultural interactions (i.e., function) as held by western views of the landscape approach. Working on the landscape approach thus requires continuous learning to improve landscape management.

2.7 Landscape metrics

If landscapes are systems, their characterization should proceed through the characterization of specific land units (structure) and of interactions between units (function), thus calling for specific landscape metrics, mostly lacking so far. In other words, we do not have clear methods for assessing the performance of a multifunctional landscape. This would require combining different measurement units for different commodities (e.g., crops vs wild products), different harvesting times and different production cycles (e.g., annual vs perennial). It would also require quantifying all the services provided by the landscape (e.g., ecosystem services such as carbon sequestration or touristic value), include a valuation (if at all possible!) of nature conservation, not to talk about parameters such as cultural or heritage value of the landscape, need for social justice or food sovereignty. Given that such a mix of 'measurements' is necessary, landscape metrics will probably remain for a long time a fuzzy science combining quantitative data with subjective value judgment. Sustainability indicators combining environmental, social and economic dimensions can here be very useful. Characterizing landscape attributes is nonetheless essential to address the challenge of developing agriculture's multifunctionality under climate change and we can hope to be able sometime soon to describe a multipurpose landscape in terms of its mitigation potential (e.g., tons of carbon which can be captured) or adaptation capability (e.g., quantified resilience to climatic uncertainty of a given cropping system). Similarly, we must be able to describe a landscape in terms of its potential to support progress towards reducing social vulnerability through parameters such as trading links, social safety nets or diversification of livelihoods.

Describing, and if possible, quantifying the multifunctionality attributes of a landscape through specific procedures, such as an index or a list of specifications, is nevertheless necessary if formal recognition of the value of a landscape is to be achieved. An example is provided by Torquebiau et al. (2013) who compared two multifunctional landscapes (in South Africa and Zimbabwe) through criteria depicting their performance in terms of integrated landscape management principles (under the concept of ecoagriculture, see Scherr & McNeely, 2008) and ecosystem services (as defined by the Millennium Ecosystem Assessment, 2005). A composite index was designed to describe the state of each landscape in terms of ecoagriculture criteria (conservation, production, institutions and livelihoods) and ecosystem services (provisioning, regulating and cultural services). The resulting index consists of different data sets each comprising 40 scores, acquired through participatory interviews. Ecosystem services were given more importance than ecoagriculture criteria by all interviewees. Cultural services received the highest scores, whereas the lowest ones went to the livelihood and institutions in the Zimbabwean and South African sites respectively. Overall, index values were higher in the South African site, displaying a diversified mosaic of land-uses (integration between land-use units) and lower in the Zimbabwean site where small scale farms surround formal wildlife conservation areas. This study thus shows that it is possible to develop a composite index characterizing the multipurpose nature of a landscape. Such an index can be used to develop a labelling procedure for multipurpose landscapes or to support a certification scheme in order to reward the skills of the people who manage and maintain multipurpose landscapes. A recent publication (Hart et al., 2014) documents two case-studies (in Kenya and Tanzania) where landscape labelling was tested as a marketing approach to reward farmers implementing integrated landscape management with a range of commodities and products. The case studies reveal that "... the road to price premiums with a landscape label can be long and insecure". While landscape labelling can enhance social organization as well as the visibility and skills of producers, major obstacles remain in terms of market access, policy constraints, tenure security, technical and business expertise, as well as scaling up farmer participation in the label's standards and practices.

3. Conclusion

Structural and functional landscape heterogeneity as it is described above can hardly be a feature of industrial agriculture based on economies of scale and hence of large, uniform fields managed with big machinery and limited labour. To the contrary, it is mostly a feature of small-scale family farming as it exists in developing countries. Exceptions exist on both sides (e.g., oil palm plantations in Indonesia or small farms in Europe), but do not refute this rule: the landscape approach is barely applicable in the context of high-input, mechanized agriculture and rather finds its usefulness for low-input, high-labour agriculture (Perfecto et al., 2009). However, there is also a trend towards small farmers adopting practices that involve less labour in order to allow household members to engage in more diverse livelihoods. This trend is particularly welcome to avoid a potentially anti-developmental attitude where small farmers would remain poor and work hard for little income. What matters is the fact that the landscape approach is fundamentally an agro-ecological approach. It is close to what some people nowadays call 'ecologically intensive agriculture' (Griffon, 2013) and belongs to the agricultural sustainability and agro-ecology debates, not to mainstream agriculture. Typically, today's 'hybrid solutions' of agriculture (e.g., trees on farms, cover crops, domesticated forests, multilayer agriculture, mixed cropping, permaculture, organic farming) easily find their niche in a heterogeneous landscape while high input monocultures do not. However, multifunctional landscapes should not be seen as an unambitious option: highly productive landscape mosaics must meet human food needs.

The set of landscape variables presented in this chapter (heterogeneity, multifunctionality, interactions, synergy, social and collective action dimensions and landscape metrics) does not purport to be exhaustive. Variables were selected with an objective of simplicity in mind so that they can potentially be used by practitioners working at the landscape level. Obviously, other variables considered important in different contexts may not be mentioned here, e.g., is adaptive management best performed at the landscape scale, do property rights influence landscape functioning (and vice versa), can norms be defined for use at landscape scale, etc. However, such other variables will be better analysed when a preliminary landscape analysis is performed based on the variable presented here. The systems approach chosen for the present paper may seem simplistic, but given the fact that the landscape approach is understood differently by different people, using basic structure and function criteria can help setting the scene to reach beyond.

The landscape approach holds great promises in the face of climate change as well as for improved biodiversity management and better livelihoods. Its main attributes, landscape bio-physical heterogeneity and socio-economic multifunctionality, are major drivers for improved land resilience and innovation in practices, directly leading to enhanced adaptation to climate change. Patch heterogeneity is a clear attribute for output diversification and the spreading of risks in space and time. Habitat diversification provides for varied niches, both for agricultural or forestry commodities and for biodiversity and agrobiodiversity. Multifunctionality addresses the fact that we no longer merely expect the land to produce, we also expect it to provide services that have not traditionally been taken into account in conventional economic calculations. Carbon sequestration is one such key service, making multifunctional landscapes major potential contributors to climate change mitigation. While synergy between adaptation and mitigation is possible within a single land-use type (e.g., agroforestry or conservation agriculture), the landscape mosaic structure adds another dimension to this synergy through providing land units for adaptation and mitigation respectively.

But the landscape approach is also fraught with traps, most notably the risks of being a long-term enterprise and of failing to deliver because of its complexity due to multiple objectives, even though it can be praised precisely for having multiple objectives and not being a 'narrow' approach. As is the case for many ambitious policy initiatives, this may make it a difficult way to follow, for all kind of stakeholders, from farmers to project staff, scientists or policymakers. Among the urgent needs is the necessity of an accepted definition and a proven methodology to assess the structure and function of multifunctional landscapes so that they can be used in land use sciences as an alternative to plot, field or farm and not only as a vague term representing 'larger' land areas. All together, the landscape approach should be careful not to set the parameters for success and measurement too strictly or too quickly and acknowledge that deviation from the 'blueprint' or potential disagreements are part of the process. This need appears to be particularly relevant in order to use multifunctional landscapes for climate change studies.

Endnotes

1 http://www1.cifor.org/ebf/t20q.html
2 http://www.landscapes.org/
3 http://landscapes.ecoagriculture.org/
4 http://carpe.umd.edu/about/landscape_detail.php?lid=2
5 http://www.cifor.org/sentinel-landscapes/home.html
6 http://blog.cifor.org/18914/drawing-role-playing-and-3d-maps-improve-land-use-planning#.UrA-keLAy70
7 http://www.ft.com/intl/cms/s/0/4a07aa8c-e039-11e3-b341-00144feabdc0.html#axzz3369YthMj
8 http://web.catie.ac.cr/wallace2013/conferencia_ing.htm

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References

Balmford, A., Green, R., & Phalan, B. (2012). What conservationists need to know about farming. *Proceedings of the Royal Society B,* 279, 2714-2724

Boserup, E. (2005). *The conditions of agricultural growth: The economics of agrarian change under population pressure.* Transaction Publishers.

Burel, F., & Baudry, J. (1999). *Écologie du paysage. Concepts, méthodes et applications.* Paris : Tec & Doc.

Chitakira, M. (2012). *Factors affecting ecoagriculture for integrated farming and biodiversity conservation in a transfrontier conservation area in Southern Africa.* PhD Thesis, University of Pretoria, Pretoria, South Africa.

Cunningham, A. B., Scherr, S. J., & McNeely, J. A. (2002). *Matrix matters: Biodiversity research for rural landscape mosaics.* Center for International Forestry Research and World Agroforestry Centre, Bogor, Indonesia.
Delli Priscoli, J. (2000). Water and civilization: using history to reframe water policy debates and to build a new ecological realism. *Water Policy,* 1(6), 623-636.
FAO (Food and Agricultural Organization of the United Nations). (2013). *Climate-smart agriculture sourcebook.* Rome: FAO.
Fischesser, B., & Dupuis-Tate, M. F. (1996). *Le guide illustré de l'écologie.* Paris, France: Editions de La Martinère - CEMAGREF Editions.
Gillson, L. (2005). Evidence of hierarchical patch dynamics in an East African savanna? *Landscape Ecology,* 19(8), 883-894.
Goldman, R. L., Thompson, B. H., & Daily, G. C. (2007). Institutional incentives for managing the landscape: Inducing cooperation for the production of ecosystem services. *Ecological Economics, 64*(2), 333-343.
Grau, R., Kuemmerle, T., & Macchi, L. (2013). Beyond "land sparing versus land sharing": Environmental heterogeneity, globalization and the balance between agricultural production and nature conservation. *Current Opinion in Environmental Sustainability 5*, 477–483.
Griffon, M. (2013). *Qu'est-ce que l'agriculture écologiquement intensive?* Paris, France: Editions Quae.
Hart, A., Planicka, C., Gross, L., & Buck, L. E. (2014). Landscape Labeling: *A marketing approach to support integrated landscape management. Framework document for landscape leaders.* Washington, DC: EcoAgriculture Partners.
Harvey, C. A., Chacón, M., Donatti, C. I., Garen, E., Hannah, L., Andrade, A., … Wollenberg, E. (2014). Climate-smart landscapes: opportunities and challenges for integrating adaptation and mitigation in tropical agriculture. *Conservation Letters, 7*(2), 77–90.
IPCC (Intergovernmental Panel on Climate Change). (2014). Summary for Policymakers. In Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., Seyboth, S., … Minx, J.C. (Eds.) Climate Change 2014, *Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.
Milder, J. C., Hart, A. K., Dobie, P., Minai, J., & Zaleski, C. (2014). Integrated landscape initiatives for African agriculture, development, and conservation: a region-wide assessment. *World Development,* 54, 68-80.
Millennium Ecosystem Assessment. (2005). *Ecosystems & Human Well-Being: Synthesis.* Washington, DC: Millennium Ecosystem Assessment and Island Press.
Milne, E., Neufeldt, H., Smalligan, M., Rosenstock, T., Bernoux, M., Bird, N., … Steglich E. (2012). *Methods for the quantification of emissions at the landscape level for developing countries in smallholder contexts.* CCAFS Report No. 9. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Retrieved from www.ccafs.cgiar.org
Munang, R., Thiaw, I., Alverson, K., Mumba, M., Liu, J., & Rivington, M. (2013). Climate change and Ecosystem-based Adaptation: a new pragmatic approach to buffering climate change impacts. *Current Opinion in Environmental Sustainability, 5*(1), 67-71.
Oldeman, R. A. A. (1990). *Forests: elements of silvology.* Berlin, Germany: Springer-Verlag.
Ostrom, E. (2008). The challenge of common-pool resources. *Environment: Science and Policy for Sustainable Development, 50*(4), 8-21.
Perfecto, I., Vandermeer, J. H., & Wright, A. L. (2009). *Nature's matrix: linking agriculture, conservation and food sovereignty.* London, U.K.: Earthscan.
Pickett, S. T. A. & White, P. S. (1985). The Ecology of Natural Disturbance and Patch Dynamics. Amsterdam, Netherlands: Academic Press.
Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J. L., Sheil, D., Meijaard, E., … Buck, L. E. (2013). Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. *Proceedings of the national academy of sciences, 110* (21), 8349-8356.
Scherr, S. J., & McNeely, J. A. (2008). Biodiversity conservation and agricultural sustainability: Towards a new paradigm of "ecoagriculture" landscapes. *Philosophical Transactions of the Royal Society,* 363, 477–494.

Torquebiau, E., Cholet, N., Ferguson, W., & Letourmy, P. (2013). Designing an Index to Reveal the Potential of Multipurpose Landscapes in Southern Africa. *Land, 2*(4),705-725.

Torquebiau E., Chitakira M., Alexander P., & Cholet N. Reconciling agriculture and biodiversity in multipurpose landscapes of TransFrontier Conservation Areas in Southern Africa. *Regional Environmental Change,* Submitted.

Tscharntke, T., Klein, A. M., Kruess, A., Steffan-Dewenter, I., & Thies, C. (2005). Landscape perspectives on agricultural intensification and biodiversity–ecosystem service management. *Ecology letters, 8*(8), 857-874.

Watt, A. S. (1947). Pattern and Process in the Plant Community. *Journal of Ecology,* 35, 1-22.

Wu, J., & Hobbs, R. (2002). Key issues and research priorities in landscape ecology: an idiosyncratic synthesis. *Landscape ecology,* 17(4), 355-365.

A member of a community-based nursery promoting agroforestry practices in communities living adjacent to Mount Elgon National Park in southeast Uganda. Agroforestry is one practice that can promote multifunctional climate-smart landscapes. Photo credit: Olivia E. Freeman

CHAPTER

3

Characterising multifunctionality in climate-smart landscapes

Olivia E. Freeman

Highlights

- The landscape scale provides an effective and efficient scale of analysis and management to establish climate-smart multifunctionality
- Multifunctionality in landscapes is achieved by promoting synergies and reducing tradeoffs across different land uses and objectives
- Both additive synergy (sum of parts that constitute the whole) and superadditive synergy (emergent whole) should be sought within landscapes to promote multifunctionality
- Objectives guiding the identification of synergy opportunities should be clearly defined and understood, and ideally identified through collaborative multi-stakeholder processes
- If synergies and landscape multifunctionality are not sought in the near future there is risk that detrimental feedback cycles will be perpetuated, building upon the negative impacts of climate change

1. Introduction

Impacts of human-induced climate change, in part caused by the large emissions of greenhouse gases (GHG), have already been occurring globally, with further unavoidable impacts projected into the future. This includes changes in weather patterns and climate with implications for precipitation, incidence of extreme events such as droughts and floods, and impacts to local ecosystem functioning (IPCC, 2013*a*). Both climate change mitigation and adaptation[1] actions are currently being pursued to reduce the impacts of climate change, while also strengthening resilience of both ecosystems and communities to cope with such impacts.

The land-use sector provides both a source of and sink for GHG emissions, and can positively or negatively impact the provisioning of ecosystem services with many potential impacts on livelihoods, and local and global supplies of food, fuel and fibre. Agriculture, forestry and other land uses currently contribute to nearly 25% of the global anthropogenic GHG emissions despite also being large carbon sinks. Within tropical countries most emissions result from such land-based activities (DeFries & Rosenzweig, 2010). Many people whose livelihoods depend upon land-based activities (e.g., crop- or livestock-based agriculture and/or forestry), particularly at small-scales, are most vulnerable to the impacts of climate change. Furthermore, the global population level will continue to increase and is expected to reach 9.6 billion by 2050. This will unavoidably result in heightened food demands, projected to increase by 50-100% by 2050 as a result of both population growth and an increase in the number of wealthier households (DeFries & Rosenzweig, 2010; Godfray et al., 2010; Foley et al., 2011). This will put further pressure upon land (and fisheries) to increase food production. The ability to pursue both land-based mitigation and adaption actions will therefore have significant impacts on both livelihoods and future climate change projections globally.

In its 5th Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) Working Group II identified the need for climate-resilient pathways, defined as, "… development trajectories that combine adaptation and mitigation to realise the goal of sustainable development. They can be seen as iterative, continually evolving processes for managing change within complex systems" (IPCC, 2013*b*). This call is largely made from the recognition that, to ensure and manage for sustainable futures, climate change and pre-existing social-ecological challenges (e.g., inequity of resource distribution) need to be addressed simultaneously to promote synergies and reduce tradeoffs.

This chapter focuses on the potential of pursuing climate-smart landscape approaches (CSLAs) for establishing climate-resilient pathways and sustainable transformations through fostering multifunctionality. Although, traditionally many land-based planning and management approaches have been sectoral, land-use change is often more complex and dynamic in nature (e.g., Geist & Lambin, 2002; Hosonuma et al., 2012). Therefore taking a landscape approach - using the landscape scale to identify integrated solutions - can be one method for effectively achieving multiple objectives by promoting synergies and reducing tradeoffs. This chapter examines potential climate-smart synergies to achieve multifunctionality by 1) discussing briefly the context of climate-smart landscapes and CSLAs, and why the landscape scale is relevant for achieving multifunctionality, 2) looking at different dimensions of multifunctionality (focusing on different kinds of synergies), how it can be achieved and what kind of tradeoffs may be involved, and 3) discussing some of the enabling conditions needed for CSLAs to promote the establishment of climate-resilient (smart) pathways.

2. Climate-smart landscapes

Minang et al. (Chapter 1, this book) describes a landscape as a mosaic of different land uses with multiple components and functioning interactions between and across ecological, social and social-ecological processes (functional interactions), made up of multiple actors and stakeholders with varying interests (negotiated spaces), and made up of nested components occurring on different scales (multiple scales). The landscape provides a scale which captures the complex matrix of individual units such as farms, families, communities and ecosystems, and relates patterns and processes between and across these units to larger scales such as the national and global (Figure 3.1). For example, it can allow for observation and navigation of the policy implications and effects of global drivers on local activities.

The landscape represents both the sum of constituting parts and emergent properties or an emergent whole, resulting from the interactions between the parts (Parrott & Meyer, 2012). While the complexity of landscapes can potentially create significant management challenges, such complexity can also provide more opportunities for synergies (Brunori & Rossi, 2000). Examining patterns and processes at the landscape scale allows for cross-sectoral solutions to be identified instead of focusing solely on a single sector such as agriculture, forestry or community development, many of which are in reality interconnected. Instead, by accounting for both the different land uses and their interactions, the landscape scale presents opportunities to identify synergies between multiple objectives, while also helping to reduce system-wide tradeoffs.

In the case of CSLAs, using spatially-explicit climate projections at the landscape scale can help to understand and identify potential climate-smart actions, whether focused on short-term risk of extreme events or on climate change mitigation and strengthened adaptive capacity over longer time frames. It is important that in these processes the landscape scale is used for understanding both environmental and social drivers of change, while also being sensitive to social and cultural norms to identify locally appropriate and acceptable approaches.

In CSLA, objectives are framed around addressing climate change mitigation and/or climate change adaptation in addition to other objectives of interest. These other objectives are oftentimes related to different dimensions of livelihoods which span functions linked to the five aspects of well-being as defined by the Millennium Ecosystem Assessment: security, basic material for good life, health, good social relations and freedom of choice and action, with the first four directly related to ecosystem service functioning (MEA, 2005).

The limited literature framed specifically around CSLAs largely builds upon the concept of climate-smart agriculture (CSA)[2], focusing on synergies between mitigation and adaptation within agricultural landscapes (Harvey et al., 2013) or between mitigation and

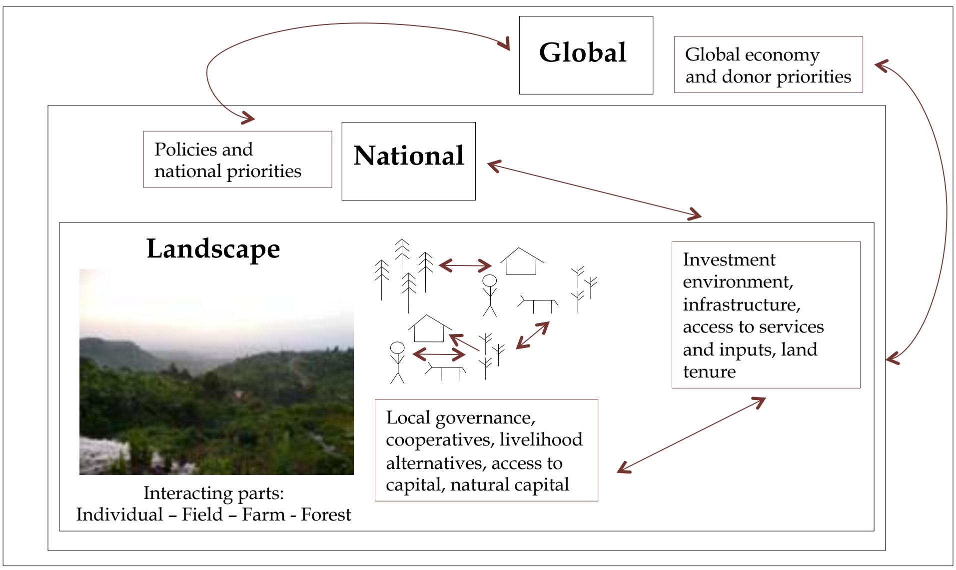

Figure 3.1 Linkages and interactions including potential drivers and incentives across local, landscape, national and global scales. The photo is of a landscape in the Kapchorwa District in southeast Uganda. Photo credit: Olivia E. Freeman

food production/food security and/or improvement of livelihoods (DeFries & Rosenzweig, 2010; Scherr et al., 2012; FAO, 2013). Although such literature is concerned with food production and/or agricultural landscapes, here, food production or food security are not determined as essential objectives to include within a CSLA, even though agriculture is recognised as an important and often defining characteristic and/or land use in many landscapes (e.g., see Iiyama et al., Chapter 14, this book, for an alternate climate-smart landscape approach based around charcoal).

Instead, a CSLA is generally characterised as: 1) using the landscape scale to define and address multiple objectives; 2) having multiple objectives including at least one related to addressing climate change mitigation or adaptation with the overall goal of achieving multifunctionality; 3) ideally using a participatory approach, collaboratively involving relevant stakeholders within and sometimes also outside of the landscape (e.g., Duff et al., 2009); and 4) applying an iterative process that promotes learning by doing and social learning (see Frost et al., 2006) where appropriate. While these points are less comprehensive than other descriptions of landscape approaches, these are seen as a minimum founding set of criteria for a CSLA. For example, Sayer et al. (2013) provides a more comprehensive list of ten principles for landscape approaches adopted by the Convention on Biological Diversity to guide sustainable use of biodiversity within land management (UNEP, 2011). Such principles can also be applied, though not all will be obligatory in all instances, and can instead be seen as a set of guidelines. The focus of this chapter is placed on characterisation of multifunctionality in such an approach and not the process of the approach itself.

3. Characterising multifuctionality in climate-smart landscapes

Multifunctionality is one of the principle defining concepts of landscape approaches (Scherr & McNeely, 2008; Sayer et al., 2013; Milder et al., 2014). Here multifunctionality is described as achieving multiple objectives or functions simultaneously by reducing tradeoffs and optimising or promoting synergies. Such functions can span many different categories and dimensions. For example, ecosystem services, as defined by the Millennium Ecosystem Assessment (MEA, 2005), are categorised into four main categories of functions (or services): provisioning, regulating, supporting and cultural. Furthermore, many activities within landscapes have direct relation, either positive or detrimental, to functions supporting livelihoods. Defining what multifunctionality means and which specific functions are sought after in a specific context will be strongly linked to the driving objectives.

As landscapes are complex systems, an intervention made to target one specific function, for example, increasing crop productivity through the application of fertilisers, may have unintended consequences, such as causing contamination of different water bodies through runoff and/or eutrophication (Bennett et al., 2001). Additionally, interactions within and between social and ecological system functions can often involve competition leading to tradeoffs. For example, expansion and establishment of monocultures, while often highly profitable, can have large tradeoffs for other ecosystem functions such as biodiversity and carbon sequestration (e.g., Steffan-Dewenter et al., 2007; Kremen & Miles, 2012) and lead to long-term degradation of land if not managed properly. To be able to achieve multiple, desirable functions, synergistic options, which allow for achieving multiple functions more effectively and/or efficiently, are usually needed to reduce potential tradeoffs and unintended consequences. Therefore, achieving multifunctionality is strongly linked to the concept of synergy. This section discusses both 1) how to achieve multifunctionality through synergy, and 2) how the way in which driving objectives are defined affects multifunctional outcomes.

3.1 Achieving multifunctionality through synergy

Theoretically, there are at least four different possible types of synergies (von Eye et al., 1998; Duguma et al., 2014). The most classic and cited type of synergy is additive synergy, based upon the sum of the parts. In the case of a landscape approach, one example of this would be the cumulative impact at the landscape scale of a collection of farmers adopting a new practice. Superadditive synergy, on the other hand, is where the whole is greater than the sum of the parts. An example of this is described in Brunori and Rossi (2000), where creating a wine route in an area of Tuscany, Italy created region-wide benefits beyond the farms themselves (e.g., created a new regional tourism industry), while also creating numerous benefits at the farm level. Subadditive synergy is when the cost of the interactions together is less than the sum of the parts (i.e., the cost of the synergy action is less than individually pursued actions). In a landscape approach this would involve avoiding larger costs (and/or risks) by addressing the landscape scale rather than individual units within the landscape (e.g., Kissinger et al., 2013). And finally, isolated synergy is where the focus is on the interaction between the parts. This chapter focuses on the first two types: additive and superadditive synergies.

Synergies can occur on multiple scales, for example, from the field to farm to landscape scale. Therefore what may be a superadditive synergy at the farm scale, when scaled up to the landscape scale, may only result in additive synergy. For instance, sustainable intensification practices have the potential to both improve farmer livelihoods, through increased production and household income, while also reducing land degradation. Such benefits improve the entire farm system by increasing efficiency in achieving the overall objectives (here improving livelihoods and environmental management), versus pursuing each objective individually. This is an example of superadditive synergy. If such farm-based practices were scaled-up to the landscape level and there were no additional benefits (or negative impacts) beyond those received at the farm scale, this would be an example of additive synergy. Superadditive synergy at the landscape-scale would require additional benefits resulting from the emergent whole, such as uptake of CSA practices opening up a region to new certified-based markets, for instance, or an infusion of climate finance made possible through collective farm-based practices. For superadditive synergy, the resulting outcome needs to be more effectively and/or efficiently achieved at the landscape scale, rather than at smaller units within the landscape. For examples of both additive and superadditive synergies see Table 3.1.

Some have argued that a landscape approach is only a landscape approach when looking at the emergent whole and it cannot simply be the sum of the parts (Kissinger et al., 2013). This is largely based upon the recognition that one of the main benefits of using the landscape scale is the ability to examine the interactions across the different units that make up the whole. Understanding such interactions allows for the identification of synergies at the landscape scale to more effectively and efficiently achieve multifunctionality, as defined by the specific objectives of the landscape approach. Furthermore, in the case

Table 3.1 Descriptions and examples of additive and superadditive synergies.

Type of Synergy	Description	Example at the Landscape Scale
Additive Synergy	Synergy resulting from the sum of the parts A+B+C…=∑[A,B,C…]	The Food and Agriculture Organization of the United Nations (FAO) Mitigation of Climate Change in Agriculture (MICCA) Programme Pilot Project in Kolero, eastern Tanzania (Zagst, 2012; Rosenstock et al., 2014*a*; Rosenstock et al., 2014*b*) Experiments were conducted to measure the extent different locally-appropriate agricultural practices (mulching, intercropping with legumes, intercropping with trees, fertiliser) contributed to climate change mitigation while also improving maize yields. The uptake of such practices at the farm level across the landscape aims to increase crop productivity and reduce agricultural expansion and deforestation. This will result in a larger cumulative contribution to both climate change mitigation and agricultural production at the landscape level. Dissemination of such practices was possible through farmer field schools, demonstration sites and the facilitation of implementing partners, CARE International and the World Agroforestry Centre (ICRAF) in Tanzania.
Superadditive Synergy	Synergy resulting from the emergent whole A+B+C…<∑[A,B,C…] +I I = interactions between the parts, here, A, B and C	Re-establishment of the traditional Ngitili land management practice in the Shingyanga Region, Tanzania (Duguma et al., 2013; Duguma et al., 2014) Involving a range of different practices at the farm and village scale, the Ngitili system addresses development, adaptation and mitigation simultaneously and has resulted in region-wide economic improvement, improved ecosystem service functioning (including an increase in biodiversity) and increased carbon sequestration. Re-establishment of the Ngitili system involved coordination and cooperation across local, regional, national and global institutions and would have not been possible if only implemented at the individual farm scale.

of additive synergy, there may be co-benefits that result from the collective uptake of practices that do not relate directly to the driving objectives, but still impact patterns and/or processes at the landscape scale. Hence, sometimes distinguishing between additive and superadditive synergy at the landscape scale can be complicated. Nevertheless, this chapter argues that both can be beneficial for achieving landscape multifunctionality.

In some cases, due to lack of capacity or other constraints, additive synergy may be the only potential option for pursuing landscape-scale multifunctionality within certain scenarios, but this pursuit must be accompanied by a critical analysis of landscape-scale patterns and processes in order to realise landscape-level benefits. Additionally, it is important to examine tradeoffs, both at the unit of implementation as well as the cumulative impact in the landscape.

3.2 Defining primary and secondary objectives

In the case of synergies between climate change mitigation and adaptation, there is an overall recognition that synergistic options exist (Klein et al., 2007; Biesbroek et al., 2009; Cooper et al., 2013; Harvey et al., 2013; Duguma et al., 2014; IPCC, 2014). Within a CSLA approach, multifunctionality will be largely defined by a specific set of driving or primary objectives and the potential synergies achieved between them.

Figure 3.2 demonstrates possible interventions addressing different combinations of primary, driving objectives: climate change mitigation, climate change adaptation and livelihoods (though such approaches can include varying and additional combinations of objectives). Here a distinction is made between primary objectives and secondary objectives: primary objectives driving the approach with secondary objectives occurring as externalities or multiplier effects (Knickel & Renting, 2000)[3], which can also be termed co-benefits. Therefore, multifunctionality is achieved by synergistic approaches addressing all primary objectives simultaneously. Secondary objectives are then addressed through direct or indirect multiplier effects that can be positive or negative, and when positive, can

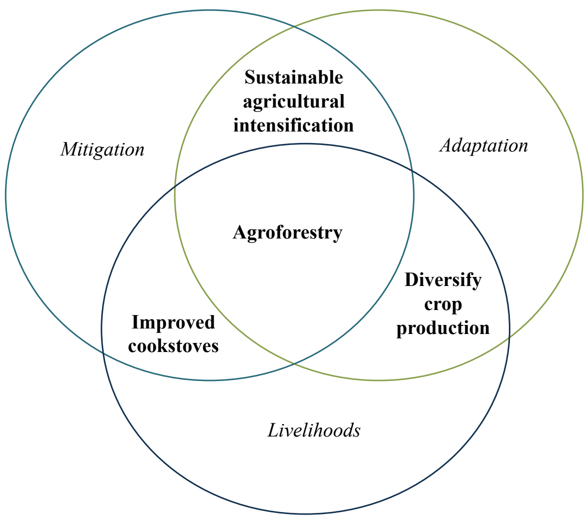

Figure 3.2 Different combinations of synergistic interventions addressing different combinations of primary objectives (for examples of the individual practices see Howden et al., 2007; DeFries & Rosenzweig, 2010; Simon et al., 2012; Harvey et al., 2013; Mbow et al., 2014).

be framed as co-benefits. Although not the explicit aim in CSLAs, secondary objectives may influence the choice of one potential synergistic approach over another, based upon the associated co-benefits related with each option.

The process of determining synergies between primary objectives will also involve the recognition of tradeoffs. In practice, many past integrated approaches with both environmental and development aims have failed to effectively deliver outcomes addressing all of the framing objectives (Tallis et al., 2008). In such approaches, actions oftentimes address a small number of specific objectives while assuming co-benefits will result addressing other stated objectives, which is not always the case. For example improved cookstoves are touted for being 'win-win' development initiatives with 'wins' for both the environment and development. While this can be true to a certain extent – they can have significant benefits related to both development and the environment – there are potential tradeoffs between the benefits created, for example, between health and climate benefits (Grieshop et al., 2011; Freeman & Zerriffi, 2012) and other co-benefits/social-net benefits (Simon et al., 2012; Jeuland & Pattanayak, 2012) depending on the specific context and type of stove. Some stoves perform better for certain benefits in certain contexts than others. For example, due to fewer emissions of particulate matter, charcoal stoves perform relatively well for potential health benefits compared to traditional three-stone stoves and other more basic types of improved biomass burning stoves, but have significant negative environmental impacts associated with the production of the charcoal fuel (Grieshop et al., 2011).

In the case of CSA, practices perform differently in different climatic or ecological conditions, varying in both potential food security and climate mitigation benefits (Branca et al., 2011). Additionally, in practice, actual implementation of promoted practices may vary quite significantly from the ideal and involve tradeoffs such as decreased time availability for other livelihood activities due to increased labour demands (Giller et al., 2009). Failure to recognise potential tradeoffs can result in increased marginalisation and/or disempowerment of already marginalised groups. This may especially be the case if such stakeholders are not effectively involved in the process of defining the challenges to be addressed and identifying the objectives of the approach. To try and avoid such negative outcomes, application of safeguards such as ensuring free, prior and informed consent may be important to integrate into such approaches. Furthermore, stakeholders can often have diverging views, making it hard to achieve some specific objectives. Therefore, realistic synergy potentials will need to be identified and may not always be the ideal; a certain level of comprise sometimes needs to be made.

Many synergy potentials may be locally specific, depending strongly on the local context. As such, Figure 3.2 is a simplistic example of different potential interventions or practices. In some cases, agroforestry may provide more climate change adaption and livelihoods benefits than mitigation; for example, when planting fast-growing species for charcoal production (in cases where such planting is not changing rates of deforestation or forest degradation) (Kutsch et al., 2011; Iiyama et al., 2014). Likewise sustainable agricultural intensification could create mitigation, adaptation and livelihoods benefits if these include CSA practices that diversify livelihood and cropping practices and result in increased incomes and resilience (Howden et al., 2007). Facilitating multifunctionality therefore requires primary and secondary objectives to be clearly defined and distinguished while assessing both potential synergies and tradeoffs. At the same time, such set objectives may need to be revised in an iterative process to ensure such approaches are context-appropriate. As discussed previously, using participatory, inclusive and collaborative approaches can by a key part of this process.

4. Enabling conditions for multifunctionality

With or without active land management activities, landscapes will be autonomously transforming over time based upon a number of different drivers of change. The onset of climate change is one significant driver having impacts both in the short term, through extreme events, as well as gradually overtime. Climate-smart approaches present the opportunity to guide such transformations to establish and re-enforce resilience and adaptive capacity within landscapes to maintain diverse ecological functioning and alternatives to support livelihoods.

This being said, there are often a number of enabling factors conducive for successful CSLAs: for example, having the appropriate supportive policies, institutions and governance, appropriate and available financing, and the capacity to measure and evaluate if actual multifunctionality and synergies are being achieved (Scherr et al., 2012; Harvey et al., 2013; FAO, 2013). Additionally, there needs to be some incentive for a coordinating or implementing body or institution to be motivated in taking a CSLA, which can relate to locally, nationally or globally driven interests. For example, the re-establishment of the Ngitili practice in the Shinyanga Region of Tanzania, as briefly described in Table 3.1, was locally driven by decreased livelihood alternatives linked to extreme environmental degradation and the threat of desertification in the area. At the provincial/district level, the Indonesian government has adopted the six-step Land-Use Planning for loW-Emissions development Strategies (LUWES; see Dewi et al., Chapter 17, this book) tool, which identifies the most effective and efficient low-emission development alternatives by crossing-sectors and accounting for landscape-scale interactions. Adoption of this tool was motivated by Indonesia's national target for unilaterally reducing emissions 26% by 2020 (Dewi et al., 2011). This resulted in regional officials looking for ways to reduce emissions at the regional (landscape) scale. And lastly, an example of globally driven incentives is multinational corporations wanting to address climate risk in their supply value chains. Two multinational corporations, Starbucks (Kissinger, 2013) and Olam International (Brasser, 2013), were concerned about the climate impacts on one of their main commodities, coffee and cacao respectively. To reduce the risk in their supply value chain, both companies used landscape approaches to incentivise farmers in their source landscapes to adopt production practices that promoted adaptation and mitigation. This was designed both to make their production systems more resilient, and to improve farmers' livelihoods through increased income. The latter objective was important to ensure farmers would continue to be incentivised to produce the specific commodities and not shift production to other cash crops.

As demonstrated, motivations for taking CSLAs will vary. Such motivations can be based upon the desire for climate risk management or reduction, advanced preparation for future climates, carbon sequestration and/or reduced GHG emissions (Cooper et al., 2013). At the international and national levels, mechanisms such as Reducing Emissions from Deforestation and forest Degradation (REDD+), Nationally Appropriate Mitigation Actions (NAMA) and National Adaption Programmes of Action (NAPA) are potential policy-based incentives where a CSLA can be applied (e.g., Bernard et al., 2013). But when implementing a CSLA through one of theses policy mechanisms, it is important that multifunctionality is directly addressed by 1) having clear primary and secondary objectives, and 2) clearly understanding synergy and tradeoff potentials for primary objectives at the landscape scale. As part of this, collaboration across different sectors and actors (e.g., government, communities and the private sector) to work on shared objectives with clearly delineated roles and responsibilities will strongly support such processes. Additionally, more research is needed to better measure, understand and monitor multifunctionality and synergy processes and outcomes, as the translation from theory to practice is often a much more challenging pursuit.

To further promote climate-resilient pathways as called for in the IPCC 5th Assessment Report, there is a need for CSLAs to address both climate change mitigation and adaptation, either together or individually. Although CSLA approaches will not be appropriate everywhere, depending on the local context and existing drivers, such an approach certainly has potential to help instigate transformations towards more sustainable futures. Capitalising on synergies that reinforce and build upon climate-smart pathways will certainly be a part of this process.

5. Conclusion

Both additive and superadditive synergies are needed to promote climate-smart multifunctionality within landscapes globally. As the impacts of climate change will continue to be intensified, it is important that climate-smart pathways are urgently pursued to reduce negative impacts. Capitalising on synergistic opportunities to promote multifunctionality can help to reduce tradeoffs and reinforce feedback cycles, which build and strengthen adaptive capacity supporting sustainable trajectories. If such approaches are not taken up, and instead climate change is left to drive landscape transformations, it is likely that maladaptive cycles will instead be reinforced with dire consequences for ecosystem functioning, environmental resources and local communities, with the resulting impacts, in many instances, extending to national and global scales. Facilitation of climate-smart landscapes through the pursuit of multifunctionality is one promising approach for promoting sustainable transformations through establishing climate-resilient pathways.

Endnotes

1 Climate change mitigation is defined as reducing the emission of greenhouse gases (GHGs) and other climate forcing species and/or enhancing sequestration/increasing carbon sinks to lessen the projected impacts of climate change. Climate change adaptation, on the other hand, can be defined as building resilience to better cope with changing conditions resulting from climate change and reducing vulnerability to such changes. This can involve both developing adaptive capacity (i.e., resilience; see Holling, 2001) and changing trajectories by using the capacity to take action (Adger et al., 2005). As described by Moser and Ekstrom (2010), adaptation strategies can range from "…short-term coping to longer-term, deeper transformations…" which, "…may or may not succeed in moderating harm or exploiting beneficial opportunities".

2 Climate-smart agriculture (CSA) involves applying specific agricultural practices with the aims to "… improve food security, help communities adapt to climate change and contribute to climate change mitigation by adopting appropriate practices, developing enabling policies and institutions and mobilising needed finances" (FAO, 2013; pg 1).

3 Knickel and Renting (2000) define multiplier effects in the context of rural development as "…relat[ing] to effects that are indirect either in spatial terms or in terms of the actors and activities involved. Conceptually, multiplier effects are related to other segments of the rural economy and not to the specific enterprises that have been the focus of analysis".

References

Adger, N. W., Arnell, N. W., & Tompkins, E. L. (2005). Successful adaptation to climate change across scales. *Global Environmental Change, 15*(2), 77–86. doi:10.1016/j.gloenvcha.2004.12.005

Bennett, E. M., Carpenter, S. R., & Caraco, N. F. (2001). Human impact on erodable phosphorus and eutrophication: a global perspective increasing accumulation of phosphorus in soil threatens rivers, lakes, and coastal oceans with eutrophication. *BioScience, 51*(3), 227–234.

Bernard, F., Minang, P. A., van Noordwijk, M., Freeman, O. E., & Duguma, L. A. (2013). *Towards a landscape approach for reduction emissions: a substantive report of reduction emissions from all land uses (REALU) project*. Nairobi, Kenya: World Agroforestry Centre. Retrieved from http://asb.cgiar.org/PDFwebdocs/Substantive Global Report_REALU II_FINAL_15nov_2_standard.pdf

Biesbroek, G. R., Swart, R. J., & van der Knaap, W. G. (2009). The mitigation–adaptation dichotomy and the role of spatial planning. *Habitat International, 33*(3), 230–237. doi: 10.1016/j.habitatint.2008.10.001

Branca, G., McCarthy, N., Lipper, L., & Jolejole, M. C. (2011) *Climate-Smart Agriculture: A Synthesis of Empirical Evidence of Food Security and Mitigation Benefits from Improved Cropland Management.* Rome, Italy: Food and Agriculture Organization of the United Nations (FAO).

Brasser, A. (2013). *Olam International and Rainforest Alliance Case Study. Reducing Risk: Landscape Approaches to Sustainable Sourcing.* Washington, DC: EcoAgriculture Partners, on behalf of the Landscapes for People, Food and Nature Initiative.

Brunori, G., & Rossi, A. (2000). Synergy and coherence through collective action: some insights from wine routes in Tuscany. *Sociologia ruralis, 40*(4), 409–423.

Cooper, P. J. M., Cappiello, S., Vermeulen, S. J., Campbell, B. M., Zougmore, R., & Kinyangi, J. (2013). *Large-scale implementation of adaptation and mitigation actions in agriculture.* CCAFS Working Paper no. 50. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Retrieved from http://ccafs.cgiar.org/publications/large-scale-implementation-adaptation-and-mitigation-actions-agriculture#.U_RCqLySwmc

DeFries, R., & Rosenzweig, C. (2010). Toward a whole-landscape approach for sustainable land use in the tropics. *Proceedings of the National Academy of Sciences, 107*(46), 19627–19632. doi: 10.1073/pnas.1011163107/-/DCSupplemental

Dewi, S., Ekadinata, A., Galudra, G., Agung, P., & Johana, F. (2011). *LUWES: Land use planning for Low Emission Development Strategy.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) SEA Regional Office.

Duff, G., Garnett, D., Jacklyn, P., Landsberg, J., Ludwig, J., Morrison, J., ... Whitehead, P. (2009). A collaborative design to adaptively manage for landscape sustainability in north Australia: lessons from a decade of cooperative research. *Landscape Ecology, 24*(8), 1135–1143. doi: 10.1007/s10980-008-9236-5.

Duguma, L. A., Minang, P.A., Kimaro, A. A., Otsyina, R., & Mpanda, M. (2013). *Climate smart landscapes: Integrating mitigation, adaptation and development in Shinyanga region Tanzania.* ASB Policy Brief No. 40. Nairobi, Kenya: ASB Partnership for the Tropical Forest Margins.

Duguma, L. A., Minang, P. A., & van Noordwijk, M. (2014). Climate Change Mitigation and Adaptation in the Land Use Sector: From Complementarity to Synergy. *Environmental Management, 54*(3), 420-432. doi: 10.1007/s00267-014-0331-x

FAO (Food and Agriculture Organization of the United Nations). (2013). *Climate-Smart Agriculture Sourcebook.* Rome: FAO.

Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E. S., Gerber, J. S., Johnston, M., … Zaks, D. P. M. (2011). Solutions for a cultivated planet. *Nature, 478*(7369), 337–342. doi:10.1038/nature10452

Freeman, O. E., & Zerriffi, H. (2012). Carbon credits for cookstoves: Trade-offs in climate and health benefits. *The Forestry Chronicle, 88*(5), 600–608.

Frost, P., Campbell, B., Medina, G., & Usongo, L. (2006). Landscape-scale approaches for integrated natural resource management in tropical forest landscapes. *Ecology and Society, 11*(2), 1–14.

Geist, H. J., & Lambin, E. F. (2002). Proximate Causes and Underlying Driving Forces of Tropical Deforestation: Tropical forests are disappearing as the result of many pressures, both local and regional, acting in various combinations in different geographical locations. *BioScience, 52*(2), 143–150. doi:10.1641/0006-3568%282002%29052%5B0143%3APCAUDF%5D2.0.CO%3B2

Giller, K. E., Witter, E., Corbeels, M., & Tittonell, P. (2009). Conservation agriculture and smallholder farming in Africa: The heretics' view. *Field Crops Research,* 114, 23–34. doi:10.1016/j.fcr.2009.06.017

Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., ... Toulmin, C. (2010). Food Security: The Challenge of Feeding 9 Billion People. *Science, 327*(5967), 812–818. doi:10.1126/science.1185383

Grieshop, A. P., Marshall, J. D., & Kandlikar, M. (2011). Health and climate benefits of cookstove replacement options. *Energy Policy, 39*(12), 7530–7542. doi:10.1016/j.enpol.2011.03.024

Harvey, C. A., Chacón, M., Donatti, C. I., Garen, E., Hannah, L., Andrade, A., ... Wollenberg, E. (2013). Climate-Smart Landscapes: Opportunities and Challenges for Integrating Adaptation and Mitigation in Tropical Agriculture. *Conservation Letters, 7*(2), 77–90. doi:10.1111/conl.12066

Holling, C. S. (2001). Understanding the Complexity of Economic, Ecological, and Social Systems. *Ecosystems, 4*(5), 390–405. doi: 10.1007/s10021-001-0101-5

Hosonuma, N., Herold, M., De Sy, V., De Fries, R. S., Brockhaus, M., Verchot, L., … Romijn, E. (2012). An assessment of deforestation and forest degradation drivers in developing countries. *Environmental Research Letters, 7*(4), 044009. doi:10.1088/1748-9326/7/4/044009

Howden, S. M., Soussana, J.-F., Tubiello, F. N., Chhetri, N., Dunlop, M., & Meinke, H. (2007). Adapting agriculture to climate change. *Proceedings of the National Academy of Sciences of the United States of America, 104*(50), 19691–19696. doi:10.1073/pnas.0701890104

Iiyama, M., Neufeldt, H., Dobie, P., Njenga, M., Ndegwa, G., & Jamnadass, R. (2014). The potential of agroforestry in the provision of sustainable woodfuel in sub-Saharan Africa. *Current Opinion in Environmental Sustainability,* 6*,* 138–147. doi:10.1016/j.cosust.2013.12.003

IPCC (Intergovernmental Panel on Climate Change). (2014). Summary for policymakers. In Field, C. B., Barros, V. R., Dokken, D. J., Mach, K. J. Mastrandrea, M. D., Bilir, T. E., … White, L. L. (Eds.) *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, 1-32. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

IPCC. (2013*a*). Summary for Policymakers. In Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S. K., Boschung, J., … Midgley, P. M. (Eds.) *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

IPCC. (2013*b*). Chapter 20. Climate-Resilient Pathways: Adaptation, Mitigation, and Sustainable Development . In Field, C.B., Barros, V. R., Dokken, D. J., Mach, K. J., Mastrandrea, M. D., Bilir, T. E., … White, L.L. (Eds.) *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Jeuland, M. A., & Pattanayak, S. K. (2012). Benefits and Costs of Improved Cookstoves: Assessing the Implications of Variability in Health, Forest and Climate Impacts. *PLoS ONE, 7*(2), e30338. doi:10.1371/journal.pone.0030338.t004

Kissinger, G., Brasser, A., & Gross, L. (2013). *Scoping study. Reducing Risk: Landscape Approaches to Sustainable Sourcing.* Washington, DC: Landscapes for People, Food and Nature Initiative.

Kissinger, G. (2013). *Starbucks and Conservation International case study. Reducing Risk: Landscape Approaches to Sustainable Sourcing.* Washington, DC: EcoAgriculture Partners, on behalf of the Landscapes for People, Food and Nature Initiative.

Klein, R. J., Huq, S., Denton, F., Downing, T. E., Richels, R. G., Robinson, J. B., & Toth, F. L. (2007). Inter-relationships between adaptation and mitigation. Climate Change 2007: Impacts, Adaptation and Vulnerability. In Parry, M. L., Canziani, O. F., Palutikof, J. P., van der Linden, P. J., & Hanson, C. E. (Eds.) *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, 745-777. Cambridge, U.K.: Cambridge University Press.

Knickel, K., & Renting, H. (2000). Methodological and conceptual issues in the study of multifunctionality and rural development. *Sociologia ruralis*, 40(4), 512–528.

Kremen, C., & Miles, A. (2012). Ecosystem Services in Biologically Diversified versus Conventional Farming Systems: Benefits, Externalities, and Trade-Offs. *Ecology and Society, 17*(4), 40. doi: 10.5751/ES-05035-170440

Kutsch, W. L., Merbold, L., Ziegler, W., Mukelabai, M. M., Muchinda, M., Kolle, O., & Scholes, R. J. (2011). The charcoal trap: Miombo forests and the energy needs of people. *Carbon Balance and Management, 6*(1), 5. doi:10.1186/1750-0680-6-5

Mbow, C., Smith, P., Skole, D., Duguma, L., & Bustamante, M. (2014). Achieving mitigation and adaptation to climate change through sustainable agroforestry practices in Africa. *Current Opinion in Environmental Sustainability*, 6, 8–14. doi: 10.1016/j.cosust.2013.09.002.

MEA (Millennium Ecosystem Assessment). (2005). *Ecosystems and Human Well-being: Synthesis*. Washington, DC: Island Press.

Milder, J. C., Hart, A. K., Dobie, P., Minai, J., & Zaleski, C. (2014). Integrated Landscape Initiatives for African Agriculture, Development, and Conservation: A Region-Wide Assessment. *World Development,* 54, 68–80. doi:10.1016/j.worlddev.2013.07.006

Moser, S. C., & Ekstrom, J. A. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences, 107*(51), 22026–22031. doi:10.1073/pnas.1007887107/-/DCSupplemental

Parrott, L., & Meyer, W. S. (2012). Future landscapes: managing within complexity. *Frontiers in Ecology and the Environment, 10*(7), 382–389. doi:10.1890/110082

Rosenstock, T. S., Kirui, J., Mpanda, M., Erasto, M., Masood, T., Shepherd, K., ... Franzel, S. (2014*a*). *Semi-Annual Report: Mitigation of Climate Change in Agriculture (MICCA) Pilot Projects.* ICRAF/CARE/FAO.

Rosenstock, T. S., Mpanda, M., Kimaro, A., Luedeling, E., Kuyah, S., Anyekulu, E., ... Neely, C. (2014*b*). *Science to support low-emissions agricultural development: Concepts and lessons learned from the MICCA Pilot Projects in East Africa.* Rome: FAO.

Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J.-L., Sheil, D., Meijaard, E., ... Buck, L. E. (2013). Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. *Proceedings of the National Academy of Sciences, 110*(21), 8349–8356. doi:10.1073/pnas.1210595110/-/DCSupplemental

Scherr, S. J., & McNeely, J. A. (2008). Biodiversity conservation and agricultural sustainability: towards a new paradigm of "ecoagriculture" landscapes. *Philosophical Transactions of the Royal Society B: Biological Sciences, 363*(1491), 477–494. doi:10.1098/rstb.2007.2165

Scherr, S. J., Shames, S., & Friedman, R. (2012). From climate-smart agriculture to climate-smart landscapes. *Agriculture & Food Security, 1*(12), 1–15. doi:10.1186/2048-7010-1-12

Simon, G. L., Bumpus, A. G., & Mann, P. (2012). Win-win scenarios at the climate–development interface: Challenges and opportunities for stove replacement programs through carbon finance. *Global Environmental Change, 22*(1), 275–287. doi:10.1016/j.gloenvcha.2011.08.007

Steffan-Dewenter, I., Kessler, M., Barkmann, J., Bos, M. M., Buchori, D., Erasmi, S., … Tscharntke, T. (2007). Tradeoffs between income, biodiversity, and ecosystem functioning during tropical rainforest conversion and agroforestry intensification. *Proceedings of the National Academy of Sciences, 10*4(12), 4973–4978. doi: 10.1073/pnas.0608409104

Tallis, H., Kareiva, P., Marvier, M., & Chang, A. (2008). An ecosystem services framework to support both practical conservation and economic development. *Proceedings of the National Academy of Sciences of the United States of America, 105*(28), 9457–9464. doi: 10.1073/pnas.0705797105.

UNEP (United Nations Environment Programme). (2011). *Report on how to improve sustainable use of biodiversity in a landscape perspective: executive summary* (UNEP/CBD/SBSTTA/15/13). United Nations Environment Programme Subsidiary Body on Scientific, Technical and Technological Advice, 15th Meeting, Montreal, Canada November 7–11. Retrieved from http://www.cbd.int/doc/meetings/sbstta/sbstta-15/official/sbstta-15-13-en.pdf

von Eye, A., Schuster, C., & Rogers, W. M. (1998). Modelling synergy using manifest categorical variables. *International Journal of Behavioral Development, 22*(3), 537–557.

Zagst, L. (2012). *Socio-economic Survey CARE-MICCA Pilot Project in the United Republic of Tanzania, Final Report.* Rome: FAO.

Participatory community meeting, Niger. Photo credit: Mahamane Larwanou

CHAPTER

4

What can climate-smart agricultural landscapes learn from the *gestion de terroirs* approach?

Florence Bernard

Highlights

- The *gestion de terroirs* approach, practiced largely in French-speaking African countries, is a potentially rich experience base for developing climate-smart landscapes
- When institutionalizing a climate-smart landscape approach, spatial variation of the landscape's boundaries needs to be taken into account
- Careful design and implementation of institutional mechanisms such as multi-stakeholder planning, clarification of rights and decentralized governance as well as strengthened stakeholder and institutional capacity are key elements needed for successful climate-smart landscapes
- Sustainability of climate-smart landscape approaches will require supportive policies at multiple scales and applying context-specific, locally-relevant incentives

1. Introduction

Climate-smart agricultural landscapes operate on the principles of integrated landscape management with explicit incorporation of adaptation and mitigation goals along with improvements in food security, rural livelihoods, biodiversity conservation and ecosystem services (Scherr et al., 2012; Harvey et al., 2014). Such approaches are driven by the ultimate goal of ensuring resilience, productivity and sustainability with emphasis placed on adaptive management, stakeholder involvement and the simultaneous achievement of multiple objectives at the landscape scale (Sunderland et al., 2013). While the concept of climate-smart landscapes is growing, its operationalization is limited and varied. There is still a need for a number of transformative changes in current policies, institutional arrangements, and funding mechanisms to bring climate-smart landscapes from concept to reality (Scherr et al., 2012; Harvey et al., 2014). In particular, institutional and governance concerns are identified as the most severe obstacles to implementation (Sayer et al., 2013).

To foster implementation of climate-smart landscapes, earlier methodologies and integrated management approaches can hold great potential to learn from. One of these earlier methodologies and approaches implemented to advance goals related to food production, biodiversity or ecosystem conservation and rural livelihoods is the *gestion de terroirs* (GT) approach. The GT approach emerged in the 1990s within the francophone West African states to cope with the failures of previous rural development programmes (e.g., Integrated Rural Development Programmes (IRDPs); the Sustainable Livelihoods (SL) approach; Community Based Natural Resource Management (CBNRM)) (Painter, 1993). Such previous programmes were technically-oriented, over-centralized, sectoral or multi-sectoral but without any real integration, or consideration of the social dimension of development and by-passing local participation (Dengbol,1996). Therefore the GT approach was the first in this region which actually applied an approach including multidisciplinarity, multi-stakeholders and community-driven management (Cleary, 2003). It was then adopted by a myriad of government projects, donors and Non-Governmental Organizations (NGOs) operating in West Africa to address agricultural development in a more holistic and participatory manner (Batterbury, 1998; Cleary, 2003). It featured prominently in environmental policy in Burkina Faso, Senegal, Mali, Côte d'Ivoire, and Niger (Batterbury, 1998). In 1994, in Mali alone, there were over two hundreds GT projects (Bassett et al., 2007).

Although the GT approach no longer forms a part of mainstream development, it has a longer history than most of the other approaches. Therefore, exploration of the strengths and weaknesses associated to the GT approach holds the potential for climate-smart landscape approaches to learn from. This chapter includes an outline of the concepts of the GT and climate-smart landscape approaches, and emphasizes their main similarities and differences. It then examines the main weaknesses of the GT approach and analyzes how lessons learned can be used to enhance implementation of climate-smart landscapes approaches.

2. Comparison of approaches: the *gestion de terroirs* versus climate-smart landscapes

2.1 The *gestion de terroirs* approach

The GT approach focuses on a socially and geographically defined space – so-called *'terroir'* – within which communities' resources and associated rights are located in order to satisfy their needs (Cleary, 2003). The *terroir* is not a concept of physical geography only but it is the basic management unit of rural development taking into account both the physical data and the socio-economic and cultural context (Bassett et al., 2007). The *terroir* represents the socio-natural heritage of a local community with its internal social organization and pattern of resource use (Bassett et al., 2007).

The GT approach calls for a rational utilisation of all resources of the *terroir* (natural, human, financial, etc.) and operates in three interrelated systems (Toulmin, 1994; Batterbury, 1998):

- **The technical system** (e.g., restoring and improving the potential of natural resources, improving the security of agricultural, pastoral and forest production, increasing soil fertility);

- **The socio-economic system** (e.g., training individuals and groups, reinforcing and strengthening local institutions at the *terroir* level)
- **The legal system** (e.g., enabling better security and enforcement of land rights)

The GT approach is a comprehensive multisectoral approach that requires multidisciplinary capacity at the local level. The GT approach is bottom-up, community-driven and decentralized to the *terroir* level. It builds upon the principle that local communities should be responsible for their own development (Cleary, 2003) and therefore seeks the empowerment of local communities through training and education. It relies on participatory appraisal, identifying local priority concerns and involving local communities in processes of planning and decision-making (Mando et al., 2001; see Figure 4.1). It also focuses on developing and reinforcing local-level institutions and bodies/committees to be able to implement sustainable management plans (Cleary, 2003). As part of this, the GT approach supports devolution of decision-making powers from the state and NGOs to the community or village level.

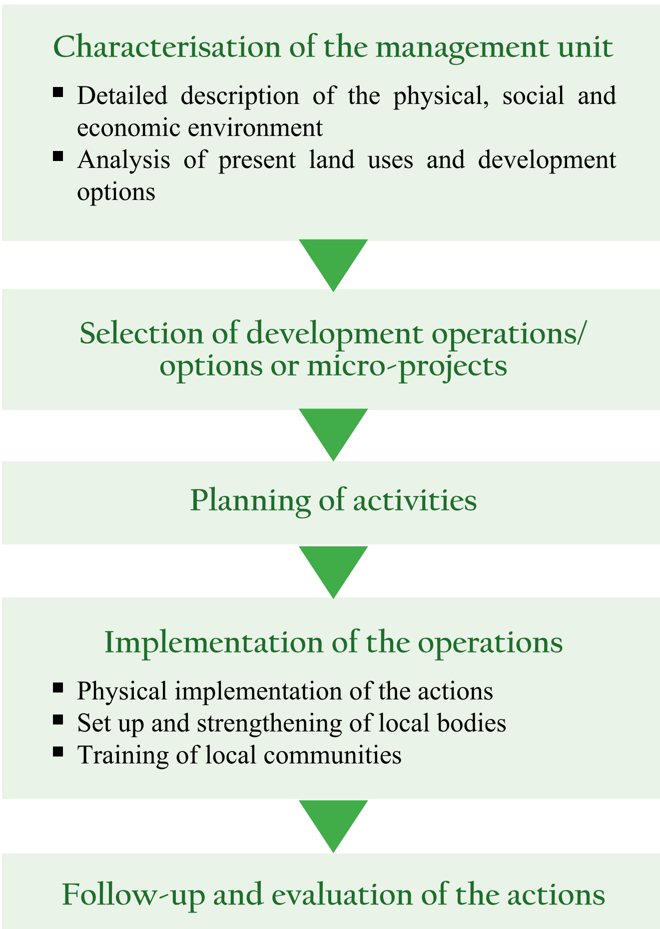

Figure 4.1 Key steps for implementation of GT (Mando et al., 2001).

2.2 The climate-smart landscape approach

Climate-smart landscapes have multiple functions, ecological, social and economic, and operate on the principles of integrated landscape management, but with focus on emission reductions, climate change adaptation and low emission development pathways. For example, Scherr et al. (2012) characterizes climate-smart landscapes by three key features with the overall aim to build resilience and enhance adaptation and mitigation:

- Climate-smart practices at the field and farm scale such as mixed crop-tree systems and integrated soil and nutrient management
- Diversifying land uses across the landscape
- Sustainable management of different land use interactions between field, forest, grasslands and other land uses at the landscape scale

Multiple scales are also a key feature of climate-smart landscapes as understanding processes at the landscape scale requires understanding interactions at scales within and beyond the landscape (Bernard et al., 2013). For instance, understanding emissions reductions in a given community would require understanding behaviour of practices at plot, farm or forest management unit level as well as the driving forces such as markets and policies that are beyond the community boundary (Bernard et al., 2013). Multi-stakeholder planning has also been identified as a founding principle of climate-smart landscape approaches ensuring that all relevant stakeholders from planning authorities, local communities, producer groups, civil society business, and private investors are involved in planning processes to define and negotiate their priorities (Scherr et al., 2012). Other key principles for successful implementation and long-term management of climate-smart landscapes include continual learning and adaptive management, strengthened stakeholder capacity, decentralized governance, and secure systems for land and resource ownership, use and access rights (Scherr et al., 2012).

2.3 Key similarities and differences between the GT and climate-smart landscape approaches

Climate-smart landscape and GT approaches share a number of similar features in terms of their multisectoral, multidisciplinary and multistakeholder approach as well as sharing the aim at achieving multiple objectives (see Table 4.1). Institutional and governance processes such as participatory processes, decentralization and clarification of land rights are emphasized as key levers in both approaches.

Key differences between the two approaches lie in the management unit itself and in their differing focus on linkages with other spatial levels. In many GT projects, the *terroir* has been limited to the village level (so-called *terroir* villageois) or to an inter-village space that would still share the same social and economic space. Therefore the *terroir* has mostly been limited to a tightly defined geographical area where land-use patterns were similar, whereas landscapes are much broader and often described as complex social-ecological systems made up of a mosaic of different land uses (Sayer et al., 2013; Milder et al., 2014). The GT approach focuses at a micro-level rather than tackling broader meso-scale development issues (Quan & Nelson, 2005) and does not address broader ecosystem management issues. Another key difference is that the GT approach has very little linkages with the macro-level, although some governments (such as in Burkina Faso) had introduced some change while cementing GT in national level policy-making. Generally, the GT approach does not provide a framework within which

Table 4.1 Key similarities and differences between the GT and climate-smart landscape approaches.

Feature	***Gestion de terroir* approach**	**Climate-smart landscape approach**
Management unit	- *Terroir*, often limited to village or inter-village scale	- The landscape
Land-use patterns	- Homogenous (in the sense that farmer's practices are similar)	- Heterogeneous in land uses and land use patterns
Sectoral focus	- Multisectoral (but with a strong bias towards agriculture)	- Multisectoral
Field of expertise	- Multidisciplinary	- Multidisciplinary
Key objectives	- Restoration and improvement of natural resources, soil fertility and food production - Security of land rights - Capacity-building of individuals and reinforcement and strengthening of local level institutions at the *terroir* level (Batterbury, 1998)	- Human well-being - Food and fiber production - Climate change adaptation and mitigation - Conservation of biodiversity and ecosystem services (Scherr et al., 2012)
Stakeholder involvement	- Incorporation of the local knowledge and identification of local priority concerns - Involvement of local stakeholders in processes of planning and development and in decision-making - Empowerment of local communities through training and education (Cleary, 2003)	- Emphasis on participatory processes, multi-stakeholder negotiation and recognition of local communities
Integration of actions	- Drawing on synergies between actions to more efficiently generate benefits	- Ecological, social and economic interactions among different parts of the landscape managed to seek positive synergies among interests and actors or reduce negative tradeoffs (Scherr et al., 2012)
Flexibility	- Accommodates changing needs - Iterative process	- Promotion of adaptive strategies based on dynamic social and economic changes
Linkages with other scales	- Focus at the micro level	- Linkages between the micro, meso and macro levels

different village communities, social groups and stakeholders can negotiate sustainable and equitable resource management arrangements or resolve resource conflicts on a wider territorial scale (Quan & Nelson, 2005). In this respect the climate-smart landscape approach is positioned to go beyond such challenges experienced by GT and promote both cooperation between the micro, meso and macro levels and increased connection with national and global strategies.

3. Enhancing operationalization of the climate-smart landscape approach

Building upon the different criticisms of the GT approach, here such limitations are examined to identify key lessons that can be drawn upon to ensure better implementation of the climate-smart landscape approach.

3.1 Space and boundaries

The *terroir* idea assumed that people belong in communities that are clearly locatable within fixed and bounded geographical spaces as argued by Keeley and Scoones (2003). However, the boundaries of the geographical area of intervention are variable and largely according to the type of people's activity. The agricultural *terroir* is not the same as the pastoral *terroir*, or the hunter or fisherman *terroir* for instance. The key limitation of the GT approach is that in most cases, the geographical area was identified almost exclusively in relation with the practice of agriculture and ignored for instance that of pastoralism. Yet migrant livestock farming is the main source of income for millions of persons in the world and in West Africa in particular, with pastoralism being defined by its spatial mobility. Therefore the limits of the geographical area of the *terroir* for a farmer do not correspond to those of a pastoralist. Holistic approaches to rural development such as GT or climate-smart landscapes should not ignore the needs of important livelihoods also present. When implementing and institutionalizing the climate-smart landscape approach, it will be necessary to take into account the spatial variation of landscape boundaries. Local diversity has to be acknowledged and it is important not to assume uniform community interests with the risk of ignoring the complex social, economic and cultural factors that affect how local communities can sustainably use natural resources.

3.2 Multi-stakeholder planning and local accountability

Various organizational committees (*Comités villageois*) have been set up to manage GT in francophone Africa. In some instances, pre-existing indigenous institutions were replaced by new externally imposed village councils rather than building upon the existing intuitional entities (Quan & Nelson, 2005). A number of experiences in different provinces of Burkina Faso (Cleary, 2003) showed that institutions which failed to build on local culture were unsustainable despite being able to attract external funds (Quan & Nelson, 2005). Furthermore, due to their inability to effectively represent local interests, the composition of such *Comités villageois* has been problematic. Such experiences with the GT implementation has shown that balancing representation between the local communities, project staff and government agency representatives is critical insuring that local communities are not overlooked within technical debates (Sayer et al., 2013). But balancing interests within the local community is equally important as in many instances committees were dominated by local elites and/or excluded some resource users such as pastoralists, settlers and sharecroppers. The mode for determining those serving on the planning committees was also important. In some GT projects there was a representative election allowing a certain degree of democracy, but in many cases this led to exclusion of some social groups, in particular, the poorest and most marginalized rural populations such as nomadic groups. Therefore, in other GT projects, the approach chosen was to appoint representatives based on locally-determined criteria to better reflect the existing balance of ethnic groups, gender, social groups and age (Cleary, 2003). Learning from these experiences, to better implement the climate-smart landscape approach, both composition and method of inclusion need to be considered with cautiousness to ensure effective representation of all stakeholder groups.

3.3 Effective decentralized governance over land resources

Transfer of decision-making powers over the management and use of natural resources from government structures to local people is described as a central feature of the GT approach (de Haan, 1998; Cleary, 2003). However, there has been a huge gap between the theory and the reality. Most GT projects have been implemented rather conventionally because the legislation never conferred legal right to community-based institutions to exercise public authority over their resources (Mando et al., 2001). Therefore institutional local structures or committees set up by GT projects or by donor agencies only had informal decision-making powers not legally recognized. This severely hampered their ability to effectively manage land use (Cleary, 2003). Despite sincere attempts in some countries, such as Mali, to apply a policy of decentralization through application of the GT approach (see Box 4.1) this has not gone in hand with serious steps towards redefining the role of the state vis-à-vis the local population (Degnbol, 1996).

In some GT projects, there was an attempt to transfer financial responsibility for rural land use planning and natural resource management to community-based land use and planning committees. The committees were given control of a credit fund provided by the project to implement its activities. These committees were in charge of setting priorities to allocate the limited funds available within the different communities. The committees were also expected to call for tenders, select and sign contracts to build infrastructure and

Box 4.1

Mali's Decentralization Programme and GT approach
(Degnbol, 1996; Woodhouse et al., 2000)

In 1993, the National Assembly in Mali adopted a law illustrating its adherence to a policy of decentralization through application of the GT approach. *Collectivités* or legal entities (e.g., region, commune) were recognized as capable of managing their own natural resources within their *terroir*. However, the GT focused on decision-making structures at village-level through the formation of GT committees. This discrepancy between legal authority and decision-making responsibility did not allow the committees to have legal standing within the new decentralized framework. Therefore the resource management decisions of the GT committees were not considered legally binding hampering the credibility of such GT committees. Experience from Mali seems to suggest that the real challenge to the GT approach, in this case, was redefining the role of the state vis-à-vis the local population. For the initiative to have been successful they needed to have started with examining issues of power relations, ideologies and attitudes of government vis-à-vis local populations.

implement other development activities (Mando et al., 2001). In practice, however, the approach did not fully live up to expectations because in addition to the above-mentioned issues, there was a significant lack of capacity within a number of the GT committees.

If decentralized governance is to happen within climate-smart landscape approaches, there will first need to be clear policies outlining who is given decision-making power over resources as well as more reflection on how to transfer authority from central government authorities to local government staff, and from government structures to local populations. Second, operational decentralized governance requires strengthened stakeholder capacity-building for effective participation, and acceptance of various roles and responsibilities (Sayer et al., 2013).

3.4 Clarification of rights and resource tenure

The process of clarifying and recording land rights is perceived as critical in both the GT and climate-smart landscape approach. In an attempt to clarify resource tenure, the GT approach has used village mapping techniques that create the village *terroir* as a defined territory with distinct boundaries. However, in areas where resource boundaries have historically been flexible and negotiated, the delineation of village spaces has exacerbated existing or latent land-use conflicts (Bassett et al., 2007). The concept of '*terroir*' was sometimes reinterpreted as 'for locals only' and instrumentalized to exclude others in the name of local heritage (Bassett et al., 2007). This is what happened in Côte d'Ivoire where certain groups asserted their indigenous privileges to resources as a means of dispossessing immigrants of their farms. This produced *terroirs* of violence that were at the centre of the the September 19th Côte d'Ivoire rebellion in 2002 (Bassett et al., 2007). Rather than achieving increased productivity and conservation, such attempts for clarifying rights and resource tenure generally led to the opposite (Bassett et al., 2007). In order to avoid such pitfalls while implementing climate-smart landscape approaches, there should be specific focus on ensuring that secondary land rights of non-landholding groups are preserved. There will be need for carefully negotiated processes and a legitimate conflict resolution and recourse system (Scherr et al., 2012). These can be supported by improving the justice system, making courts more accessible, and devolving conciliation powers to local authorities or customary chiefs (Cotula et al., 2004).

3.5 Supportive policy and legal framework

Most GT programmes took place in a policy and institutional vacuum (Cleary, 2003) and many projects therefore operated in an autonomous manner even though formally attached to government structures (Degnbol, 1996). Without an overarching framework, there have been different methodologies and implementation approaches for the GT projects which have contributed to extend the boundaries of methodological innovation but which have also not always respected the principles of active participation of the local population (Cleary, 2003). The only exception to this lack of policy framework is the Government of Burkina Faso which made GT a specific policy in their efforts to promote rural development and created the *Programme National de Gestion de Terroir* within the Ministry of Agriculture to ensure a harmonised and coordinated approach (Cleary, 2003).

Furthermore, the focus of the GT approach at the micro-level has resulted in a very limited impact on influencing wider institutional and policy issues, and did not facilitate cross-sectoral coordination of government programmes in responding to local priorities (Quan & Nelson, 2005). This suggests that for more effective and efficient programmes, there is a need for greater cooperation between the micro, meso and macro levels and above all, the need for acknowledging climate-smart landscape approaches within national decision-making processes. It is important that the landscape approach can influence wider policy and institutional issues so that effective land use planning and management can happen in a coherent manner from local to national levels.

3.6 Maintaining local incentives

In the history of GT implementation, there has been some disillusionment of local community involvement, much of which only encompassed participating in meetings and making plans over multiple year time frames without manifestation of any corresponding tangible benefits (Cleary, 2003). Furthermore, there has been a lack of attention to source sustainable financing for such projects with most GT programmes having been reliant on external financing (Quan & Nelson, 2005). Therefore, while climate-smart landscape approaches are being further developed, it is critical to develop local incentives which relate to direct, concrete benefits. Local incentives for climate-smart landscapes will be guided by demand for reduced emissions, high-carbon stock landscapes and by-products and can be financial (e.g., compensation for opportunity costs) or non-financial (e.g., increased range of livelihood opportunities, public infrastructure, access to technical and credit services, formalizing land tenure and local resource rights, and intensifying productivity on non-forest lands).

4. Conclusion

The GT approach was very innovative by leading the way in participatory approaches, empowering local communities, institution building and promoting decentralization. However, a review of the approach suggests the reality often fell far short of the rhetoric and promise of GT. Therefore lessons learnt from the GT approach are highly valuable in the process of operationalizing climate-smart landscape approaches. First, when implementing climate-smart landscape approaches, it will be necessary to take into account the spatial variation of landscape boundaries based on the various type of people's activity and livelihoods. Second, it is also crucial to emphasize the importance of careful design and implementation of key institutional mechanisms such as multi-stakeholder planning, decentralized governance and clarification of rights. Thus, effective multi-stakeholder planning processes need to build upon historical, cultural and institutional realities, acknowledge heterogeneous interests and support genuine accountability and representativeness. Furthermore, integration of local institutions into decentralized legal, economic and institutional frameworks should be encouraged. Additionally, clarification of rights needs to be included within the development of a legitimate conflict resolution and recourse system. Overall, the review of the GT approach revealed the importance of strengthened stakeholder capacity and extensive institution building. Eventually, climate-smart landscape approaches need to be included in a clear policy and institutional framework to support the long-term adoption of sustainable practices in landscapes. Context-specific local incentives are also needed to support the long-term adoption of sustainable practices in landscapes. These various lessons should inform future investments in institutional and governance development to support climate-smart landscapes.

References

Batterbury, S. (1998). *Local environmental management, land degradation and the 'Gestion des terroirs" approach in west Africa: policies and pitfalls.* Uxbridge, UK: Department of Geography & Earth Sciences, Brunel University.

Bassett, T. J., Blanc-Pamard, C., & Boutrais, J. (2007). Constructing Locality: The Terroir Approach in West Africa. *Africa*, 77, 104-129. doi:10.3366/afr.2007.77.1.104

Bernard, F., Minang, P. A., van Noordwijk, M., Freeman, O. E., & Duguma, L. A. (Eds.) (2013). *Towards a landscape approach for reducing emissions: substantive report of Reducing Emissions from All Land Uses (REALU) project.* Nairobi, Kenya: World Agroforestry Centre (ICRAF).

Cleary, D. (2003). *People-centred approaches: A brief literature review and comparison of types.* Rome, Italy: Food and Agriculture Organization of the United Nationas (FAO).

Cotula, L., Toulmin, C., & Hesse, C. (2004). *Land tenure and administration in Africa: lessons of experience and emerging issues.* London, U.K.: International Institute for Environment and Development.

de Haan, L. (1998). Gestion de Terroir at the Frontier: village land management including both peasants and pastoralists in Benin. In: Bruins, H.J. & Lithwick, H. (Eds.), *The Arid Frontier. Interactive Management Of Environment And Development.* Boston, MA: Kluwer Academic Publishers, 209-277.

Degnbol, D. (1996). *The Terroir Approach to Natural Resource management, Panacea Or Phantom?: The Malian Experience.* Bodoe, Norway: International Development Studies, Roskilde University.

Harvey, C. A., Chacon, M., Donatti, C., Garen, E., Hannah, L., Andrade, A., … Wollenberg, E. (2014). Climate-smart landscapes: opportunities and challenges for integrating adaptation and mitigation in tropical agriculture. *Conservation Letters, 7*(2), 77-90.

Keeley, J., & Scoones, I. (2003). *Understanding Environmental Policy Processes: cases from Africa.* Sterling, VA: Earthscan.

Mando, A., van Rheenen, T., Stroosnijder, L., & Nikiema, R. (2001). Village Land Use in Burkina Faso: "Gestion Terroir". In: Stroosnijder, L., & van Rheenen, T. (Eds.), *Agro-Silvo-Pastoral Land Use in Sahelian Villages.* Reiskirchen, Germany: Catena-Verlag.

Milder, J. C., Hart, A. K., Dobie, P., Minai, J., & Zaleski, C. (2014). Integrated Landscape Initiatives for African Agriculture, Development, and Conservation: A Region-Wide Assessment. *World Development,* 54, 68-80.

Painter, T. (1993). *Getting it right: linking concepts of action for improving the use of natural, resources in Sahelian West Africa.* Issues Paper no 40. London, U.K.: International Institute for Environment and Development.

Quan, J., & Nelson, V. (2005). *Territory and rural development: concepts, methods and approaches.* Land and Territory Research Paper No. 2. University of Greenwich, UK: Natural Resources Institute.

Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J. L., Sheil, D., Meijaardb, E., … Buck, L. E. (2013). Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. *Proceedings of the national academy of sciences, 110*(21), 8349-8356.

Scherr, S. J., Shames, S., & Friedman, R. (2012). From climate-smart agriculture to climate-smart Landscapes. *Agriculture & Food Security 1*(12). doi:10.1186/2048-7010-1-12

Sunderland. T., Sayer, J., & Minh-Ha, H. (Eds.) (2013). *Evidence-Based Conservation: Lessons from the Lower Mekong.* Bogor, Indonesia: CIFOR.

Toulmin, C. (1994). *Gestion de Terroir: Concept and Development.* London, U.K.: International Institute for Environment and Development.

Woodhouse, P., Bernstein, H., & Hulme, D. (Eds.) (2000). *African enclosures? The social dynamics of wetlands in drylands.* Oxford: James Currey; Trenton, NJ: Africa World Press; Cape Town: David Philip, and Nairobi: EAEP.

A restored Ngitili system in the Shinyanga Region, Tanzania. Photo credit: Lalisa A. Duguma

CHAPTER

5

Landscape restoration from a social-ecological system perspective?

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Highlights

- Ecosystem degradation is increasingly creating concerns about the provisions of various services (e.g., food, feed, wood, water, etc.)
- Landscape restoration is being done in different parts of the world with different implementation frameworks
- The Social-Ecological Systems Framework (SESF) provides a good basis for assessing progress made by landscape-scale restoration programmes despite having its own challenges
- The HASHI programme in Tanzania was used to illustrate SESF application at the landscape level

1. Introduction

Millennium Ecosystem Assessment (2005) revealed that around 60% of ecosystem services that are heavily relied on by humans are either degraded or being used unsustainably. This is alarming as the majority of the people who directly depend on such functions and services are the poor, rural communities who are disproportionately being affected by the degradation. The extent of the problem is severe in developing countries where measures to curb the problem are often marred by shortage of resources (e.g., finances, infrastructure, technology) and the required capacity to handle the problems. For instance, land degradation remains a key challenge that is hampering the production potential of rural landscapes. A landscape can be degraded due to a number of reasons, for example, overuse (e.g., exploitation), natural disasters (e.g., landslides, flood effects, drought, etc.), and misuse (e.g., pollution, improper land use practices, etc.). Degradation often occurs when the replenishment potential of the landscape is exceeded by utilization and/or when this feature of the landscape is severely depleted by natural forces such as flooding, fire, landslides, etc. As a result, communities may engage in exploiting nearby resources such as natural forests and biodiversity conservation areas to gain more farmlands that are productive and to extract tree products such as timber and fuelwood to generate additional income to sustain their families (Duguma et al., 2009). What makes the degradation problem even worse is the strong interdependence among the different ecosystem services. For example, forest clearing for creation of new agricultural lands affects the habitat services provided by the forest and influences the hydrology of the landscape thereby negatively affecting the water supply of the area.

The extent to which the different functions and services could be provided by a landscape depends on its management state. Three possible states of a landscape can be identified: 1) a landscape that is functioning properly and well managed, 2) a landscape that is being degraded due to unsustainable exploitation, and 3) a landscape that is severely degraded where the net worth of restoration outcomes may not be greater than the efforts and resources required to restore it. It is necessary to note that even these categories are very subjective. Of the three landscape states, in this chapter we mainly look at those needing restoration with some inherent restoration potential.

Realizing the degradation problems, a number of restoration actions were taken in different parts of the world ranging from global programmes such as the International Union for Conservation of Nature (IUCN), global forest landscape restoration programme, natural resource management programmes by the Global Environment Facility (GEF), and the Worldwide Fund for Nature (WWF) restoration programmes focusing on local level restoration efforts by the affected communities and national governments. However, most of such efforts have their own frameworks of implementation and evaluation regarding the restoration activities, and thus pose a challenge on how to uniformly assess the progress made by such systems and its sustainability. Another key concern in most restoration programmes is they largely emphasize ecological processes and provide limited space for socioeconomic attributes (Wortley et al., 2013). Recognizing the limitations of such restoration efforts of the past, recent restoration programmes and projects are focusing on inclusive processes where the local communities' societal/development needs are also taken into account. However, this effort to embrace the societal needs within restoration programmes is not done using a consistent framework. That is why the call for a coherent framework that captures the two dimensions (socioeconomic and ecological) while also guiding the monitoring of landscape management is increasing. In our view, the Social-Ecological Systems Framework (SESF) (Ostrom, 2009) would be a very helpful approach for landscape-level restoration initiatives. Restoration in this context refers to efforts made to bring back the functions that the landscape used to provide before the degradation processes started and hence our emphasis is largely on functional restoration (see Crow, 2014; Olivier, 2014).

In this chapter, we examine how applicable the SESF is to landscape restoration schemes and highlight some of the limitations of the framework under such contexts. We illustrate the applicability and usefulness of the SESF using the HASHI (Hifadhi Ardhi Shinyanga - Shinyanga Soil Conservation) programme in Tanzania as a case study example.

2. Landscape restoration for multiple objectives

The landscape is a complex system (Parrot et al., 2012) composed of biophysical, social, economic, and governance elements. It is the dynamic equilibrium resulting from the interactions between these different components and processes (Meinig, 1979). A landscape comprises a multitude of functions, actors, sectors and units. The functions and the units that provide those functions are often delimited from the perspective of the actors and sectors active within the landscape. Functions here refer to "…the capacity of natural processes and components to provide goods and services that satisfy human needs directly or indirectly" as defined by De Groot et al. (2002). They are classified broadly as provisioning, regulating, cultural and supporting functions (Millennium Ecosystem Assessment, 2005). Service is defined as "…the aspects of ecosystems utilized directly or indirectly to produce human well-being", according to Fisher et al. (2009). In managed landscapes, there is often some stake from humans that link with landscape features, components or outputs. Even abandoned areas are associated with a certain type of function/service linked to human interests. This, in most cases, is due to the presence of both 'active' and 'passive' stakeholders in a given landscape. The former includes communities and institutions currently living/working in the landscape, local governments, and other relevant landscape actors. The latter includes national governments, international organizations and other global community actors whose link with the landscape is through functions such as climate regulation, hydrological effects and biodiversity conservation that often go beyond the 'boundary' of the landscape.

The interactions and interdependences among the components in the landscape are strong determinants of the magnitude of functions/services a given landscape could deliver. Interaction is more related to the tradeoffs between the different functions/services, hence, looking more to how the functions/services negatively influence each other. Interdependence, on the other hand, is more in line with 'symbiotic' relations between functions/services whereby the extent of a given function/service depends on how well the function(s) it depends on is managed. For example, if a landscape is to deliver ecological functions such as habitat for wildlife, it is necessary to have the woodlands or forests managed properly. There should also be a water source for the animals, the extent of which is determined by the hydrological functions from the components of the landscape. Thus, there is a strong interdependence between habitat management, hydrological functions, wildlife presence and economic benefits from tourism to mention a few. Such objectives on the other hand could also influence each other negatively when wild animals damage crops grown by the farmers/agropastoralists (e.g., Gillingham & Lee, 2003; Wang et al., 2006). Wild animals could also transmit diseases to domestic animals (e.g., livestock) if they interact closely (Daszak et al., 2000; Martin et al., 2011). Running such interdependent functions and dealing with those that interact negatively in the same landscape requires a well-planned management strategy that is considerate of such relationships.

Ostrom (2009) argues that communities may not see the added value of conserving resources if there is abundance or if they believe the resource is severely exhausted. Though this notion is realistic, it seems to be confined to the two extremes under which restoration efforts could possibly happen. At times restoration can also be thought of when supply of products required fails to meet the associated demand especially under conditions where alternative options to satisfy that specific demand are absent or more expensive to choose. This means that communities may not always wait until the resource is exhausted, particularly if there is no alternative. Besides, in areas where people are largely dependent on land resources (e.g., agrarian or pastoral communities in the developing nations), they may engage in restoration efforts even before the level of degradation becomes irreversible. Restoration may happen as far as the inherent restoration potential of the landscape is there (Figure 5.1). To achieve a restoration objective, it requires resources amounting to the differences between the inherent potential of the landscape and the resources required to achieve the set objective. Such resources are derivatives of the management interventions (practices and technologies), time and any material and financial inputs required to achieve the restoration objective. For example, it is less likely, or at least very expensive, to start restoration in a landscape where the soil parent material is exposed with no capability of supporting regeneration/growth of plants. The context of exhaustion expressed by Ostrom (2009) is also very general in that it does not qualify the extent explicitly. There are some levels of exhaustion that could possibly be rehabilitated while in cases with sever exhaustion (i.e., where the inherent restoration potential is so minimal), restoration may not be possible or at least too costly and time consuming to achieve.

As illustrated in Figure 5.1, efforts required to restore a landscape very much depend on where you start along the degradation trajectory, which largely is based on an in-depth understanding of the resource systems and resource units. Examining the resource systems and resource units helps to understand the current state of the landscape and estimate the restoration efforts required to get the landscape closer to the reference state. Restoration efforts require resources, which are largely determined by a governance system through negotiations and consultations with the actors in and outside the landscape. The governance system (a core component of SESF as discussed in the following section) also includes monitoring frameworks that can help alert the necessary actors to take timely action to sustain or restore functions and services provided by the landscape. Such timely actions could considerably reduce the efforts required to restore a landscape. For instance, restoration trajectory A (Figure 5.1) requires less effort and resources than

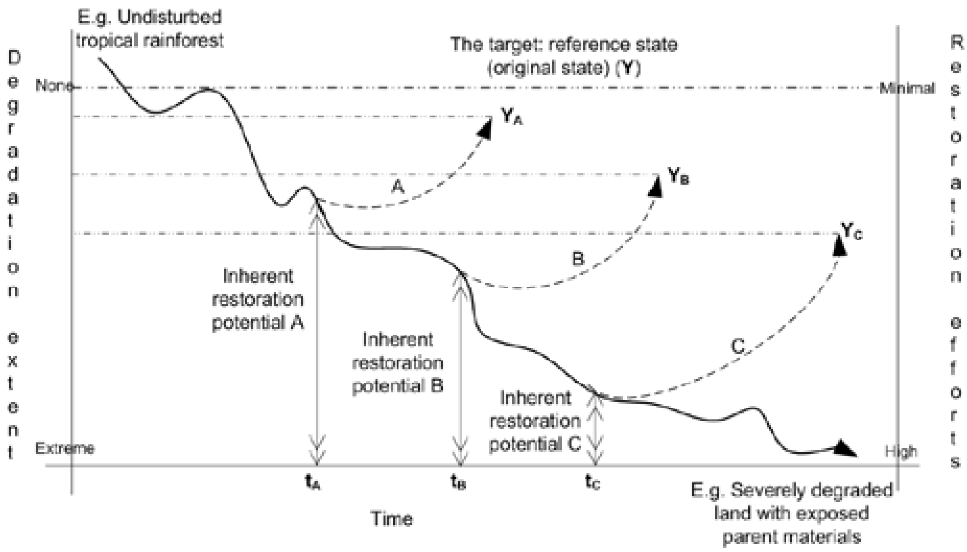

Figure 5.1 Hypothetical degradation-restoration schematic in natural resources management at scales such as a landscape. A, B and C represent hypothetical restoration trajectories that respectively might be taking place at t_A, t_B and t_C. The line represented by Y stands for the reference state. Y_A, Y_B and Y_C stand for hypothetical achievable targets for restoration trajectories A, B and C respectively.

trajectories B and C because in the latter two cases the inherent restoration potential of the landscape is less than in the former one. In a landscape affected by deforestation for instance, the reference state is the undisturbed forest and due to specific activities (e.g., excessive timber extraction and charcoal production, slash and burn, mining), forest cover decreases. If at time t_A, restoration is not done following trajectory A, additional parcels of forests will be cleared and the degradation will continue, resulting in most functions associated with the forest diminishing. The more delayed the restoration is, the more resources required to achieve results closer to the reference state, and hence the difference between the reference state and what could practically be achievable through restoration, increases. This is largely because there are functions that may not easily rehabilitate in the landscape even after extensive restoration. For instance, wild animals may go extinct if there are no more habitats for them. This is why in Figure 5.1, we see after trajectory A, B or C is taken, the corresponding results achieved Y_A, Y_B or Y_C is lower than the original state, Y. It is important to note here that through restoration some functions may exceed the reference state case if complementary new technologies are used in the process, but in general this is not a common occurrence.

3. The social-ecological systems: a brief introduction

Berkes and Folke (1998) define social-ecological systems (SES) as nested multi-systems that provide essential services (e.g., food, fiber, energy, water, habitat, etc.) to societies associated with them. Broadly, the definition has a utility perspective and is thus anthropocentric, making the contextualization of functions in a system to be deliberated from the perspective of human benefits. Ostrom (2009) states that resources used by humans are embedded in complex SESs composed of multiple subsystems having their own attributes. Ostrom (2007; 2009) came up with a framework, the SESF that can help address this social and ecological coupling. Some of the components of the framework were borrowed from Agrawal (2001), which attempted to elicit the critical enabling conditions for sustainability of the commons. Binder et al. (2013) examined the extent to which the social and ecological dimensions are addressed in the different frameworks claiming to be addressing SESs and found that SESF is the one that treats the two components at comparable level besides its multi-tiered variables to describe the key components of the SESs. The social system in SESF is mainly addressed through resource users and the governance structure composed of rules and regulations that determine the extent of the right to use the resources. The ecological system on the other hand is captured through the resource systems composed of different resource units.

SESF has six primary components: four core subsystems comprising of resource systems, resource units, governance systems and users; and two elements, i.e., the social, economic and political setting and related ecosystems that help to understand the linkages between the system (landscape in our case), and bigger subnational and national administrative units (Ostrom 2007; 2009). It is the interplay among the six components that yield an outcome that either benefits the society or affects other ecosystems in a given social, economic and political setting. The outcome has a feedback mechanism for each of the four core subsystems, which contribute to potential improved performance of the SES. Each of the core subsystems are again addressed through a number of specific variables (including at least 50 indicators) which can be referenced in Ostrom (2007; 2009)'s work.

4. The application of SESF to the HASHI programme in the Shinyanga Region, Tanzania

The HASHI programme was implemented since 1980s in the Shinyanga Region in response to ecosystem degradation problems. The programme officially closed in 2004 though the project activities continued to be carried out by Natural Forest Resources and Agroforestry Management Centre (NAFRAC) and the community members after its closure. The Shinyanga Region is home to Wasukuma people, and covers approximately 5.4% of the total land area of Tanzania in its pre-2005 extent, but hosts over 80% of the country's livestock population. Between 1980 and 2003 the region's population doubled reaching about 2.8 million (Mlenge, 2004). The Wasukuma are agropastoral communities dependent on mix of livestock rearing and sedentary agriculture, relying predominantly on the former one. The area is semiarid and the vegetation type is mostly acacia and Miombo woodlands (Mlenge, 2004). Ngitili is an indigenous fodder management system for the dry seasons using enclosure systems wherein farmers enclose a piece of land with trees, grasses, shrubs and forbs to increase fodder production and supply of tree products (Kamwenda, 2002).Two major types of Ngitili exist: household Ngitili owned by individual families and communal Ngitili that is often managed by a group of people, usually community leaders.

The Shinyanga region has undergone a number of processes in terms of the land use characteristics and the associated practices (Figure 5.2). The period before the 1930s, referred to as the reference state, was when the landscapes in the region were considered sustainably managed, before becoming intensely degraded during the period between the 1930s-1980s due to a number of drivers indicated in Figure 5.2 (the degradation phase). The degradation created huge social and ecological problems, which needed restoration measures using practice and action portfolios shown in Figure 5.2's restoration phase. As discussed in Duguma et al. (2014) the restoration effort through the HASHI programme received considerable political support at the national level, in particular, with the government making a number of policy provisions (e.g., revisions of land tenure policies) and financial resources mobilization to support restoration efforts.

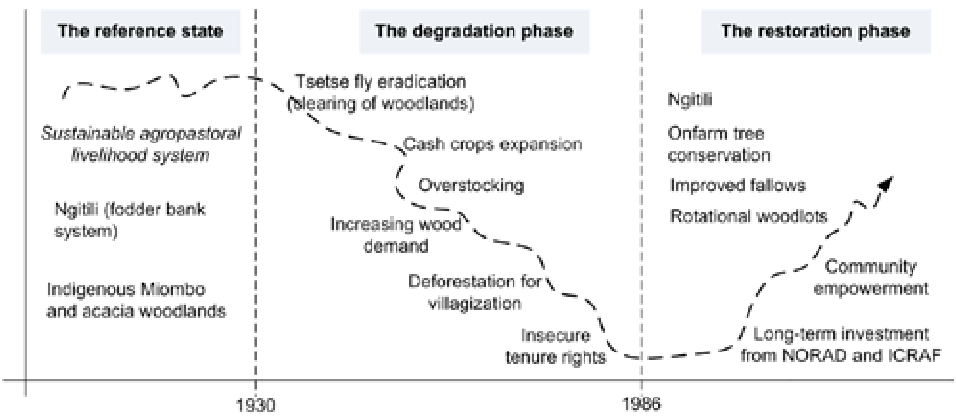

Figure 5.2 Schematic showing elements that characterized the gradual changes in the Shinyanga Region, Tanzania.

4.1 The resource system and the resource units

Resource systems mark a designated area, which encompasses a number of resource units that are governed by certain rules and regulations developed by the community (resource users) and/or by governmental bodies. The expansion after the programme almost covered around 377,756 ha benefiting directly or indirectly approximately 2.8 million people in 833 villages (Monela et al., 2005). HASHI was a multi-sectoral approach addressing woodland reclamation, pasture management, soil conservation and water resource management. Each of the sectors entails resource units such as croplands, pasturelands, woodlands, ponds and mini-dams, that respond to the various needs of the community, for example, providing food, pasture, wood and/or water functions. As the community living in the Shinyanga Region rely strongly on the outcome of the landscapes to meet their basic resource needs (e.g., food, wood, herbal medicines, income sources, etc.) (Mlenge, 2004; Monela et al., 2005), restoring the productivity of the system was mandatory to ensure that the community livelihoods were not threatened. Though so far the system dynamics, particularly the re-emergence of woody species, is being viewed as an achievement, there is a need to examine the expansion limit of such activities as there is a likelihood that the canopy may close at some point in time and limit grass growth. The restoration came with a positive aggregate benefit to the local community estimated at a per capita economic value of around 168 USD per year (Monela et al., 2005).

4.2 The governance system

As an entry point the HASHI programme strongly emphasized empowering local communities to make their voices heard leading to the promotion of the indigenous fodder management practices such as Ngitili together with other agroforestry practices (see Figure 5.2, the restoration phase). This boosted the community's trust of the programme leading to their self-initiated integration of their local resource management practices into the programme by revamping local institutions such as Dagashida (a local unit tasked with conflict resolution through dialogue involving elders), Baraza le Wazee (an elders council serving as a mediator between the traditional and formal institutions) and Sungusungu (a traditionally organized local unit composed of youth and adults tasked with law enforcement) (Monela et al., 2005). The villages also established village environmental committees, which were trained by the HASHI programme to monitor the restoration activities (Mlenge, 2004). The village environmental committees together with the village elders maintained the links between the local community and the formal institutions like the village government and the district-level authorities and representatives overseeing the project. A considerable number of governmental and nongovernmental organizations took part in this programme including the Ministry of Environment and Natural Resources of Tanzania (by facilitating the programme implementation process at national level including policy reforms), NAFRAC (by implementing the project at regional level), local district authorities (by facilitating project implementation and approval of by-laws proposed at the village level), NORAD (Norwegian Agency for Development Cooperation) (by financially supporting the programme), ICRAF (World Agroforestry Centre) (by providing technical support to the programme from planning to the implementation phase), village governments (by facilitating implementation and monitoring the progress of the programme at the grassroots level), and others. The village environmental committee was the central body in making sure the networks among the different actors remained intact. In order to encourage communities in managing the resources sustainably, the government enacted the 1997 Land Policy and the 1999 Land and Village Land Acts, which created a framework for local communities to possess land title deeds, and hence, reducing tenure insecurity.

4.3 The users and the interactions

Local communities are the principal users and beneficiaries of restoration efforts though the benefit accrued by a given community largely depended on the level of engagement in implementing the interventions. For instance, in the case of the communal Ngitili, there are specific rules and regulations put in place by the local leaders and the village government to ensure it is only those who engage in the specific management activities that benefit from it. This Ngitili type is actually managed by groups of communities, and thus, portraying a number of strong self-organizing activities. For those not involved in the restoration process, there is an option of paying for the services or products collected from the Ngitili. However, as expressed by the village environmental committees, there are cases of illegal uses, though the majority of the community respects the local norms and values. The village environmental committee and local leaders determine the level of harvest by different users and the Dagashida and Sungusungu make sure this decision is properly implemented on the ground.

4.4 The outcomes

The communities have rules and regulations on how much of the products are to be harvested by whom under what circumstances. This is a strong indicator to avoid overharvesting which later affects the sustainability of the system. The programme ensures there is fair and equitable sharing of the benefits among group members engaged in managing parcels of the landscape. Often the benefits go to public infrastructure (e.g., schools, roads, etc.) and whenever there is any additional remaining cash, it is shared among the members. Discussion with the communities revealed that the current management system of the restoration programme is fair and accountable as there is a monitoring scheme in place. Still, there are concerns in communal Ngitilis on the unequal benefit sharing as reported in Selemani et al. (2012). Tradeoffs should also be considered as parts of the outcome in SESF. The following are some key tradeoffs observed in Shinyanga region. When the tsetse fly problem declined in the area the livestock population increased significantly, hence, resulting in overstocking and overgrazing. Also, due to the clearance of the woodlands and conversion to cotton and other cash crops, wood scarcity increased and thus leading to the exploitation of the remnant woodlands for wood products.

5. Reflections on the applications of the SESF to the HASHI programme

The SESF proved to be a promising analytical tool to understand different characteristics of the landscape. First, the fact that SESF is more or less a holistic diagnostic tool encompassing social, ecological and governance dimensions, makes it a very practical tool for use at the landscape level. Second, its ability to deconstruct the landscape into various components, as highlighted in the core subsystems of the framework, provided a good basis to understand how landscape management is working from both the social and ecological perspectives. With the often-mentioned 'complexity' of landscapes, this option of deconstruction makes the SESF an ideal framework to understand landscape management from multiple perspectives such as the resource systems and resource units, the users, the governance systems, and the interactions among these variables. Third, such deconstruction also helps landscape managers to understand where the strengths and weaknesses are within the landscape, and hence, giving a clue on intervention areas to change any negative future outcomes.

From the application of the framework to the HASHI programme we identified a number of potential areas of future research and for further refinement of the framework in the context of landscape restoration. These are as follows:

1. The SESF is a diagnostic/analytical framework that helps to understand the landscape largely from its current state, and hence, is not a planning tool though it significantly complements the planning processes.
2. Not all the elements in the SESF, as of now, have specific measurable indicators. This poses a challenge when it comes to the metrics for monitoring progress/change in the management of SESs landscapes.
3. The SESF puts resource systems and resource units as core subsystems. However, decisions that largely affect land use behaviours are associated with the functions and services the users gain from the landscapes. Importance to resource users appears in SESF as one element in the users subsystem, which in fact, should be given more emphasis.
4. Another context of special interest in contexts like landscapes is the issue of tradeoffs. Actors in a landscape make their collective or individual decisions based on the functions and services the landscape provides. Not every function and service is a priority for all users and often decisions are made based on prioritizations among the benefits also resulting in tradeoffs. The SESF, being such a holistic tool, should have had a component specifically addressing this element.
5. Particularly within the landscape restoration context, drivers of change and historical land use patterns play crucial roles in understanding what is happening in the landscape, when, by whom and under what conditions. Such knowledge is important to define the reference state for the landscape and set the objectives to be achieved based on the landscape's capacity. However, the SESF in its current framing gives limited emphasis to such drivers of change and how they relate to the context of the specific objectives identified within the SESF.

6. Concluding thoughts

Looking at landscapes from multi-tiered, hierarchical processes as in the SESF has a number of advantages particularly in restoration efforts. First, it helps to disaggregate, to some extent, the complexity that is often associated with managing landscapes. Such possibilities of disaggregation help to identify where the challenges to sustainability within the different components of the landscape lie, particularly looking at the four core subsystems, which together make up the SESF. Second, it gives a hint about what level of effort is required, at what point in time to avoid the 'tragedy of the commons' in landscapes (Ostrom, 2009). Third, viewing landscapes from the SES perspective brings in the largely underemphasized social and economic dimensions while addressing landscape-level actions. Thus, viewing landscapes from the SES perspective has a number of advantages in promoting successful restoration and sustainable landscape management.

From the Shinyanga case study, the regional restoration programme in Tanzania can be well described using the SESF, though the initial designs of the project were not based on this framework. Nevertheless, some important elements still need further attention to promote the restoration effort in the way it addresses the social and ecological objectives. Such elements include the predictability of the system dynamics, the future investment behaviours, addressing and exploring the tradeoffs, and the efficiency of the restoration scheme in terms of understanding the benefits and costs for further replication. Current assessment of the outcomes are also mostly based on the direct resulting benefits and need to capture the indirect benefits of such restoration schemes and their relation to other regional processes such as mesoclimatic effects and cross-border hydrological impacts. In applying the SESF to the HASHI programme, a number of issues surfaced which need further attention particularly on the way the framework looks at those key indicators; these include 1) the framework in itself is more of an analytical tool than a planning tool, which is more sought after these days especially in view of the increasing resource degradation in many parts of the globe, and 2) the limited emphasis on functions and services, tradeoffs, metrics and drivers of change.

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References

Agrawal, A. (2001). Common property institutions and sustainable governance of resources. *World Development, 29*(10),1649-1672.

Berkes, F., & Folke, C. (1998). Linking social and ecological systems for resilience and sustainability. In Berkes, F., & Folke,C. (Eds.) *Linking social and ecological systems: management practices and social mechanisms for building resilience,* 13-20.

Binder, C. R., Hinkel, J., Bots, P. W., & Pahl-Wostl, C. (2013). Comparison of Frameworks for Analyzing Social-ecological Systems. *Ecology and Society,* 18(4), 26.

Crow, T. R. (2014). Functional Restoration: From Concept to Practice. *Journal of Sustainable Forestry, 33*(sup1), S3-S14.

Daszak, P., Cunningham, A. A., & Hyatt, A. D. (2000). Emerging infectious diseases of wildlife--threats to biodiversity and human health. *Science, 287*(5452), 443-449.

De Groot, R. S., Wilson, M. A., & Boumans, R. M. (2002). A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics, 41*(3), 393-408.

Duguma, L. A., Hager, H., & Gruber, M. (2009). The community-state forest interaction in Menagesha Suba area, Ethiopia: the challenges and possible solutions. *Forests, Trees and Livelihoods, 19*(2), 111-128.

Duguma, L. A., Minang P. A., & van Noorwidjk, M. (2014). Climate Change Mitigation and Adaptation in the Land Use Sector: From Complementarity to Synergy. *Environmental Management, 54*(3), 420-432.

Fisher, B., Turner, R. K., & Morling, P. (2009). Defining and classifying ecosystem services for decision making. *Ecological Economics, 68*(3), 643-653.

Gillingham, S., & Lee, P. C. (2003). People and protected areas: a study of local perceptions of wildlife crop-damage conflict in an area bordering the Selous Game Reserve, Tanzania. *Oryx, 37*(03), 316-325.

Kamwenda, G. J. (2002). Ngitili agrosilvipastoral systems in the United Republic of Tanzania. *Unasylva, 53*(4), 46-50.

Martin, C., Pastoret, P. P., Brochier, B., Humblet, M. F., & Saegerman, C. (2011). A survey of the transmission of infectious diseases/infections between wild and domestic ungulates in Europe. *Veterinary Research 42*, 70.

Meinig, D. W. (1979). The beholding eye: Ten versions of the same scene. The interpretation of ordinary landscapes. *Geographical essays*, 33-48.
Millennium Ecosystem Assessment. (2005). Ecosystems and Human Well-being: Synthesis. Washington, DC: Island Press.
Mlenge, W. (2004). *Ngitili: An Indigenous Natural Resources Management System in Shinyanga, Tanzania*. Nairobi, Kenya: Arid Lands Information Network - Eastern Africa.
Monela, G. C., Chamshama, S. A. O., Mwaipopo, R., & Gamassa, D. M. (2005). *A study on the social, economic and environmental impacts of forest landscape restoration in Shinyanga Region*. Tanzania, Final Report. International Union for Conservation of Nature (IUCN).
Oliver, C. D. (2014). Functional Restoration of Social-Forestry Systems across Spatial and Temporal Scales. *Journal of Sustainable Forestry*, accepted.
Ostrom, E. (2007). A diagnostic approach for going beyond panaceas. *Proceedings of the National Academy of Sciences, 104*(39), 15181-15187.
Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science*, 325, 419-422.
Parrott, L., Chion, C., Gonzalès, R., & Latombe, G. (2012). Agents, individuals, and networks: modeling methods to inform natural resource management in regional landscapes. *Ecology and Society, 17*(3), 32.
Selemani, I. S., Eik, L. O., Holand, Ø., Ådnøy, T., Mtengeti, E., & Mushi, D. (2012). The role of indigenous knowledge and perceptions of pastoral communities on traditional grazing management in north-western Tanzania. *African Journal of Agricultural Research, 7*(40), 5537-5547.
Wang, S. W., Curtis, P. D., & Lassoie, J. P. (2006). Farmer perceptions of crop damage by wildlife in Jigme Singye Wangchuck National Park, Bhutan. *Wildlife Society Bulletin, 34*(2), 359-365.
Wortley, L., Hero, J. M., & Howes, M. (2013). Evaluating ecological restoration success: a review of the literature. *Restoration Ecology*, 21(5), 537-543.

Farmer Field School in the Trifinio Territory; participative learning mechanisms are key elements of Climate Smart Territories. Photo credit: Maicon Barrera

CHAPTER 6

Climate Smart Territories (CST): An integrated approach to food security, ecosystem services, and climate change in rural areas

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Highlights

- Addressing the challenges of climate change requires integrated, systemic, interdisciplinary and collective responses and achieving results at different geographical and temporal scales, adjusted to the needs for restoration of ecosystems and their services vital for human wellbeing
- The Climate Smart Territories (CST) approach provide such responses, working through multi-stakeholder platforms that facilitate meeting local societal needs while contributing to the implementation of international agreements
- Joint planning, monitoring and continuous learning are essential elements of such collective responses, requiring information and knowledge management systems that connect actors, sources of knowledge and decision-making processes at different levels and from a variety of sectors
- CST builds local response capacity and leadership, and contributes to human sustainable development, outweighing initial transaction costs
- Creating an enabling environment where policy and institutional frameworks and their services are aligned with CST responses could reduce transaction costs
- Tree-based and ecosystem-based responses to climate change are long term, cost effective and resource efficient components of the proposed CST approach

1. Introduction

As global food production rises steadily (FAO, 2006), and more people have access to an adequate food supply than before, the latter is mainly achieved through an increased dependence on trade (Porkka et al., 2013). Many small landholders in the tropics have only limited access to such trade flows and still depend on rain-fed agriculture for selfconsumption (Barrett, 2010) coming from steadily degrading resources (land, water) and sensitive to increasing temperatures and increasing unpredictability of climate variability (Rosenzweig et al., 2001). Thus, climate change is expected to increase the threats to food security, in particular in rural areas in the tropics (Vermeulen et al., 2010; Porter et al., 2014), where many of the landholders have limited access to resources to make adjustments in their livelihoods. Availability of water for agriculture and households, and availability of affordable energy for small industries and households are also factors of concern for rural society and may be aggravated by climate change. The development pathway (Parry et al., 2005), the quality of soil, water and diversity management (Nicholls et al., 2013) and farmer's resilience and capacity to adapt to climate change (Smit et al. 2003; Parry et al., 2005) are mentioned as among the main factors that will determine the relationships between food production, food security (including access to good quality food) and climate change.

Climate-Smart Agriculture (CSA) (FAO, 2010; 2013*a*) has been promoted as an important response to climate change and variability, while the potential contribution of livestock management to emission reduction and compensation has also been highlighted (Gerber et al., 2013). CSA contributes to ensure future food security under a changing climate, and if well designed, may increase water and energy use efficiency. At the same time, forests and their appropriate management are also highly recommended for inclusion in both mitigation and adaptation strategies (Innes et al., 2009; FAO, 2013*b*). Although both approaches (CSA and 'climate-smart forestry') recognize the need for an appropriate institutional setting with supporting policies and finance mechanisms while applying an ecosystem approach at the landscape level, in practice most strategies for CSA and forest management are still oriented towards individual actions by farmers, forest managers, their organizations or sectors, and, in spite of relative successes in improving adaptive capacity of farmers, may not address the complex challenges that climate change poses on the regulation and provision of ecosystem services and food, water and energy security.

Other ecosystem services, such as provision of fresh and clean water, disease and pest regulation, pollination, nutrient cycling and soil formation and conservation, are essential for agricultural production (Power, 2010) and for the general wellbeing of society (MEA, 2005). Access to markets, water and energy, as well as to technical, financial and other supply chain services are essential for food security (e.g., Gregory et al., 2005). All of these services are increasingly threatened by climate change (Porter et al., 2014; Scholes et al., 2014) and new approaches are being developed that build on the foundations of CSA and climate-smart forestry, but seek to optimize synergies between sectors, scales, different ecosystem services and between adaptation and mitigation (e.g., climate-smart landscapes; Scherr et al., 2012; Harvey et al., 2013). Harvey et al. (2013) note that such new approaches require "... transformative changes in current policies, institutional arrangements and funding mechanisms".

In this chapter, we argue that one of those transformational changes lies in the approach itself: rather than looking from the farmer or forest area towards the outside and designing enabling policies and mechanisms to upscale climate-smart practices, we need to upscale our thinking and learning patterns, geographically, thematically and through time to understand the socio-ecological systems in which we live and improve our capacity for integrated and sustainable development planning. We propose to do so through the implementation of what we call Climate Smart Territories (CST): "social and geographic spaces where the actors collaboratively manage ecosystem services to equitably improve human well-being, continuously optimizing land use and mitigation and adaptation to climate change"[1].

2. Climate Smart Territories

The approach of CST as applied by CATIE[2] evolved from more than 25 years of work in agriculture, (agro)forestry and watershed management, applying four basic system approaches to achieve sustainable rural development objectives: sustainable livelihoods (people centred), aligning policies, institutions and incentives (including achieving monetary and other benefits), territorial management (defining and achieving common goals and implementing strategies concerted among multiple stakeholders within a clearly defined space) and the well-known ecosystem approach[3]. CST is an attempt to combine the many lessons learned in the implementation and analysis of numerous research and development projects in Latin America in which CATIE has been involved along with multiple partners and put them in the context of achieving sustainable rural development while accounting for the impacts of climate change. Rather than focussing on adaptation and mitigation, or specific CSA or forestry practices, this chapter focuses on strengthening the local capacity to analyse, learn and incorporate such projects' lessons into local joint planning and implementation, seeking real integration of climate change considerations into their development processes.

This approach shows substantial similarities with CSA and climate-smart forestry, and in particular, is very similar to coupled socio-ecological climate-smart landscapes (see Minang et al., Chapter 1 this book). From these approaches, it differs mainly in the emphasis on strengthening social and human capital within the territory. Our CST approach puts greater emphasis on the functioning of the socio-ecological system, assuming that many local stakeholders, for their production and well-being, depend on locally available ecosystem services which are influenced both by individual and collective actions. Thus, we enter from within, identifying together with an initial group of stakeholder representatives, a common goal or problem. Based on the relations of these stakeholders with their surrounding (agro)ecosystems and their common goal or problem, territorial boundaries are defined. In this approach, territorial learning mechanisms, climate and vulnerability related knowledge management, adaptive management and the need for collaborative efforts for the conservation and provision of ecosystem services are central components in shaping the decision-making processes at multiple scales: family, farm, community and territory. In addition, CST promotes the extension of these components to the more vulnerable groups within the territories. This approach is similar to the integrated landscape management approach as described recently by Scherr et al. (2014), but has a greater emphasis on climate and vulnerability knowledge management, collective decision-making processes, learning mechanisms as well as on the role of ecosystem services (Figure 6.1).

As in the integrated landscape management approach of Scherr et al. (2014), in CST multiple stakeholder platforms are the key for fostering collective action. It is here that stakeholders define the identity and the limits and functions of the territory, usually considering their common interests. Within this platform, stakeholders also define their priorities and discuss the potential opportunities and threats to achieve these priorities

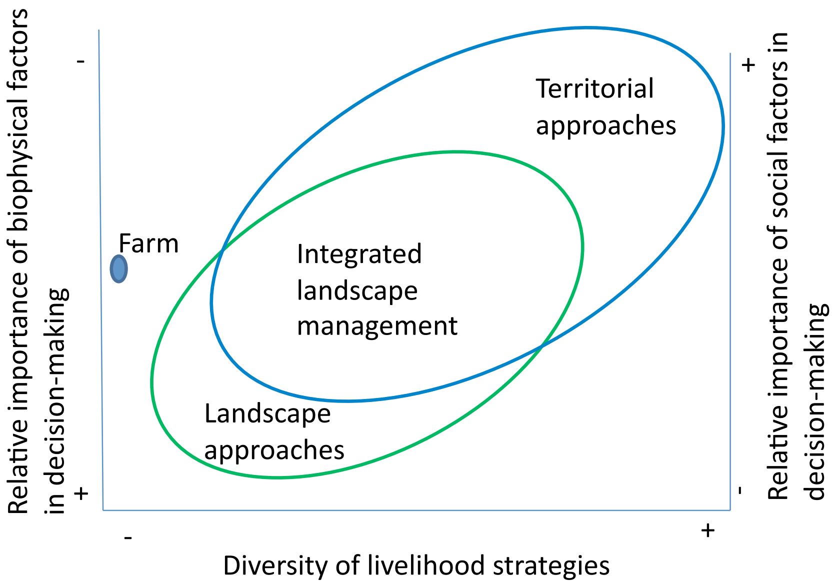

Figure 6.1 Diagram of the relationship between landscapes and territories. The isolated position of the farm along the first vertical axis indicates that working on at the farm level alone is not sufficient to meet landscape or territorial criteria. However, landscape and territorial approaches need to be aware of the needs of farmers to avoid targeting only social or ecological goals while forgetting about individual needs.

and how to respond to them. In successful CST, such platforms will be inclusive of local authorities, participating in strategic planning processes and providing continuity in achieving the long-term goals. Such platforms, which can include farmer organizations, decision-makers, academics and scientists, facilitate intersectoral learning and knowledge management. In addition, they involve national actors and representatives of specific value chains that link the local actors to a variety of stakeholders at different geographical scales. Due to this organization and involvement of the stakeholders, the CST strengthens local to global links and may facilitate the implementation of several international agreements framed within the context of international conventions (e.g., United Nations Framework Convention on Climate Change[4], Agenda 21 and the Sustainable Development Goals currently under discussion[5]). The 'climate-smartness' of CST is achieved when the decision-making processes use the existing collective intelligence for the integration of climatic and development considerations into their deliberations, and explicitly lead to increased well-being, increased resilience to climate and other stresses, and low and/or reduced emissions of greenhouse gases.

2.1 Current experiences

The CST approach builds on local realities and existing experiences; as a result, it may have different entry points, different leaders, and may require different time spans for full implementation. CATIE´s Mesoamerican Agroenvironmental Program (CATIE/MAP), for example, operates in two 'territories': Trifinio and NicaCentral. In each of these territories it uses different entry points for the implementation of a CST approach and strengthening local stakeholder groups' participation in territorial processes. Similarly, in Colombia, CATIE has supported the development of the Huila 2050 plan, the first departmental climate change plan in Colombia, with its own CST approach. Both of the CATIE/MAP and Huila 2050 experiences are described in the following sections.

2.1.1 The CATIE/MAP approach

The two territories supported by CATIE/MAP differ in terms of geography, the existence of a common vision, shared issues and the presence of participative planning processes. The Trifinio territory comprises the upper watershed of the Lempa River that is shared by Guatemala, El Salvador, and Honduras and is jointly managed by the three countries under the Trifinio Plan (passed in 1998). The area is a watershed and its management has applied a territorial approach, strengthening a territorial identity and the participation of different actors and platforms in its territorial planning (Artiga, 2003). The NicaCentral territory, on the other hand, is based within Nicaragua. It partially overlaps with the Bosawas Biosphere Reserve and contains the Peñas Blancas natural reserve, an important provider of ecosystem services. Despite the population sharing common interests around water and the Peñas Blanca natural reserve, a sense of belonging and common vision is still to be realized in this territory. CATIE/MAP considers these different realities. Thus it works in Trifinio with tri-national and local platforms, mainstreaming CST issues in territorial planning frameworks such as the Trifinio Development Plan. In NicaCentral it works mainly with local platforms, strengthening their planning capacity, exploring the common issues and seeking consensus on how to improve climate resilience of farmers by improving both their livelihoods and the environment they live in.

Another entry point used by CATIE/MAP has been CSA, which we see as complementary to CST. However, our experience has shown that, despite the fact that focusing on the individual needs of farmers and their systems is important, the goals of CSA can only be sustainably achieved through collaboration and continuous learning processes. Taking this into account, CATIE/MAP continues working at the farmer level, in both territories, but also works with different local/regional platforms (e.g., value chain, knowledge and innovation, research, planning) to link farmers and other local actors to a variety of regional, national and international stakeholders. Such linkages provide some of the capacity needed to address critical issues at different geographical scales, such as ecosystem services, and to scale up climate-smart practices.

Using this approach, CATIE/MAP is scaling up CSA practices identified from an analysis of climate threats to coffee and cattle farming and other crop alternatives that both strengthen resilience and reduce emissions on these farms. Part of this analysis was participatory using farmer field schools (FFS) to involve local farmers (see Box 6.1). These schools gave the farmers the opportunity to combine scientific knowledge with their own experiences to identify a range of different sustainable farming and land management practices. These also led to a considerable number of farmer families adopting CSA practices, though scaling up turned out to be a slower process than initially anticipated due to a number of critical issues (e.g., conflicting land uses, access to clean and sufficient water) that could not be addressed, hampering full achievement of climate -smart objectives.

During the FFS it became clear that some climate threats, such as a decrease in the water supply for farmers and communities, or crop diseases like coffee rust, need collaborative actions that go beyond the farm (e.g., Imbach et al., 2010; Avelino et al., 2012). In response, CATIE/MAP has strengthened its work with local and regional multi-

Box 6.1

Multi-thematic farmer field schools for CST implementation

Farmer field schools (FFS) are classrooms without walls where participants learn about different agricultural and (agro)forestry topics of common interest through observation, discovery and exchange of experiences. Furthermore, additional topics are dealt with to strengthen capacity for improving livelihoods while also supporting the establishment of a CST. Examples of topics include, gender equity, food and nutritional security, mitigation and adaptation to climate change, restoration of ecosystems and business administration. The concept of FFS was originally developed by the Food and Agriculture Organization of the United Nations (FAO) in the context of integrated pest management in Indonesia. CATIE's FFS application in Central America is an adaptation to the local context considering changes in climate conditions.

An FFS usually is developed at the community level with direct activities on the farm of each of the participating farmer families. It is usually composed of 20 to 30 men and women (adults and youths), representatives of the families who have common interests and similar levels of skills and knowledge. One or more members of each family may participate in FFS activities. After formation of an FFS and informing the community of its structure and operation, a farm and home garden plan is prepared with each family. As a basis for the plan, diagnostics of the farm's resources (biophysical and socio-economic), its constraints and its opportunities are prepared and the dream farm or home garden is defined. Information from the plans is used to design the curriculum of the FFS for each community. These FFS then implement a variety of learning sessions, test plots, individual technical assistance visits, exchanges between families, and induction tours to farms with advanced innovations. In addition, farmers jointly analyse the potential financial instruments that could support farm innovation (e.g., payment for environmental services schemes). In each of these topics, care is taken to integrate cross-cutting topics, such as equity (e.g., gender, ethnic, age), climate change adaptation and mitigation, organization and administration, business plans and marketing, aimed at improving farm production as part of the implementation of the CST approach. In the NicaCentral and Trifinio territories, for example, the FFS have addressed topics such as environmentally conscious cattle farming, cultivation of basic grains, cacao, coffee, home garden planning, healthy habits at home, nutrition education and food preparation, vegetable production, establishment and management of fruit trees in the home garden, water management and agro-ecological management of home gardens and its implications in the context of climate change. In the case of Trifinio and Nicacentral, the FFS has become an important instrument for monitoring and getting feedback, where farmers try out technical assistance recommendations in addition to each other's ideas, and later reconvene to evaluate results of their implementation, discussing the results and recommending adjustments to the original practices. In addition, the FFS evolve over time, addressing the new needs of the farmer families, such as responding to climate change. As one evaluator of an FFS put it "they learned many things, but above all, they strengthened their capacity to innovate, to solve their own problems".

stakeholder platforms and national authorities to create the enabling environment that will allow it to address, in a collaborative way, issues that result in climate-smart outcomes at the territorial level and beyond. This includes development and validation of methods for assessing vulnerability through participatory approaches, looking at the dynamics and potential responses of different cropping systems under climate change stressors and determining the overall impact on ecosystem services resulting from changes within socio-ecological systems. It also includes strengthening capacity for the development of local adaptation strategies, the integration of climate change into existing development strategies and the integration of climate information in short- and medium-term decision-making. These processes will require collaboration between different stakeholder groups to strengthen dissemination and knowledge exchange mechanisms, such as the FFS, either by joining resources, providing new discussion materials or examples of good practices that can be tried, discussed and implemented.

2.1.2 The Huila 2050 approach

In Colombia, the "Huila 2050: preparing for climate change plan"[6], presented by the Government of Huila and the Regional Autonomous Corporation of the upper Magdalena (CAM), developed an innovative model that aims to create a CST in the medium- to long-term. Huila´s location, at the foot of the Colombian Mountain range (Macizo Colombiano), makes it biologically highly diverse, rich in hydrocarbons (petroleum) and an important water catchment area for the Magdalena River, forming the major watershed of Colombia. At the same time, the Department is highly exposed to increases in temperature and reduced precipitation in the long-run, and the effects of extreme rainfall events in the short-term. The threats to the provision of water and other ecosystem services, together with limited success of previous efforts to protect the natural resources, made the Department look for a different approach to effectively manage its natural resources. With the financial support of the Forest, Carbon, Markets and Communities (FCMC) Program of the United States Agency for International Development (USAID) and the general coordination of E3 (Ecologia, Economia y Etica), it formed a multi-sectoral departmental council for climate change as the main mechanism for defining priority actions to reduce the threats to its natural resources, reduce emissions, and at the same time facilitate achievement of departmental development goals. With technical assistance and financial support, they endeavoured into a two-year planning exercise, during which they analysed the Department's general vulnerability to climate change, its emissions profile, options for internal financing and a detailed current and future water balance of the upper watershed. In addition, multi-stakeholder dialogues were held to define and identify pathways for integrating climate change considerations into the departmental development planning processes. This resulted in an integrated climate change action plan, prioritizing five sectors, as well as the establishment of a climate change observatory, supporting decision-making processes through knowledge generation and management.

Simultaneously, local capacity was strengthened using a data and knowledge management system designed to allow departmental authorities to make evidence-based policy decisions to increase resilience and reduce vulnerability in its municipalities. The next steps will be oriented towards strengthening farmer capacity to increase climate resilience of coffee and cattle production, reduce pressures on the forest, and improve the efficiency of water and energy use in the agricultural and urban sectors. In particular, in the livestock sector this will be done using FFS, based on the experiences with FFS in CATIE/MAP (see Box 6.1). Such FFS or similar participative learning mechanisms, are an essential element of the action research and learning cycle of CST, linking knowledge management platforms, scientists, extension agents and farmers within a process of continuous action, reflection, and adjustments.

The CST approach of the Huila 2050 plan has led to the identification of a number of interesting issues. First, there is a need to have more detailed information from the territory to make informed decisions. Many decisions are based on assumptions in relation to climate, water availability and soil quality, as in most areas this information is not readily available. The importance for such locally available information was shown when downscaled climate change projections indicated that the lands suitable for Granadilla (*Passiflora* sp.), one of the major non-traditional crops, will be reduced to a small strip of land in the north of the Department. This may require a shift in current extension efforts, currently geared towards the introduction of this (and other) crop(s) as a complement to coffee in order to reduce vulnerability of the region to changes in the coffee market.

Second, there is a great scope for exploiting the synergies between adaptation and mitigation within the territory. For example, establishing biological corridors that link protected areas at two different altitudes may have, as an additional benefit, the sequestration of carbon dioxide through the establishment of new trees and/or restoration of original vegetation. In Huila this will require collaboration between the State (who owns the land in the protected areas) and local landowners, in particular cattle farmers, who own the land between the forest patches. Similarly, incorporation of trees on farms and in cattle lands will improve growing conditions under extreme weather conditions, providing shade during hot sun, improving infiltration rates (e.g., Benegas et al., 2014) and contributing to carbon sequestration. Performing this analysis within the participatory stakeholder platforms led to the realization of the stakeholders that they could actually contribute to conservation (connectivity) while at the same time benefitting from their actions. Since there is some concern among some of the stakeholders that such practices might negatively affect the availability of water for people downstream, it is envisaged that more detailed studies will determine the effect on the water table.

Third, through a joint-vision oriented approach, the Huila 2050 plan was able to reach out to a larger number of stakeholder groups. This resulted in unexpected financial support for implementation from private sector stakeholders.

3. Key steps towards implementation of CST

Analyzing these cases along with the results of the 2013 Wallace Conference, organized by CATIE with partner institutions to discuss the CST approach with researchers and decision-makers at different levels[7], we can identify a number of characteristics that describe the general pathway territories are taking to integrate climate change in their development strategies.

We argue that the main characteristics that distinguish the CST approach from other climate-smart approaches lie in the social-political dimension; our main premise is that any territory is a social construct, therefore we need to work first on the social, political and institutional arrangements that shape a given territory, before we start implementing technological solutions. Therefore, we are building on a conceptual framework that combines the spiralling-up theory proposed by Emery and Flora (2006) with our experiences in adaptive co-management of watersheds (e.g., Prins & Kammerbauer, 2009). Strengthening human and social resources facilitates the construction of a joint-vision, planning of appropriate pathways, and the design of norms, rules, arrangements and practices needed to work towards that vision. It considers all the resources people have available to build their livelihoods and recognizes the relations they have with those resources as well as with other people and institutions. It allows limiting the territories to areas of influence of groups of people that feel affinity between them and with the area. From our experience, this is key in building a common vision and facilitates collaborative action. Depending on the functions of the territories, it may also result in a 'nested territorial' approach. For some functions, such as ecosystem conservation, the territory may be large (e.g., Trifinio, the Department of Huila), while for other functions, such as strengthening resilience to specific climatic changes and its consequences, the area may be smaller (e.g., a watershed, municipality, productive landscape).

As promoting a climate-smart agenda requires decisions about management of both private and common (public) goods, no one stakeholder is well positioned to push forward this agenda alone. In Central America, multi-stakeholder platforms have shown that they can be an effective mechanism to support the planning and implementation of regional sustainable forest management strategies (e.g., Galloway, 2001) and watershed management (Prins & Kammerbauer, 2009). They provide the space to identify potentially problematic issues raised by some of the stakeholders involved, and try to reconcile potentially differing interests. While managing potential conflicts can be arduous, consuming both time and money, to the degree that it prevents future conflicts and damages, it may be a very rewarding exercise in the medium- and long-term. Also in the CATIE/MAP and Huila cases involving stakeholders still is a major time-consuming issue, but already some promising results have been obtained through the dialogues: consensus among participating stakeholder groups on the long-term goals and commitment of both existing and new human and financial resources to meet those goals.

In each of the cases, actor mapping, resilience and vulnerability assessments, mapping of ecosystem services, and territorial planning are considered to be fundamental for effective and efficient application of interventions that combine adaptation, mitigation and development goals. In a similar manner, access to remote sensing images, GIS skills, good internet connection and well-organized FFS are considered essential elements for successful knowledge management. The exact methods and tools to get there vary according to the needs of the local stakeholders, highlighting the need for extensive climate change toolkits.

While the social-policy dimension may be the entry point for the CST, it is also clear that the success of the CST approach in the end lies in successful application of mitigation and adaptation practices and their contribution to development goals at the territory and farm/household level. Pilot experiences with the implementation of tree- and ecosystem-based farming systems in each of the territories show promising results for such systems under climate change conditions, where trees contribute to compensating for the emission of greenhouse gases through the sequestration of carbon dioxide, while at the same time contributing to the provision of shade and reducing the flow of wind, reducing thus also the spread of important crop pests and diseases (e.g., Avelino et al., 2012). The benefits of trees in agricultural systems in terms of the hydrological cycle are less clear, with evidence suggesting they can both reduce and increase water availability for the production system, depending on the type of system, soil conditions, management practices and specific climate conditions (e.g., Benegas et al., 2014). Scaling up these pilot experiences requires appropriate institutional arrangements, FFS, and incentives for innovation.

4. Challenges ahead

Looking at the advances in implementation of the CST approach we have identified a number of challenges, of which we want to emphasize the following three major ones:

Sustainability of co-management and multi-stakeholder platforms

Setting up such platforms is a large investment, in particular in terms of time required of the stakeholders involved. Once established, however, their continuity will depend above all on the motivation of the members. For example, if in the first few years there are no clearly achieved benefits or there is a lack of clear rules and transparency to guide decision-making processes, many stakeholders may become discouraged with the whole process. In addition, due to the high turnover rates of personnel in many governmental organizations in Latin America, there is the risk of loosing key stakeholders during the process, potentially resulting in the loss of political will and continuity of initiatives promoted by previous administrations.

In addition, strong local leadership, building of trust, a sense of belonging to the CST, sharing of its long-term goals, capacity to generate funds and clear, frequent benefits will help to increase sustainability of these platforms. The costs of co-management structures, however, need to be weighed against the potential benefits. These benefits will usually accrue at mid- and long-term intervals and will contribute to achieving development goals under a changing climate including: water security, control of plant and animal pests and diseases, reducing the risk of malaria and dengue, protection of infrastructure, and risk and disaster management, among others.

Making decisions under uncertain climate scenarios

Projecting future impacts is still a very complex matter with its specific impacts on effect on people, production systems, flora, fauna and ecosystem functions, uncertain. This makes it important to reduce uncertainty by improving information, to explicitly consider this uncertainty in decision-making, and to reduce risk of negative outcomes.

It is necessary that local stakeholders have access to useful agro-meteorological information in order to strengthen their knowledge on natural variability and future climates: when are conditions right to sow, when to monitor for specific pests and diseases, what weather conditions to expect during the next two to three months or during harvest time, etc. Through, for example, a climate observatory, the information of different networks can be shared and used by universities for research into specific climate-related questions relevant for decision-making within the territory.

Achieving short-, medium- and long-term benefits for the local population

One of the strengths of CSA is that it has been able to address immediate needs of local farmers. CST goes beyond this and also focuses on future benefits, strengthening local capacities to plan for, and react to, future constraints on production, conservation and ecosystem service provision to a wide range of local stakeholders. CSA and CST are complementary in that respect and should be applied jointly to mutually strengthen their implementation. To be successful, however, benefits need to be real and perceived. With this in mind, we implement and validate participative local adaptation strategies that seek to match bottom-up planning with short-term goals with top-down national and regional development medium- and long-term goals. Although promising results are being obtained, it is too early to tell whether these will have the desired outcomes.

Thus, while there have already been promising applications of the CST approach, it is still evolving. The clearest advances have been achieved in 1) joining efforts through the different stakeholder platforms, reaching agreements on common, long-term goals that allow for more climate-resilient and low-carbon development that address key issues of the people in the territories, and 2) the sharing of existing resources and assets to meet these goals. Knowledge (including local), stakeholder learning (e.g., FFS) and dialogue platforms are essential components of the CST and have contributed to the application of CSA practices within the territories. However, a number of challenges have also been identified in the application of the CST approach. These need to be met for the CST approach to become successful.

Endnotes

1 Definition contained in the Declaration of Turrialba, drafted at the Wallace Conference held at CATIE in 2013: http://catie.ac.cr/index.php/es/noticias-catie/entry/territorios-climaticamente-inteligentes.
2 Spanish acronym for Tropical Agricultural Research and Higher Education Center. CATIE is a not for profit, regional research organization based in Costa Rica.
3 See: http://www.cbd.int/ecosystem/
4 http://unfccc.int/2860.php
5 http://sustainabledevelopment.un.org/
6 For the plan and related documents see: http://www.e3asesorias.com/#!publicaciones/csvj
7 http://web.catie.ac.cr/wallace2013/home_ing.htm

References

Artiga, R. (2003). *The case of the Trifinio plan in the upper Lempa: Opportunities and challenges for the shared management of Central American transnational basins.* IHP-VI. Technical documents in Hydrology. PC CP series. No. 18. Paris: UNESCO.

Avelino, J., Romero-Gurdian, A., Cruz-Cuellar, H. F., & DeClerck, F. A. J. (2012). Landscape context and scale differentially impact coffee leaf rust, coffee Berry borer, and coffee root-knot nematodes. *Ecological applications, 22*(2), 584-596.

Barrett, C. B. (2010). Measuring food insecurity. *Science*, 327(5967), 825-828.

Benegas, L., Ilstedt, U., Roupsard, O., Jones, J., & Malmer, A. (2014). Effects of trees on infiltrability and preferential flow in two contrasting agroecosystems in Central America. *Agriculture, Ecosystems & Environment*, 183, 185-196.

Emery, M., & Flora, C. (2006). Spiraling-up: mapping community transformation with community capitals framework. *Community development, 37*(1), 19-35.

FAO (Food and Agriculture Organization of the United Nations) (2006). *World agriculture: towards 2030/2050*. Rome: FAO.

FAO (2010). *"Climate Smart" Agriculture. Policies, practices and financing for food security, adaptation and mitigation.* Rome: FAO.

FAO (2013*a*). *Climate smart agriculture sourcebook.* Rome: FAO.

FAO (2013*b*). *Climate change guidelines for forest managers.* FAO Forestry Paper 172. Rome: FAO

Galloway, G. (2001). Las redes operativas y su papel en la política forestal. Experiencias prometedoras en Honduras y Nicaragua. *Revista Forestal Centroamericana*, 37, 26-32.

Gerber, P. J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., ... Tempio, G (2013). *Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities.* Rome: FAO.

Gregory, P. J., Ingram, J. S. I., & Brklacich, M. (2005). Climate change and food security. *Philosophical Transactions of the Royal Society, B* 360, 2139-2148. doi: 10.1098/rstb.2005.1745

Harvey, C., Chacón, M., Donatti, C. I., Garen, E., Hannah, L., Andrade, A., ... Wollenberg, E. (2013). Climate-smart landscapes: opportunities and challenges for integrating adaptation and mitigation in tropical agriculture. *Conservation Letters,* 1-14. doi: 10.1111/conl.12066.

Imbach, P., Molina, L., Locatelli, B., Roupsard, O., Ciais, P., Corrales, L., & Mahé, (2010). Climatology-based regional modelling of potential vegetation and average annual long-term runoff for Mesoamerica. *Hydrology and Earth System Sciences*, 14, 1801-1817. doi:.5194/hess-14-1801-2010

Innes, J., Joyce, L. A., Kellomäki, S., Louman, B., Ogden, A., Parrotta, J., & Mahé, G. (2009). Chapter 6: Management for adapatation. In: Seppala, A. Buck & P. Katila (Eds.) *Adaptation of forests and people to climate change*. IUFRO World Series 22. Helsinki: IUFRO.

MEA (Millennium Ecosystem Assessment) (2005). *Ecosystem and human well-being. Synthesis*. Washington D.C.: Island Press.

Nicholls, T., Elouafi, I., Borgemeister, C., Campos-Arce, J. J., Hermann, M., Hoogendoorn, J., ... Roy, A. (2013). *Transforming rural livelihoods and landscapes: sustainable improvements to incomes, food security and the environment*. Association of International Research and Development Centers for Agriculture (AIRCA). Retrieved from http://www.airca.org/images/pdf_files/AIRCA_White_Paper_Landscapes.pdf

Parry, M., Rosenzweig, C., & Livermore, M. (2005). Climate change, global food supply and risk of hunger. *Philosophical Transactions of the Royal Society B*, 360, 2125-2138. doi: 10.1098/rstb.2005.1751

Porkka, M., Kummu, M., Siebert, S., & Varis, O. (2013). From Food Insufficiency towards Trade Dependency: A Historical Analysis of Global Food Availability. *PLoS One, 8*(12), e82714.

Porter, J. R., Xie, L., Challinor, A., Cochrane, K., Howden, M., Moshin Iqbal, M., ... Ziska, L. (2014). Chapter 7: Food security and food production systems. IPCC WGII AR5 (final draft). Retrieved from http://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap7_FGDall.pdf

Power, A. G. (2010). Ecosystem services and agriculture: tradeoffs and synergies. *Philosophical Transactions of the Royal Society B*, 365, doi: 10.1098/rstb.2010.0143

Prins, K., & Kammerbauer, H. (2009). *Análisis y abordaje de conflictos en cogestión de cuencas y recursos hídricos*. Serie técnica boletín técnico no 39. Turrialba, Costa Rica: CATIE.

Rosenzweig, C., Iglesias, A., Yang, X. B., Epstein, P. R., & Chivian, E. (2001). Climate Change and Extreme Weather Events; Implications for Food Production, Plant Diseases, and Pests. *Global change and human health, 2*(2), 90-104.

Scherr, S. J., Buck, L., Willemen, L., & Milder, J. C. (2014) Ecoagriculture: Integrated Landscape Management for People, Food and Nature. In: Neal Van Alfen (Eds.) *Encyclopedia of agriculture and food systems 3*. San Diego: Elsevier.

Scherr, S. J., Shames, S., & Friedman, R. (2012). From climate-smart agriculture to climate-smart landscapes. *Agriculture & Food Security*, 1,12. Retrieved from http://www.agricultureandfoodsecurity.com/content/1/1/12

Scholes, R., Settele, J., Betts, R., Bunn, S., Leadley, P., Nepstad, D., … Winter, M. (2014). Chapter 4: Terrestrial and inland water ecosystems. IPCC WGII AR5 (final draft). Retrieved from http://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap4_FGDall.pdf

Smit, B., Pilifosova, O., Burton, I., Challenger, B., Huq, S., Klein, R. J. T., … Wandel, J. (2003). Adaptation to climate change in the context of sustainable development and equity. *Sustainable Development, 8*(9), 9.

Vermeulen, S. J., Aggarwal, P. K., Ainslie, A., Angelone, C., Campbell, B. M., Challinor, A. J., ... Wollenberg, E. (2010). *Agriculture, Food Security and Climate Change: Outlook for Knowledge, Tools and Action*. CCAFS Report 3. Copenhagen, Denmark: CGIAR-ESSP Program on Climate Change, Agriculture and Food Security.

Landscape in Mbeya, Tanzania. Photo credit: Abigail K. Hart

CHAPTER 7

Integrated landscape initiatives in practice: assessing experiences from 191 landscapes in Africa and Latin America

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Highlights

- Landscape approaches are increasingly being undertaken as a way to achieve positive outcomes related to agricultural production, ecosystem conservation, rural livelihoods, and multi-stakeholder coordination
- We used a systematic survey and assessment process to characterize the context, motivations, investments, outcomes and participants of 191 initiatives using landscape approaches in Africa and Latin America
- The objectives, investments, and outcomes of these initiatives addressed agriculture, livelihoods and conservation issues, and nearly all initiatives invested in institutional coordination and capacity building to support cross-sector synergies
- Key challenges for effective and scalable landscape approaches included unsupportive policy frameworks, incomplete stakeholder engagement and lack of sustainable funding
- Although practitioners recognized landscape approaches as challenging long-term endeavours, they also perceived them as necessary to solve problems where traditional sector-based approaches and scales of intervention have proven inadequate

1. Introduction

In recent years, there has been a dramatic increase in demands on agriculture and other land uses to increase food and energy production while conserving critical ecosystems and the services they provide, reducing poverty and mitigating climate change. While these demands have grown, the land and water resources available to meet them are diminishing in many places due to severe environmental degradation resulting from unsustainable agriculture and other land use practices (Foley et al., 2005; Clark et al., 2012), depletion of groundwater reserves, and impacts of climate change, among other factors. With land for agriculture expected to expand by 49 million ha in Latin America and the Caribbean and 51 million ha in Africa by 2050 (FAO, 2011), competition for already scarce land and water resources will further heighten in the coming decades.

To address these challenges, there has been a growing call for management approaches that promote multifunctional rural landscapes that more effectively deliver food production, ecosystem conservation, and human development goals, while reducing tradeoffs among these goals. Multi-sector, integrated landscape approaches are becoming increasingly common in Africa, Latin America, and elsewhere. These are manifest in a wide range of forms, with associated fields of study such as whole landscape management (DeFries & Rosenzweig, 2010), bioregional planning (Brunckhorst, 2000), ecoagriculture (Scherr & McNeely, 2008), land sparing (Phalan et al., 2011), land sharing (Perfecto & Vandermeer, 2010), integrated watershed management (Heathcote et al., 1998), and climate-smart landscapes (Harvey et al., 2014).

In Africa and Latin America, current models of integrated landscape management have antecedents dating from the 1980s and 1990s. For example, throughout the 1990s in Sahelian West Africa, governments and development organizations promoted 'gestion de terroir' as a holistic and integrated approach to managing village lands (Painter et al., 1994; Teyssier, 1995; see Bernard, Chapter 5, this book). Similarly, integrated natural resource management (INRM) focused on incorporating community well-being into ecosystem management (Campbell & Sayer, 2003; German et al., 2012). Throughout Latin America, territorial development approaches to economic development aimed to improve rural livelihoods through decentralized planning and endogenous development interventions (Schejtman & Berdegué, 2008). From the conservation side, both continents have legacies of integrated conservation and development projects (ICDPs), which aimed to integrate livelihood considerations into conservation projects, but which have been criticized for their general lack of success (McShane & Wells, 2004).

Integrated landscape approaches – which serve as an umbrella for a range of related terms, approaches and practices (e.g., see Scherr et al., 2013) – are defined as approaches which use landscape management practices to address multiple objectives and provide multiple benefits (Sayer et al., 2013; Scherr et al., 2014). They emphasize the promotion of synergies and management of tradeoffs among economic, social and ecological dimensions of the landscape, collaborative decision-making processes, and supportive market and policy contexts (Scherr et al., 2014). As a result of converging demands for landscape multifunctionality, landscape initiatives have proliferated as ways of achieving positive outcomes related to agricultural production, ecosystem conservation, rural livelihoods, and institutional planning and coordination. In the international arena, the emergence of dialogues and coalitions such as the Global Landscapes Forum (GLF, 2014) and the Landscapes for People, Food and Nature Initiative (LPFN, 2014), demonstrates interest and commitment to landscape approaches from leading organizations across the fields of agriculture, development, conservation and climate change.

However, despite the growing interest in and implementation of integrated landscape approaches there has been a lack of systematic, empirical characterization of initiatives using such approaches, their objectives, activities and outcomes. We aimed to fill that gap by conducting a structured survey of landscape initiatives drawing on practitioners and participants across Africa, Latin America and the Caribbean. Results of these studies are detailed in separate works (Milder et al., 2014 and Estrada-Carmona et al., 2014, respectively). Here we provide a synthesis of key findings in both regions and highlight implications for future policy development, investment, and programmatic activities to implement effective initiatives in support of sustainable rural landscapes globally.

Six research questions guided the studies: 1) where and in what kinds of contexts are landscape approaches taking place?; 2) why are landscape approaches taking place, and what kinds of challenges do they seek to address?; 3) what kinds of investments, activities and governance structures are included in landscape approaches?; 4) what kinds of stakeholders are involved in landscape approaches?; 5) to what extent were the surveyed initiatives reported to achieve positive outcomes across four 'domains' of landscape performance – food production, livelihoods, ecosystem conservation, and institutional planning and coordination?; and 6) what were the most and least successful aspects of each initiative, and are there patterns in the effectiveness of landscape approaches across the full sample? While not exhaustive, the surveys provide insight into the motivations for stakeholders to apply integrated landscape approaches, the types of investments that they have made to improve landscape multifunctionality, the range of outcomes they have achieved, and the barriers and opportunities that they see for landscape approaches moving forward.

2. Methods

In the studies for both Africa (Milder et al., 2014) and Latin America and the Caribbean (LAC) (Estrada-Carmona et al., 2014), we initially identified potential initiatives through a combination of internet keyword searches, key informant interviews, and canvassing of individuals active in the Landscapes for People, Food and Nature Initiative. For the purpose of the study, we defined integrated landscape initiatives as initiatives that 1) seek to advance goals across the four domains of landscape performance (i.e., landscape multifunctionality), 2) work at a landscape scale (i.e., areas between tens to tens of thousands of sq. km), 3) support multi-stakeholder processes, platforms or institutions, and 4) have moved beyond the concept development and design phase to implement specific activities and report outcomes.

We aimed to identify initiatives and activities led by diverse actors, including grassroots organizations, government programmes, private sector actors, and donor organizations. We included initiatives seeking to integrate new activities and investments across sectors as well as efforts to maintain or adapt existing integrated land management systems, including traditional or indigenous systems. We used basic information gathered on each initiative – location, timeframe, activities, investments, and stakeholder involvement – to screen the initiatives for adherence to our definition and suitability for inclusion in the survey sample. We identified a total of 284 candidate initiatives in Africa and 382 candidate initiatives in the LAC region (Estrada-Carmona et al., 2014; Milder et al., 2014).

For each initiative, we provided a structured survey (consisting of 45 questions) to one leader or participant who was very familiar with the initiative and the landscape in which it was being implemented. To address the six research questions, the survey included a combination of closed- and open-ended questions on the locations, context, motivations and objectives, participating stakeholder groups, funding and governance structures, investments, outcomes and most and least successful aspects of each initiative (see Milder et al., 2014 and Estrada-Carmona et al., 2014 for more details on the survey structure). Survey questions on initiatives' investments were designed to understand the activities or processes supported by the initiatives' intellectual, technical and financial resources. Similarly, the questions on initiatives' outcomes aimed at understanding the impact of initiative activities'. Respondents selected the investments made and outcomes achieved by their initiatives in each of the four 'domains' of landscape multifunctionality (production, conservation, livelihoods, and institutional planning and coordination) from a list of possible options.

The survey had a response rate of 45% (173 out of 382) for the LAC region and 37% (105 out of 284) for Africa. We screened the survey responses for completeness and confirmation that they met our definition of an integrated landscape initiative. The final set of surveys included 104 complete responses from LAC and 87 from Africa.

We used descriptive statistics to summarize information on the dates and duration, motivations, investments, number and type of participating stakeholder groups and sectors, outcomes of the initiatives, and the location, size, and land cover composition of the landscapes where these initiatives took place. We created investment and outcome indices to characterize the breadth of investments made and outcomes achieved across the four domains. We used bivariate statistical tests (t-test and ANOVA) to examine the relationships among various initiative attributes, and between initiative attributes and the outcome index. Open-ended responses were coded to analyze patterns in responses and the emergence of themes.

It is important to note that, although we used a variety of methods to identify and contact initiatives, the 191 initiatives surveyed are not necessarily representative of all initiatives implementing landscape approaches. In particular, grassroots initiatives and those with limited connection to international networks or poor online representation may be under-represented in our sample. Additionally, all survey data were self-reported by respondents without independent verification by the research teams. While introducing the potential for bias, the leaders are the most knowledgeable individuals about the participants, activities and outcomes of initiatives. Given these limitations, the findings are not definitive, but offer an important contribution toward understanding the practice of integrated landscape management in two of the world's tropical regions.

3. Overview of results

There were many similarities in the general characteristics of integrated landscape initiatives in both continents (Table 7.1). The initiatives took place in mosaic landscapes, consisting of a mix of more than eight land cover and use types on average in Africa and more than ten on average in LAC, including crop, pasture, forest and urban lands. The respondents reported that landscape approaches are being used in landscapes ranging from tens to tens of thousands of square kilometres. The size of the populations living in the study landscapes varied widely in both continents, from hundreds to millions of people. Although heterogeneous in area and population size, it is important to note that the initiatives self-identified as landscape initiatives and the diverse political, ecological and geophysical factors influenced the rationale for their boundaries.

Conservation objectives related to biodiversity conservation, natural resource management and sustainable land management more often motivated the work of initiatives in both continents than other objectives. The prioritization of objectives related to the management of common pool resources (e.g., biodiversity, water and soil)

Table 7.1 Summary of selected characteristics of surveyed initiatives in Africa (87) and Latin America and the Caribbean (104). All data are based on information provided by the survey respondents.

	Africa	Latin America and the Caribbean
Number of survey responses included in final dataset after screening (response rate)	87 (37%)	104 (45%)
Number of countries represented by surveyed initiatives	33	21
Percent of surveyed initiatives beginning before the year 2000	5%	29%
Average number of objectives, selected from a list of 15 options*	9 (s.e. = 0.43)	10 (s.e. = 0.28)
Average number of stakeholder groups participating in the design and/or implementation of initiatives	9 (s.e. = 0.38)	11 (s.e. = 0.41)
Average number of sectors involved in surveyed initiatives (e.g., forestry, agriculture, tourism, etc.)	4 (s.e. = 0.20)	4 (s.e. = 0.19)
Percent of surveyed initiatives reported to have invested in all four 'domains' of landscape multifunctionality (agriculture, conservation, livelihoods, and institutional planning and coordination)	83%	75%
Percent of respondents that reported as least one positive outcome in each of the four domains	63%	55%
Investment index (0-100): Weighted proportion of investments in each domain (0-25), and the weighted sum of the indices for each domain (0-100)		
Agriculture	12	11
Conservation	14	13
Livelihoods	10	11
Institutional planning and coordination	15	14
Total investment index	*51*	*50*
Outcome index (0-100): Weighted proportion of outcomes in each domain (0-25), and the weighted sum of the indices for each domain (0-100)		
Agriculture	10	10
Conservation	10	11
Livelihoods	9	9
Institutional planning and coordination	14	16
Total outcome index	*44*	*47*

* The survey respondents could select from the following fifteen objectives: enhance food security, improve crop productivity, diversify food production, conserve biodiversity,

conserve soil or increase soil fertility, stop or reverse natural resource degradation, enhance sustainable land management, reduce conflict among different resource users in the landscape, increase farmer incomes, improve livestock productivity, improve health or nutrition, conserve or increase water quality or water flow, reduce the environmental impacts of agriculture, mitigate climate change or obtain carbon credits, reduce vulnerability to extreme weather events.

suggests that stakeholders recognized a need to organize around the management of such resources. In addition to these common objectives, African initiatives more often reported objectives related to improving livelihoods, such as food security, reducing conflict and reducing vulnerability than their Latin American counterparts, while initiatives in LAC more often reported other conservation objectives such as water conservation and reducing negative impacts of agriculture. Areas that were rarely mentioned as important objectives for initiatives included improving crop and livestock productivity, mitigating climate change and improving health and nutrition. Often, these areas were reported to be supported by other organizations in the same landscapes that did not participate directly in the initiatives' design or implementation. This could signal that initiatives tended to focus on complementing existing investments in their landscapes, even when such investments were not planned in collaboration with the initiative and its participants, rather than duplicating existing efforts. It also could indicate that initiatives have yet to engage influential actors working on issues that they perceived as tangential to the core objectives of integrated landscape management.

Initiatives on both continents reported including a wide range of stakeholder groups (average of 11 groups per initiative in LAC and 9 in Africa). In both cases, local farmer groups or producer associations were the most commonly involved stakeholder group, participating in 83% and 86% of surveyed initiatives in Africa and LAC, respectively. Local government entities, extension agents, and local non-governmental organizations (NGOs) were involved in more than 70% of initiatives on both continents. Notably, private sector stakeholder groups representing agribusinesses and extractive industries such as timber, oil and gas, rarely participated in the initiatives (participating in <10% of surveyed initiatives in Africa and 22% in LAC). On average, initiatives engaged stakeholder groups from at least four sectors, three of which were the same on both continents: natural resources and environment, agriculture and forestry.

Respondents also reported that most initiatives invested in activities in all four domains (agriculture, conservation, livelihoods, and institutional planning and coordination; Figure 7.1). In both Africa and LAC the proportion of investments related to institutional planning and coordination was higher than the proportion of investments in other domains, significantly so in LAC (ANOVA, $F3 = 3.978$, $p = 0.008$). The outcomes reported by initiatives in both continents reflect the pattern of their investments, with significantly more outcomes reported in relation to institutional planning and coordination than in the other domains (ANOVA, $p < 0.001$, for both LAC and Africa). In particular, initiatives reported improvements in coordination and cooperation among stakeholders, in 77% and 80% of initiatives in Africa and LAC, respectively, and improvements in the capacity of local communities to sustainably manage agriculture and natural resources in 77% and 72% of initiatives in Africa and LAC, respectively. In agreement with the principles set forth by Sayer et al. (2013), these results suggest that capacity building activities are centrally important to the work of landscape initiatives and foundational to the achievement of other objectives. An alternative or additional explanation is that capacity building activities are easier to fund and implement within a short time frame and with limited funding, two of the key challenges that initiatives reported.

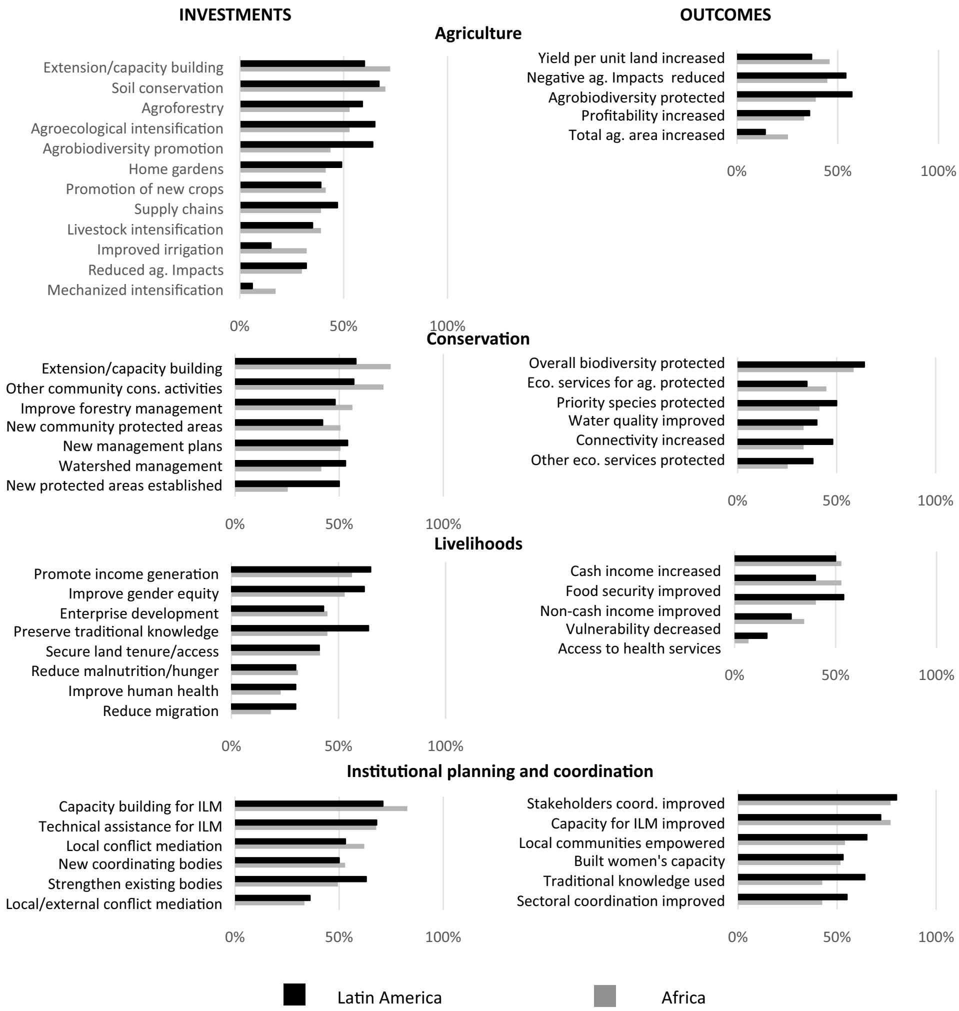

Figure 7.1 Proportion of the respondents who reported their initiative as including each of the 33 specific investments and activities (left panel) and as achieving each of the 22 specific outcomes (right panel) across the four domains of landscape multifunctionality. Respondents in Africa (n = 87 projects) and in Latin America (n = 104 projects) selected from pre-identified sets of investments/activities and outcomes (adapted from Milder et al., 2014 and Estrada-Carmona et al., 2014).

4. Comparison of key results from Latin America and the Caribbean and Africa

4.1 Initiative objectives

Conservation objectives (such as conserving biodiversity, reducing land degradation and improving sustainable land management) were the most common motivations for initiatives in Africa and LAC, occurring in more than 78% and 95% of initiatives respectively. Despite these objectives, the participation of international conservation organizations in African initiatives was weak compared to their involvement in initiatives in LAC (in 39% and 56% of initiatives, respectively). Therefore, although conservation was a common entry point, many African initiatives evolved into landscape initiatives from more traditional development initiatives, while in LAC many initiatives grew out of single-sector conservation initiatives. Also in contrast to initiatives in LAC, African initiatives tended to place more emphasis on objectives related to agricultural intensification, food security and the well-being of producer groups.

4.2 Participation

Representatives of landscape initiatives in LAC reported strong multi-stakeholder representation overall. Compared to initiatives in Africa, there was a stronger representation of grassroots initiatives in the LAC survey population. Local stakeholder groups (e.g., producer associations, local governments, local NGOs and local research institutions) were the core of initiatives in LAC and the most frequent participants. Other groups that integrated development and conservation programmes have struggled to include, particularly women and landless people groups, were often involved in implementation but rarely in the design of initiatives in LAC, indicating that potentially marginalized groups are still absent during decision-making processes. Despite these potential limitations, in Africa the participation of women's groups (in 57% of initiatives), was significantly associated with achieving broader outcomes in African initiatives (t-test, $p = 0.05$). In contrast, international NGOs and donors participated in 74% and 87% of initiatives in Africa and LAC, respectively, particularly during the design phase, providing technical guidance and funding. Although private sector actors were the least frequently involved in initiative activities, in LAC local agribusiness (in 22%) and forestry companies (in 20%) were notably more often involved than foreign agribusiness companies (in 7%) or other extractive industries such as oil, gas and mining (in 7%). In Africa, private sector participation was even lower, with only 8% of initiatives reporting the participation of local agribusiness, 5% forestry companies, 3% mining, and no participation from foreign agribusiness companies.

While landscape initiatives on both continents have established platforms for gathering diverse stakeholders, generating effective incentives for large-scale commercial stakeholders and setting objectives they agree on, remains a challenge. Failure to find strategies for including such actors, who often influence the landscape in important ways, was often reported among the least successful aspects of LAC initiatives, often leading to significant challenges during the implementation phase.

4.3 Investments and outcomes

When looking at start dates, the number of new initiatives each year has accelerated over the past decade, and in the case of Africa, in the last five years in particular. The median start date of initiatives was 2005 in LAC and 2008 in Africa. In general, the age of initiatives was positively correlated with the number and diversity of outcomes they reported. In LAC, older initiatives also achieved more outcomes related to conservation and were able to involve more sectors. These relationships indicate that some of the activities supported by initiatives take years to bear fruit, including activities related to the most important motivations for the initiatives, such as conservation objectives. Therefore, the relatively younger African initiatives may not yet have achieved many of these conservation outcomes. While creating platforms for collaboration may be achieved in a few years, it may take more time to engage and coordinate the necessary stakeholders and sectors to accomplish outcomes related to some objectives.

Initiatives in both continents reported relatively more investments and significantly more outcomes related to institutional planning and coordination than the other three domains (ANOVA, $p < 0.001$ for LAC and Africa). Investments in capacity building were common across domains, but particularly in relation to institutional planning and coordination (see Figure 7.1). These findings suggest that initiative leaders in LAC may perceive platforms for coordination as an important foundation for achieving specific outcomes related to their primary objectives. African initiatives that invested in the creation or strengthening of coordination bodies reported significantly more outcomes than those that did not invest in coordination bodies across all domains (t-test, $p = 0.03$). Within the institutional planning and coordination domain, investments by African initiatives to reduce community vulnerability and conflict among stakeholder groups suggest that initiatives perceive landscape platforms as a potential tool for addressing conflicts between stakeholders and working across sectors to tackle complex challenges like community vulnerability (see Figure 7.1).

Investments in the other domains (e.g, agriculture, conservation and livelihoods) tended to support the emphasis on capacity building and conservation objectives. Taking the agriculture domain as an example, initiatives in LAC tended to focus on investments for supporting diversified farming systems that are more compatible with conservation (e.g., promotion of agrobiodiversity, agroecological intensification and agroforestry), a high priority objective for initiatives, rather than conventional strategies for mechanized intensification or agricultural expansion (reported by only 6% of initiatives; Figure 7.1). In Africa, only three outcomes were reported across the agriculture, conservation and livelihoods domains by more than half of initiatives – protection of biodiversity, improved food security and increased household cash income. The significant and positive relationship between investments in local stakeholder participation, capacity building and cooperation and the number of outcomes reported (t-test, $p < 0.001$, $p = 0.01$, $p = 0.03$, respectively), also suggests that such investments provide a foundation for stakeholders to navigate complex challenges and diverse stakeholder interests.

4.4 Most and least successful aspects

African initiatives often reported tangible achievements, such as the designation of a new protected area, soil or water conservation, the establishment of a new coordinating body, or the adoption of new tools and practices, as their greatest successes. LAC initiatives tended to report successes related to improvements in capacity for implementing integrated management, and in natural resource management. Interestingly, livelihood improvements (e.g., improved cash income, improved food security, etc.) were reported as the most successful aspects by 16% of African initiatives despite the fact that the livelihoods domain received the lowest proportion of investment of all domains (see Figure 7.1). Respondents in both continents reported that coordinating stakeholder groups was often cited as an ongoing challenge for initiatives. However, the most common challenge was limited and sporadic funding for implementing the initiatives' activities. Initiatives also reported poor market access and infrastructure, as well as unsupportive policies as additional challenges to integrating management approaches in their landscapes.

5. Implications for policy and practice

Many countries in LAC and Africa have experienced highly contested debates over paradigms for development, conservation and agricultural production (see, for example, Wezel et al., 2011 and Martinelli et al., 2011). Latin America has provided 35% of the increase in global food production over the past 30 years (FAO, 2011) and Africa is expected to increase available food by 20% and land under agriculture by 23% by 2050 (Hubert et al., 2010). At the same time, LAC and Africa are home to thirteen biodiversity hotspots (Myers et al., 2000). General political trends of decentralization, agrarian reform, and transition to democracy have created an environment where integrated landscape approaches have been able to take root.

The LAC and Africa reviews suggest that the prevalence of landscape initiatives as approaches for simultaneously achieving positive outcomes related to agricultural production, ecosystem conservation, rural livelihoods, and institutional planning and coordination has increased over the past ten to twenty years. The expansion of integrated management in LAC and Africa is consistent with recent trends in conservation to work in production landscapes (Fischer et al., 2006; Chazdon et al., 2009), and a shift in thinking of agriculture and rural development policymakers and practitioners to give greater attention to the ecological underpinnings of their objectives and agenda (Pretty et al., 2011). In particular, complex challenges resulting from land degradation and climate change, as well as significant opportunities for ecosystem restoration (Laestadius et al., 2011), have generated interest across communities of practice to work together in new ways.

Notwithstanding the challenges initiatives faced, the findings demonstrate that outcomes can be achieved simultaneously in domains that at times have been thought to be incompatible (e.g., agriculture and conservation). The experiences of the surveyed initiatives in LAC and Africa also suggest that a move toward multi-objective management can lead to the achievement of a broad set of outcomes, rather a dilution of initiatives' effectiveness, particularly by reducing tradeoffs through cross-sector cooperation and enabling access to the resources and energy of multiple stakeholders.

The willingness of initiatives to incorporate multiple objectives into management, their emphasis on capacity building and stakeholder coordination, and their efforts to integrate multiple sectors and stakeholders point to important changes from previous approaches to conservation and development. Achievements related to new or enhanced institutions and human capacity to support cross-sector collaboration were not only frequently reported, but also cited among the most successful aspects of initiatives. Considering that the majority of the 191 initiatives were young, having begun since 2005, it appears that such investments are central features of the initiatives, particularly in the early stages of initiatives' development.

The initiatives achieved some of the principles for integrated management laid out by Sayer et al. (2013). For example, they started from a common entry point, pursuing multifunctionality and multistakeholder engagement, and strengthening stakeholder capacity. However, they fell short on others (e.g., having clear roles and responsibilities, and effective participatory monitoring). Unfortunately, institutional and political contexts did not always support integrated landscape management, and in many cases provided incentives or mandates that worked against inter-sector collaboration and multifunctional landscape management. For instance, agricultural subsidies that incentivize expansion into natural areas or excessive use of chemical inputs were cited as barriers for the implementation of integrated landscape management approaches by several respondents. Additionally, incomplete stakeholder engagement, or shallow (i.e., lack of commitment of intellectual and financial resources) and inconsistent participation, indicates that the benefits of participating in landscape initiatives do not outweigh the costs (i.e., investments in time and effort) or address the interests of all stakeholder groups. The non-participation of powerful actors with influence over land management decisions can severely limit or undermine the effectiveness of initiatives. Therefore, initiatives will need to clarify the benefits of integrated landscape management and promote policy frameworks that create regulatory environments and incentives for such stakeholders to participate in more collaborative ways (e.g., reduced risk in sourcing materials, reputational benefits, etc.) (Mermet, 2011; Kissinger et al., 2013).

The frequency of the creation of new platforms for coordination compared to the strengthening of existing platforms suggests that many existing institutions are unsuitable for supporting the work of integrated landscape initiatives. It is likely that many organizations in initiative landscapes will continue to operate under specific mandates that will limit their suitability to host initiatives. However, landscape approaches provide a long-term framework for strategically coordinating and complementing the short-term, sectoral efforts. Most investment in rural landscapes continues to stem from specific sectoral agendas and is designed to address these agendas, such that, despite the involvement of government agencies and international donors, initiatives continue to struggle to obtain long-term or permanent funding for their activities, limiting their effectiveness and scalability. Creativity in sustainably integrating operating mechanisms such as payments for ecosystem services, legislation, or other incentives engaging with both the public and private sectors will be needed to ensure the long-term benefits of initiatives. The incorporation of principles for integrated management at the policy level also will be important for establishing opportunities for sustained funding for initiatives.

Although practitioners recognized landscape initiatives as challenging, long-term endeavours, they also perceived them as necessary to solve problems where traditional sector-based approaches and scales of intervention have proven inadequate. As the complexity of challenges facing rural landscape increases and demand for their resources grows, the viability of single sector approaches will likely continue to be questioned. It remains to be demonstrated that the benefits of integrated approaches outweigh their transaction costs, and if the magnitude of benefits that they provide to diverse stakeholders is greater than single sector strategies for development and conservation. This will contribute to ongoing debates on land sparing versus land sharing approaches, common pool resource management, and the participatory land management processes.

Measuring the outcomes of initiative investments in coordination is challenging, particularly given the long-term and adaptive nature of landscape initiatives. Demonstrating these benefits to policymakers and donors will be crucial for scaling up landscape approaches by improving policy environments and access to long-term funding. Ensuring the success of initiatives also will depend on their ability to create regulatory environments or incentives for engaging influential stakeholder groups that currently appear to be underrepresented in landscape approaches. However, addressing these challenges will require the commitment and cooperation between actors at international, national and sub-national levels to broaden the evidence base of integrated management and shape enabling environments in which such initiatives can succeed. The findings of this study can help inform the design of policies that support landscape approaches by promoting integration across sectors and facilitating coordination of diverse actors. This assessment also contributes to improving implementation of landscape approaches by identifying key issues that initiatives might address through cross-landscape collaboration and institutional partnerships.

References

Brunckhorst, D. J. (2000). *Bioregional planning: resource management beyond the new millennium.* London: Routledge.

Campbell, B. M., & Sayer, J. (Eds.). (2003). *Integrated natural resource management.* Wallingford, United Kingdom: CABI Publishing.

Chazdon, R. L., Harvey, C. A., Komar, O., Griffith, D. M., Ferguson, B. G., Martínez-Ramos, M., … Philpott, S. M. (2009). Beyond Reserves: A Research Agenda for Conserving Biodiversity in Human-modified Tropical Landscapes. *Biotropica*, 41, 142–153. doi: 10.1111/j.1744-7429.2008.00471.x

Clark, M. L., Aide, T. M., & Riner, G. (2012). Land change for all municipalities in Latin America and the Caribbean assessed from 250-m MODIS imagery (2001–2010). *Remote Sensing of Environment*, 126, 84–103. doi:10.1016/j.rse.2012.08.013

DeFries, R., & Rosenzweig, C. (2010). Toward a whole-landscape approach for sustainable land use in the tropics. *Proceedings of the National Academy of Sciences of the United States of America, 107*, 19627-19632. doi:10.1073/pnas.1011163107

Estrada-Carmona, N., Hart, A. K., DeClerck, F. A., Harvey, C. A., & Milder, J. C. (2014). Integrated landscape management for agriculture, rural livelihoods, and ecosystem conservation: an assessment of experience from Latin America and the Caribbean. *Landscape and Urban Planning, 129*, 1-11. http://dx.doi.org/10.1016/j.landurbplan.2014.05.001

FAO (Food and Agriculture Organization of the United Nations). (2011). *Looking ahead in world food and agriculture: Perspectives to 2050*. Rome, Italy: Food and Agriculture Organization of the United Nations (FAO). Retrieved from http://www.fao.org/docrep/014/i2280e/i2280e.pdf

Fischer, J., Lindenmayer, D., & Manning, A. D. (2006). Biodiversity, ecosystem function, and resilience: ten guiding principles for commodity production landscapes. *Frontiers in Ecology and the Environment, 80*(5).

Foley, J. A, Defries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, … Snyder, P. K. (2005). Global consequences of land use. *Science, 309*, 570–574. doi:10.1126/science.1111772

GLF (Global Landscapes Forum). (2014). Global landscapes forum: landscapes for a new climate and development agenda. Retrieved from http://www.landscapes.org

Harvey, C. A., Chacón, M., Donatti, C. I., Garen, E., Hannah, L., Andrade, ... Wollenberg, E. (2014). Climate-Smart Landscapes: Opportunities and Challenges for Integrating Adaptation and Mitigation in Tropical Agriculture. *Conservation Letters, 7*(2), 77-90.

Heathcote, I. W., Edwards, J. R., Greener, H., & Coombs, H. M. (1998). *Integrated watershed management: principles and practice*. USA: John Wiley & Sons Inc.

Hubert, B., Rosegrant, M., van Boekel, M. A., & Ortiz, R. (2010). The future of food: scenarios for 2050. *Crop Science, 50* (Supplement_1), S-33.

Kissinger, G., Brasser, A., & Gross, L. (2013). *Reducing risk: landscape approaches to sustainable sourcing*. Washington, DC: EcoAgriculture Partners.
Laestadius, L., Saint-Laurent, C., Minnemeyer, S., & Potapov, P. (2011). *A world of opportunity: the world's forests from a restoration perspective*. Washington, DC: The Global Partnership on Forest Landscape Restoration.
LPFN (Landscapes for People, Food and Nature). (2014). The Landscapes for People, Food and Nature Initiatives. Retrieved from http://landscapes.ecoagriculture.org
Martinelli, L. A., Garrett, R., Ferraz, S., & Naylor, R. (2011). Sugar and ethanol production as a rural development strategy in Brazil: Evidence from the state of São Paulo. *Agricultural systems, 104*(5), 419-428.
McShane, T. O., & Wells, M. P. (Eds.). (2004). *Getting biodiversity projects to work: towards more effective conservation and development.* Columbia University Press.
Merment, L. (2011). Strategic environmental management analysis: addressing the blind spots of collaborative approaches. *Working Papers No. 5*. Paris: IDDRI.
Milder, J. C., Hart, A. K., Dobie, P., Minai, J., & Zaleski, C. (2014). Integrated landscape initiatives for african agriculture, development, and conservation: A region-wide assessment. *World Development, 54*, 68-80.
Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature*, 403(6772), 853-858.
Perfecto, I., & Vandermeer, J. (2010). The agroecological matrix as alternative to the land-sparing/ agriculture intensification model. *Proceedings of the National Academy of Sciences, 107*(13), 5786-5791.
Painter, T., Sumberg, J., & Price, T. (1994). Your terroir and my 'action space': implications of differentiation, mobility and diversification for the approche terroir in Sahelian West Africa. *Africa*, 64(04), 447-464.
Phalan, B., Onial, M., Balmford, A., & Green, R. E. (2011). Reconciling food production and biodiversity conservation: land sharing and land sparing compared. *Science, 333*(6047), 1289-1291.
Pretty, J., Toulmin, C., & Williams, S. (2011) Sustainable intensification in African agriculture. *International Journal of Agricultural Sustainability, 9*(1), 5-24.
Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J. L., Sheil, D., Meijaard, E., … Buck, L. E.(2013). Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land-uses. *Proceedings of the National Academy of Sciences of the USA,* 110, 8349-8356.
Schejtman, A., & Berdegué, J. (2008). *Towards a territorial approach for rural development (Discussion Paper no. 17)*. Manchester, UK: Research Programme Consortium for Improving Institutions for Pro-Poor Growth. Retrieved from http://www.ippg.org.uk/papers/dp17.pdf
Scherr, S. J., Buck, L. E., Willemen, L., & Milder, J. C. (2014). Ecoagriculture: Integrated landscape management for people, food and nature. In van Alfen, N. (Eds.). *Encyclopedia of Agriculture and Food Systems*.
Scherr, S. J., & McNeely, J. A. (2008). Biodiversity conservation and agricultural sustainability: towards a new paradigm of "ecoagriculture" landscapes. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences,* 363, 477-494. doi:10.1098/rstb.2007.2165
Scherr, S. J., Shames, S., & Friedman, R. (2013). *Defining integrated landscape management for policy makers.* Ecoagriculture Policy Focus (No. 10.). Washington, DC: EcoAgriculture Partners.
Teyssier, A. (1995). La gestion de terroir: A review of a francophone concept and a case study of its application. *Rural Extension Bulletin, 7*, 43–8.
Wezel, A., Bellon, S., Doré, T., Francis, C., Vallod, D., & David, C. (2011). Agroecology as a science, a movement and a practice. In *Sustainable Agriculture Volume 2.* Netherlands: Springer.

Senegal groundnut basin landscape with Faibherbia trees. Photo credit: Gray Tappan, US Geological Survey, EROS Center

CHAPTER

8

How can an integrated landscape approach contribute to the implementation of the Sustainable Development Goals (SDGs) and advance climate-smart objectives?

Cheikh Mbow, Constance Neely and Philip Dobie

Highlights

- Sustainable Development Goals (SDGs) and their targets articulate the global priorities for accelerating progress toward a more sustainable and just world, and subsequently the appropriate means of implementation for reaching those targets are of paramount importance
- The integrated landscape approach that has evolved over the last several decades facilitates the implementation of actions across social, economic and environmental dimensions and offers the possibility to address climate-smart objectives at scale
- The approach, which also builds upon functioning governance arrangements that meet diverse stakeholder objectives, should be considered as a means of implementation for achieving multiple inter-related SDGs and a broader set of targets as they play out, often simultaneously, at the local level
- Drawing on the evolution of proven technologies and approaches to food security and improved livelihoods, a framework is needed to better integrate the social, economic and environmental dimensions of sustainable development in a practical and coherent way
- The integrated landscape approach is proposed to bridge science, practice and policy to overcome barriers and accelerate action for achieving the SDGs and associated targets

1. Introduction

Global environmental and development agendas are now converging into a shared framework that addresses the three dimensions of sustainable development (economic, social, and environmental) and their governance requirements. At the landscape scale this includes the dual need for efficient production systems and environmental sustainability while addressing food, nutrition and economic security. Underpinning this convergence is a greater understanding of the interrelationships of poverty alleviation, food security, a healthy natural resource base and functioning ecosystem processes. Current trends in agriculture and food systems have proved inadequate and unsustainable (Gaffney, 2014*a*), illustrated by continued hunger and malnutrition, recurrent humanitarian crises, and unprecedented environmental degradation stemming from loss of forests and biological diversity, and deterioration of land, water and other natural resources (Alexandratos & Bruinsma, 2012; SDSN, 2014). To meet growing food and nutritional demands in the context of sustainable food systems, production must increase substantially, and at the same time, agriculture's environmental and carbon footprint, must be reduced dramatically (Foley et al., 2011; Sayer & Cassman, 2013).

Many governments and societies have argued the importance of sustainable development over the last 30 years. Innumerable attempts have been made to intervene within social, economic and environmental dimensions to advance toward agreements cast in Agenda 21 and associated conventions that were articulated as targets within the Millennium Development Goals (MDGs), restated in negotiations during Rio+20, and soon to be reframed formally as the Sustainable Development Goals (SDGs). While the intention and priority has been made clear, it has been challenging for the international community to realize sustainable development objectives due to a lack of integration across the social, economic and environmental dimensions, incoherence in institutional goals, and limited political determination (Bogardi et al., 2012).

The SDGs build upon and supplement the MDGs creating what is being termed the post-2015 development agenda. The emerging development agenda will depend greatly upon achieving environmental sustainability that reinforces the capacity to achieve associated social and economic dimensions. The means of implementation will have to place particular emphasis on the tradeoffs and synergies between and among the different dimensions and assess the sustainable development returns on investments.

Evidence of numerous environmental challenges have been highlighted through the Millennium Ecosystem Assessment (MEA, 2005) and the Global Environmental Outlook 5 (UNEP, 2012) and more recently revisited within the context of resilience through the introduction of the concept of planetary boundaries (Rockström et al., 2013). In order to establish planetary boundaries, environmental threats were synthesized into three major domains: depleting non-renewable fossil resources (energy and water), threats to the living biosphere (ecosystems and biodiversity), and human waste flows (greenhouse gases and toxic products). The challenge now is to undertake alternative sustainable development pathways while addressing the unprecedented risks of abrupt, irreversible environmental changes, with potentially catastrophic implications for human development. The transformation towards sustainability will require re-thinking the national and international development structures through better governance, partnerships and knowledge sharing for an explicit integration of environmental and human development agendas at all scales (SDSN, 2014).

It is anticipated that many countries will not be able to achieve their economic and social development goals without modifying practices, policies, and investments to fully encompass environmental sustainability. Current agricultural production systems are either too intensive—high levels of inputs decoupled from ecological objectives—creating many negative consequences on existing environmental resources, or are too extensive—

low levels of inputs or cycling of resources, slash and burn approaches, deforestation or inappropriate land use conversion—with negative side effects on the ecosystem (Haberl et al., 2014). The emerging SDGs will, *inter alia*, seek to increase efficiency in the use of land, water and agricultural inputs to better contribute to environmental goals while bridging the gap between current yields and the projected requirements to feed the Earth's population throughout the rest of the 21st century. Productivity is necessary but not sufficient alone to ensure food and nutrition security, generate necessary income, and maintain the health of the natural resource base.

The necessity for integration of sustainability dimensions is becoming clearer and more urgent. This integration has proved difficult to achieve using existing governance systems and cadastral approaches that define boundaries, ownership and rights and land use in terms of farms and fields rather than the landscape that they form part of. Agricultural and conservationist communities have found it difficult to come up with common solutions to achieve their objectives, as demonstrated in the debates promoting land sparing versus land sharing (Phalan et al., 2011). As a result, researchers and development professionals have begun to turn their attention to achieving integrated approaches within naturally-defined 'landscapes' (Frost et al., 2006). The term 'landscape' is widely used to describe the mosaics of land uses, flora, fauna, people, and infrastructure that exist in definable geographical locations. It is a valuable concept for understanding how people, agriculture, forestry and fisheries, non-agricultural livelihood systems, biodiversity and infrastructure can co-exist. Integrated landscape approaches "... deliberately support food production, ecosystem conservation, and rural livelihoods across entire landscapes" (Scherr et al., 2012). Thus landscape approaches promote land use management schemes to achieve development and environmental objectives based on shared values and co-benefits (Sayer et al., 2013; Bustamante et al., 2014). Landscape approaches could allow – within the normative framework of the SDGs – for a practical cross-sectoral implementation strategy. This includes clear metrics that can be integrated to represent biophysical, economic, social, and cultural changes. Such a strategy should account for policy-relevant institutional and governance arrangements (Kozar et al., 2014) to enhance their coherence and sustain success.

More recently, the concept of climate-smart landscapes has emerged and is gaining traction as a practical way to achieve mitigation, adaptation and agricultural production objectives while ensuring that important synergies continue to be generated among different and biologically diverse land uses, livelihood strategies and food and nutrition security priorities (Scherr et al., 2012). In this way, the climate change agenda is compatible if not fused with the overall sustainable development agenda, as these two cannot be tackled by separate means. It is therefore timely to discuss the means of implementation. In this chapter, we argue that integrated landscape approaches provide effective ways of achieving them.

2. The integrated landscape approach as a framework for implementing the Sustainable Development Goals

The integrated landscape approach has been advanced as a response to increasing societal concerns about environment and development tradeoffs within sustainability initiatives.

Adverse effects on landscapes have been caused by directive 'forcing regimes' that have affected environmental processes as diverse as the dynamics of disease, wildfire, carbon destocking, invasive species, and biogeochemical cycles (Leadley et al., 2014). There have been unanticipated outcomes from numerous development projects, including, for example, the loss of native species or the introduction of exotics that have proven not only deleterious to the environment and related livelihoods, but extremely difficult to remedy (Estes et al., 2011; Phelps et al., 2013). Under the integrated landscape approach, the objectives are not only production or biodiversity conservation for ecosystem services, or to select a particular land use structure rather over another, but to see how to manage heterogeneity at all scales to prevent those changes that limit *de facto* environmental sustainability (Sayer & Cassman, 2013; Sayer et al., 2013). The integrated landscape approach has therefore emerged as the most widely advocated means to address growing pressures on land, water and other resources to achieve sustainability (e.g., Bogardi et al., 2012).

Unanticipated negative outcomes of development activities are not limited to the environmental dimension, but have also taken their toll on social and economic dimensions (Tripp, 2012). Across all three dimensions, most of the failures to date can be attributed to inappropriate technical interventions and ineffective governance frameworks (Bogardi et al., 2012). Landscape governance is indeed a crucial component of successful and sustained integrated landscape management in order to integrate divergent values and interests of different actors, clarify appropriate rights and resources, and overcome inequities and power dynamics in decision-making. These challenges relate to a misalignment between ecologically defined landscapes and administrative and political boundaries (Kozar et al., 2014). These challenges of landscape management at scale were addressed through new governance arrangements by the Model Forests Network, Landcare International, and the Northern Rangelands Trust (Neely et al., 2014). The integrated landscape approach is therefore a framework for negotiating needs for production and access to resources, minimizing conflicts and promoting learning by all parties to accelerate the achievement of beneficial impacts. Landscapes provide the workable space for understanding, intervening and monitoring coupled socio-ecological systems (Holmgren, 2013; Milder et al., 2014).

The integrated landscape approach is not by any means new and in many ways has served as a light or invisible backdrop for the many technologies and stakeholder-based interventions that have been implemented over the last 20 years. And, while the aspirational practices and approaches noted in Figure 8.1 is not an exhaustive list, one can readily see how the underlying principles related to the social and environmental dimensions evolved alongside the political negotiations (Neely & Moore, 2014). The term 'landscape' begun to appear in these political decisions since 2000 and the SDGs are an ideal opportunity to combine the evolving multiplicity of ideas into a working paradigm for action. People, economies and the environment live together while conflicting priorities can be resolved and resource use optimized for the greatest benefit of humans.

More recently, there has been much more focus on the need to feed a growing population and the term 'sustainable intensification' has come into use, which according to the FAO (2011) "... aims to increase crop production per unit area, taking into consideration all relevant

	1992	1996	2000-2002	2008-2010	2012
Political decisions trend	Earth Summit	World Food Summit	MDGs, World Summit on Sustainable Development (Rio+10)	MDGs Summit	Rio+20, SDGs
Sustainability science and practice trend	Sustainable agriculture, farming systems, farmer-to-farmer knowledge, participatory approaches, landscape approach	Ecosystem, landscape, holistic approaches, organic agriculture, biodiversity conservation, combat desertification, sustainability indicators	Sustainable livelihoods, eco-agriculture, sustainable land management, climate change mitigation and carbon dynamics, ecosystem services, decision-making, knowledge sharing, innovation support, good agricultural practices	Sustainable intensification, climate-smart agriculture, innovation platforms, evidence-based decision-making, landscape system approach, conservation agriculture, sustainability principles	Governance, natural capital in development, green economy, universality of sustainability principles, landscape principles, climate-smart landscapes, sustainable intensification, research in development, resilience

Figure 8.1 The evolution of approaches within the scientific and development contexts (adapted from Neely & Moore, 2014).

factors affecting productivity and sustainability, including social, political, economic and environmental impacts. With a particular focus on environmental sustainability through an ecosystem approach, Sustainable Crop Production Intensification aims to maximize options for crop production intensification through the management of biodiversity and ecosystem services". At the same time it has been recognized that climate change is both a risk to agriculture and a result of agriculture as agriculture contributes 10-12% of global anthropogenic greenhouse gas emissions (Smith et al., 2014).

The term 'Climate-Smart Agriculture' was coined to link agricultural and climate change policy together with a view to reduce the impact of agriculture on climate while ensuring that agriculture adapts to the effects of climate change. Climate-smart agriculture is "... an agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation) while enhancing the achievement of national food security and development goals" (FAO, 2010; 2013). As a result, in 2014, formal political agreements were made to create the Global Alliance for Climate-Smart Agriculture as well as an African Alliance for Climate-Smart Agriculture. Many of the practices in Figure 8.1 are being revisited and tested for their 'climate-smartness'. Using the same parameters that define climate-smart agriculture, others have demonstrated that climate-smart landscapes may not only provide greater opportunities for accelerating mitigation, adaptation, food security and development goals by capitalizing on their synergies, but in some cases landscape-level efforts will be required to meet these demands (Scherr et al., 2012; Harvey et al., 2014).

The landscape approach, taking into account the institutional and governance structures, to address the complexities associated with meeting multiple land use objectives, has a proven track record that should be taken seriously as a means of implementation for addressing SDGs and climate-smart objectives. In the next section, a framework is presented to underpin this statement.

3. Towards a normative framework linking landscape approaches to the SDGs

The implementation of Agenda 21 and subsequent agreements on sustainable development have foundered on a lack of common definitions and framework for implementation and a clear deficiency of political will. In principle, achieving one target should not be at the expense of achieving any other (Gaffney, 2014*b*). As described above, there is an emerging coherence of aims to achieve sustainable development. Applying landscape approaches is a valuable and vital pathway for bringing these development aspirations together to practically manage development initiatives and achieve the SDGs while at the same time advancing climate-smart objectives (Mbow et al., 2014*a*). In this context, the question is how to accelerate the implementation of the integrated landscape approach to support the SDGs (Scherr et al., 2014; SDSN, 2014). A starting point could be the list of landscape principles regimented by Sayer et al. (2013) (see Box 8.1) that could be used as a basis for defining hierarchy and entry points on how landscape approaches can be used in the implementation of SDGs.

Box 8.1

Ten principles from Sayer et al. (2013)

Principle 1: Continual learning and adaptive management

Principle 2: Common concern entry point

Principle 3: Multiple scales

Principle 4: Multifunctionality

Principle 5: Multiple stakeholders

Principle 6: Negotiated and transparent change logic

Principle 7: Clarification of rights and responsibilities

Principle 8: Participatory and user-friendly monitoring

Principle 9: Resilience

Principle 10: Strengthened stakeholder capacity

We learn from the ten principles—considered here as a good starting point for implementing the SDGs—that some of them are prerequisites or enabling conditions (common concern and entry point), others are related to actions and community needs (management, negotiations, skills, participation) and finally a few address the overall objectives of integrated landscape approaches (resilience, food security) While the core idea is to avoid contradictory actions in resource management, some important cross-cutting aspects must be kept at the centre of such approaches including issues related to relative scale differences and multifunctionality (i.e., micro landscape multifunctionality aspects are different from those at macro landscape levels), both of which are very context dependent. Here, as a first step, we reorganized the ten principles in three categories, namely prerequisites, action items and aims (Figure 8.2). This framework is used as a conceptual model to identify potential areas of action to achieve sustainability goals using sustainable landscape approaches. Using this framework we attempted to link landscape approaches to the SDGs in Table 8.1 where we shows examples of outcomes and activities that contribute to the SDGs.

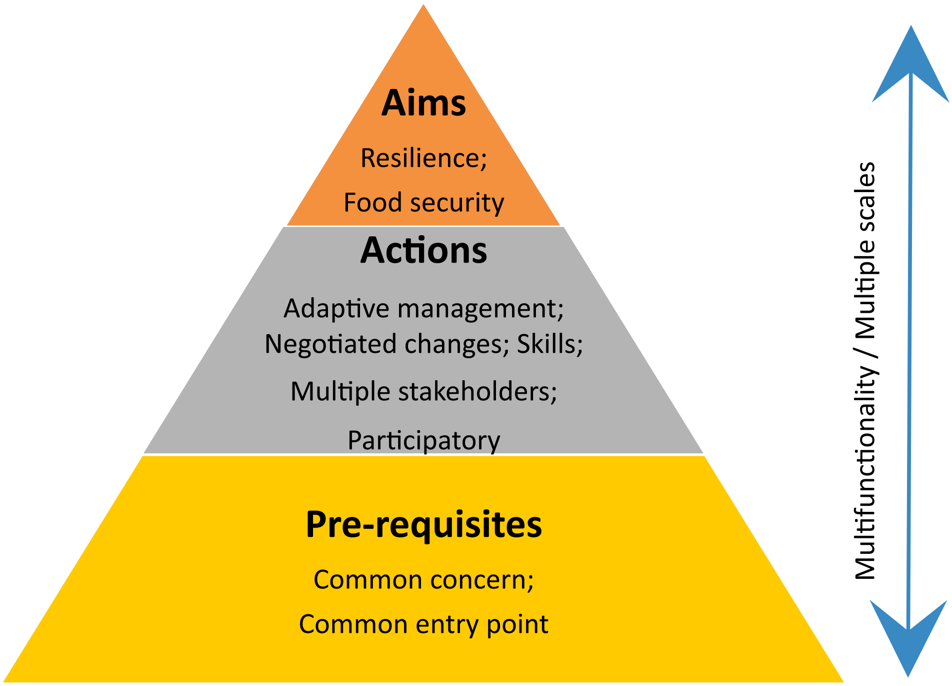

Figure 8.2 An interpretation of the various principles of a landscape approach (based on Sayer et al., 2013; see Box 8.1) described in three categories: prerequisites, action items and aims.

The set of SDGs goals is broad and yet quite inclusive. They can point to many directions, some of which are largely specified on the appended targets. The targets themselves are intentional outcomes but the mean of implementation is yet to be defined for each. In Table 8.1 we suggested examples of how the landscape approach in three dimensions – necessary enabling and pre-conditions, actions to be taken, and the sustainability objectives – could be an effective tool for achieving the SDGs. By cataloguing the potential barriers, we also highlighted some supportive actions that are needed to ensure success and limit some of the inconveniences of the suggested approaches. It is important to recognize that landscapes are highly heterogeneous and their social and ecological contexts vary often along with many different impediments that limit the achievement of operational objectives. There is therefore no single approach to managing landscapes, in particular, achieving sustainability in development projects requires the integration of biodiversity and ecosystem services (Lucas et al., 2014; Mbow et al., 2014*b*).

The main challenge will be the management of tradeoffs and synergies between the various SDGs. When political negotiations reach the point of discussing means of implementation of agreements, reconciling various objectives often becomes difficult. There cannot be an ‘either or’ approach when it comes to solutions, but rather there needs to be principles that can be adhered to and tested against. The integrated landscape approach will provide the means for ensuring that the most appropriate practices and approaches are implemented in the right place for the right reasons to achieve the goals of sustained and sustainable development.

Table 8.1 The SDGs and the potential contribution of the landscape approach to these goals.

	SDGs Goals[1]	Where landscape approaches can contribute	Alignment with 10 principles (Sayer et al., 2013)	Examples of potential barriers
1.	End poverty in all its forms everywhere	Sustainable intensification of agriculture, integrated resources management, climate risk management, resolving land tenure issues, diversified livelihoods	Common concern entry point, multiple stakeholders, negotiated and transparent change logic, clarification of rights and responsibilities, resilience	Poverty programmes are conventionally organized within government administrative units. Landscapes seldom follow administrative boundaries and policy boundaries.
2.	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	Sustainable intensification, diversification of agricultural products, promotion of local fruits and other sources of good nutrition, agrobiodiversity, ecosystems services, ecological management of waste	Common concern entry point, multifunctionality, multiple stakeholders, resilience	Food and agriculture are conventionally the remit of agricultural ministries and departments, and other authorities (environment, water, etc.) have limited influence. This militates against the multifunctional management of landscapes. Food preferences, behaviour and diets may have to change, which will meet cultural resistance.
3.	Ensure healthy lives and promote well-being for all at all ages	Production of affordable nutritional food, sustainable ecosystem goods and services	Resilience	Global, national and local farm input and production markets will need to shift from high-output models that favour inputs over integrated management approaches that achieve sufficient food production. Resistance of some private companies.

4.	Ensure inclusive and equitable quality education and promote life-long learning opportunities for all	Co-learning and co-design of landscapes and development options, participation and inter-generational dialogs	Strengthened stakeholder capacity, continued learning and adaptive management	Conventional learning stresses one-way transmission of knowledge. It will be important to shift to a co-learning paradigm and participatory learning, by putting local knowledge in practice.
5.	Achieve gender equality and empower all women and girls	Multiple roles for men and women across landscapes, clear roles and responsibilities of social groups in achieving various landscape objectives	Negotiated and transparent change logic, multiple stakeholders, clarification of rights and responsibilities, strengthened stakeholder capacity	Landscapes will provide increased opportunities for men and women, but change will not be inevitable. Further social reform needed.
6.	Ensure availability and sustainable management of water and sanitation for all	Soil and water management, watershed management, better controlled water cycles, water recycling with trees, increased water infiltration, reduction of water erosion	Multifunctionality, multiple scales, resilience	National water planning often depends upon grand master plans. There will be a challenge in developing water management strategies around numerous interconnected landscapes.
7.	Ensure access to affordable, reliable, sustainable, and modern energy for all	Sustainable bioenergy from landscapes including biofuels and wood from agroforestry, integrated sustainable food, water and energy systems	Common concern entry point, resilience, multiple scales	Conventional energy policies recognize the importance of landscapes for hydropower, but seldom fully recognize the potential of bioenergy.
8.	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	Sustainable intensification at various scales, markets for natural and place-based products, fair shares of natural resources based income, reduced food price through increased production	Common concern entry point, multiple scales, resilience, strengthened stakeholder capacity, negotiated and transparent change logic	To benefit from the multiplicity of work opportunities in landscapes it will be necessary to significantly reduce, and then eliminate, employment and income differentials between men and women.

9.	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Supply of commodity products, promotion of entrepreneurial skills at the local level, develop value chains	Resilience, strengthened stakeholder capacity	The tendency of commodity-purchasing enterprises to extract value without sharing value locally will need to be replaced by partnership approaches.
10.	Reduce inequality within and among countries	Landscape approaches may have some value in reducing inter-country inequity through cross-border landscape initiatives and managing the inherent variation in natural resources distribution over time	Multiple scales, negotiated and transparent change logic, common concern entry point	The inevitable trade advantages of richer countries will take time and considerable progress to overcome.
11.	Make cities and human settlements inclusive, safe, resilient and sustainable	Rural migration better managed with people offering skills and knowledge moving to cities, sustainable landscapes feeding cities	Common concern entry point, multiple scales, continued learning and adaptive management, resilience	Few countries have any functioning policies to manage the transition from rural agrarian to urban industrialized societies.
12.	Ensure sustainable consumption and production patterns	Sustainable production and recycling are central to the landscape approach, agrobiodiversity, development of high value products for local consumption	Resilience	Rapid increase of population may undo some efforts in improving production and consumption.
13.	Take urgent action to combat climate change and its impacts	Climate-smart land use systems, reduced climate risks, improved mitigation potential while enhancing adaptation and food security	Common concern entry point, multiple scales, resilience	Poorly-managed industrial growth and the continued use of high levels of energy in developed countries might overwhelm benefits from improved landscape management.

14.	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	Landscapes incorporate coastal and estuarine areas, better land management reduces pressures on coastal areas and oceans, particularly deltas and mangroves, sustainable landscape approaches incorporate geographical connections between land and ocean	Resilience, multifunctionality	Lack of integrated policies on linkages between land-based development and their marine influence.
15.	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	Land sharing, support for agrobiodiversity, farmers' management of natural regeneration, clear plans for ecosystem services management	Resilience, multifunctionality, negotiated and transparent change logic, clarification of rights and responsibilities	The divergence of views on the relative values of land sharing and land sparing is still unresolved, which leads to challenges in making decisions on landscape use.
16.	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	The landscape approach can provide a framework for negotiating management rules, bylaws and co-designing management options	Continued learning and adaptive management, negotiated and transparent change logic, multiple stakeholders	The ability to negotiate fair rules across landscapes will depend upon the existence of functioning rule of law, an impartial judicial system and the flexibility of national law to decentralize authority.
17.	Strengthen the means of implementation and revitalize the global partnership for sustainable development	Shifting to landscape approaches could provide a genuinely new and innovative means of implementation that national and global partners can support	Multiple scales, multiple stakeholders	As long 'means of implementation' remains code for the transfer of resources, and while national sovereignty limits global cooperation, progress will remain challenging.

1 These 17 goals were taken from the SDSN web page: http://sustainabledevelopment.un.org/focussdgs.html, accessed the 27th of August 2014. While the SDGs as they had been formulated at the time of drafting this chapter might be further negotiated and modified before the 2015 Millennium Summit, their overall structure and thrust is unlikely to change.

4. Conclusion

The establishment of the SDGs will be the latest step in attempting to create normative frameworks for sustainable development and applying them to development agendas. Earlier attempts to implement sustainable development agreements have been only partially successful and a major obstacle has been the difficulty in integrating the social, economic and environmental dimensions of sustainability. During the period from the Earth Summit in 1992 to the Rio+20 meeting in 2012, there have been numerous international conferences that have sought to accelerate the sustainable development agenda and the development of increasingly sophisticated knowledge of what needs to be achieved that has resulted in a spin-off of a plethora of ideas, platforms and initiatives, many of which have become part of the current development dialogue (e.g., climate-smart agriculture, sustainable intensification and others). But many of the aspirations of these initiatives remain unattained. There are many reasons for this, but one is that governance systems provide neither the means of integrating decision-making and management across sectors, nor the places where integration of social, economic and environmental objectives can be readily achieved. Landscape approaches could provide both: the close proximity of people with differing, but complementary interests should encourage integrated planning and management, and the potential for the interdependence of elements in landscapes leading to improved integration of social, economic and environmental interests. The transition from existing ways of making political decisions will not be easy, as institutions and boundaries are seldom associated with landscapes. However, the advantages of integrated landscape approaches should make it attractive to decision-makers to introduce landscape thinking into their planning and management approaches.

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References

Alexandratos, N., & Bruinsma, J. (2012). *World Agriculture towards 2030/2050*. Rome: Food and Agriculture Organization of the United Nations (FAO).

Bogardi, J. J., Dudgeon, D., Lawford, R., Flinkerbusch, E., Meyn, A., Pahl-Wostl, C., ... Vorosmarty, C (2012). Water security for a planet under pressure: interconnected challenges of a changing world call for sustainable solutions. *Current Opinion in Environmental Sustainability,* 4, 35-43. doi: 10.1016/j.cosust.2011.12.002

Bustamante, M., Robledo-Abad, C., Harper, R., Mbow, C., Ravindranat, N. H., Sperling, F., … Smith P. (2014). Co-benefits, trade-offs, barriers and policies for greenhouse gas mitigation in the agriculture, forestry and other land use (AFOLU) sector. *Global Change Biology, 20*(10), 3270-3290. doi: 10.1111/gcb.12591

Estes, J. A., Terborgh, J., Brashares, J. S., Power, M. E., Berger, J., Bond, W. J., … Wardle D.A. (2011). Trophic downgrading of planet Earth. *Science, 333*(6040), 301-306. doi: 10.1126/science.1205106

FAO (Food and Agriculture Organization of the United Nations). (2010). *"Climate-Smart" Agriculture: Policies, practices and financing for food security, adaptation and mitigation.* Technical contribution to the Hague Conference on Agriculture, Food Security and Climate Change. Rome: FAO. Retrieved from http://www.fao.org/fileadmin/user_upload/newsroom/docs/the-hague-conference-fao-paper.pdf

FAO. (2011). *An Ecosystem Approach to Sustainable Crop Production Intensification: a conceptual framework.* Rome: FAO. Retrieved from http://www.fao.org/fileadmin/templates/agphome/scpi/SCPI_Compendium/SCPIConceptual_framework_02.pdf

FAO. (2013). *Climate Smart Agriculture Sourcebook.* Rome: FAO. Retrieved from http://www.fao.org/docrep/018/i3325e/i3325e.pdf

Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E. S., Gerber, J. S., Johnston, M., … Zaks, D. P. (2011). Solutions for a cultivated planet. *Nature, 478*(7369), 337-342. doi: 10.1038/nature10452

Frost, P., Campbell, B. M., Medina, G., & Usongo, L. (2006). Landscape-scale approaches for integrated natural resource management in tropical forest landscapes. *Ecology and Society, 11*(2), 30. Retrieved from http://www.ecologyandsociety.org/vol11/iss32/art30 /

Gaffney, O. (2014*a*). Quiet green revolution starts to make some noise. *Nature, 505*(7485), 587. doi: 10.1038/505587a

Gaffney, O. (2014*b*). Sustainable Development Goals. Improving human and planetary wellbeing. *Global Change*, IGBP, 82:20-23. Retrieved from http://www.igbp.net/news/features/features/sustainabledevelopmentgoalsimprovinghumanandplanetarywellbeing.5.62dc35801456272b46d1f7.html

Haberl, H., Mbow, C., Deng, X., Irwin, E. G., Kerr, S., Kuemmerle, T., & A. Reenberg (Eds.), *Rethinking Global Land Use in an Urban Era. Strungmann Forum Reports Vol. 14*. Cambridge, MA: MIT Press, 35-69.

Harvey, C. M., Chacon, C., Donatti, E., Garen, L., Hannah, A., Andrade, L., … Wollenberg, E. (2014). Climate-smart landscapes: Opportunities and challenges for integrating adaptation and mitigation in tropical agriculture. *Conservation Letters, 7*(2), 77-90. doi: 10.1111/conl.12066

Holmgren, P. (2013). Could the sustainable development goals include landscapes? Bogor, Indonesia: CIFOR. Retrieved June 2014 from http://blog.cifor.org/14788/could-the-sustainable-development-goals-include-landscapes/#.UjESBMZHI5s

Kozar, R., Buck, L., Barrow, E., Sunderland, T., Catacutan, D., Planicka, C., … Willemen, L. (2014). *Towards Viable Landscape Governance Systems: What works?* Landscapes for People, Food and Nature (LPFN) Working Paper. Washington, DC: EcoAgriculture Partners.

Leadley, P., Proenca, V., Fernandez-Manjarres, J., Pereira, H. M., Alkemade, R., Biggs, R., … Walpole, M. (2014). Interacting Regional-Scale Regime Shifts for Biodiversity and Ecosystem Services. *BioScience*. doi: 10.1093/biosci/biu093

Lucas, P. L., Kok, M. T. J., Nilsson, M., & Alkemade R. (2014). Integrating Biodiversity and Ecosystem Services in the Post-2015 Development Agenda: Goal Structure, Target Areas and Means of Implementation. *Sustainability, 6*(1), 193-216. doi: 10.3390/su6010193

Mbow, C., Smith, P., Skole, D., Duguma, L., & Bustamante, M. (2014a). Achieving mitigation and adaptation to climate change through sustainable agroforestry practices in Africa. *Current Opinion in Environmental Sustainability, 6*(0), 8-14. doi: 10.1016/j.cosust.2013.09.002

Mbow, C., van Noordwijk, M., Prabhu, R., & Simons, T. (2014b). Knowledge gaps and research needs concerning agroforestry's contribution to Sustainable Development Goals in Africa. *Current Opinion in Environmental Sustainability, 6*(0), 162-170. doi: 10.1016/j.cosust.2013.11.030

MEA (Millenium Ecosystem Assessment). (2005). *Rapport de synthèse de l'Évaluation des Écosystèmes pour le Millénaire.* MEA, 59. Retrieved from http://www.unep.org/maweb/fr/Synthesis.aspx

Milder, J. C., Hart, A. K., Dobie, P., Minai, J., & Zaleski, C. 2014. Integrated Landscape Initiatives for African Agriculture, Development, and Conservation: A Region-Wide Assessment. *World Development*, 54, 68–80. doi: 10.1016/j.worlddev.2013.07.006

Neely, C., & Moore, K. (2014). Twenty years of the Sustainable Agriculture and Natural Resources Management Collaborative Research Support Program. Presentation provided to USAID, May 20, 2014, Washington, DC: USAID.

Neely, C., Buck, L., Kozar, R., Muller, C., Njomkap, J. C. , & Worden, J. 2014. Supporting African Landscape Objectives through Local Landscape Governance. Synthesis document prepared for the Landscapes for People, Food and Nature in Africa Conference, July 1-3, 2014, Nairobi, Kenya.

Phalan, B., Onial, M., Balmford, A., & Green, R. E. (2011). Reconciling food production and biodiversity conservation: land sharing and land sparing compared. *Science, 333*(6047), 1289-1291. doi: 10.1126/science.1208742

Phelps, J., Carrasco, L. R., Webb, E. L., Koh, L. P., & Pascual, U. (2013). Agricultural intensification escalates future conservation costs. *Proceedings of the National Academy of Sciences, 110*(19), 7601-7606. doi: 10.1073/pnas.1220070110

Rockström, J., Sachs, J., Öhman, M. & Schmidt-Traub, G. (2013). *Sustainable development and planetary boundaries.* Background paper for the High-Level Panel of Eminent Persons on the post-2015 development agenda. Paris & New York: Sustainable Development Solutions Network. Retrieved from http://www.post2015hlp.org/wp-content/uploads/2013/06/Rockstroem-Sachs-Oehman-Schmidt-Traub_Sustainable-Development-and-Planetary-Boundaries.pdf

Sayer, J., & Cassman, K. G. (2013). Agricultural innovation to protect the environment. *Proceedings of the National Academy of Sciences, 110*(21), 8345-8348. doi: 10.1073/pnas.1208054110

Sayer, J. A, Sunderland, T. C. H., Ghazoul, J., Pfund, J. L., Sheil, D., Meijard, E., … Buck, L. E. (2013). Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. *Proceedings of the National Academy of Sciences, 110*(21), 8349–8356. doi: 10.1073/pnas.1210595110

SDSN (The Sustainable Development Solutions Network). (2014). Solutions for Sustainable Agriculture and Food Systems. SDSN. Retrieved from http://unsdsn.org/wp-content/uploads/2014/02/130919-TG07-Agriculture-Report-WEB.pdf

Scherr, S. J., Shames, S., & Friedman, R. (2012). From Climate-Smart Agriculture to Climate-Smart Landscapes. *Agriculture & Food Security*, 1:12, doi: 10.1186/2048-7010-1-12

Scherr, S. J., Holmgren, P., Simons, T., Tutwiler, A., Arce, J. J. C., Kimble, M., & McNeely J. A. (2014). An Integrated Landscape Target for the Sustainable Development Goals: A Position statement from the Landscapes for People, Food and Nature Initiative to the Open Working Group on the Sustainable Development Goals. Retrieved from www.landscapes.ecoagriculture.org

Smith, P., Bustamante, M., Ahammad, H., Clark, H., Dong, H., Elsiddig, E. A., … Tubiello, F. N. (2014). *Chapter 11 Agriculture, Forestry and Other Land Use (AFOLU).* Climate Change 2014. IPCC. Geneva, WMO. WG-III: 181 p. Retrieved from http://report.mitigation2014.org/drafts/final-draft-postplenary/ipcc_wg3_ar5_final-draft_postplenary_chapter11.pdf

Tripp, A. M. (2012). Donor assistance and political reform in Tanzania. UNU-World Institute for Development and Economics Research, Working Paper No. 20212/37.http://ideas.repec.org/p/unu/wpaper/wp2012-37.html

UNEP (United Nations Environment Programme). (2012). *Global Environmental Outlook (GEO-5)*. Malta: UNEP. Retrieved from http://www.unep.org/geo/geo5.asp


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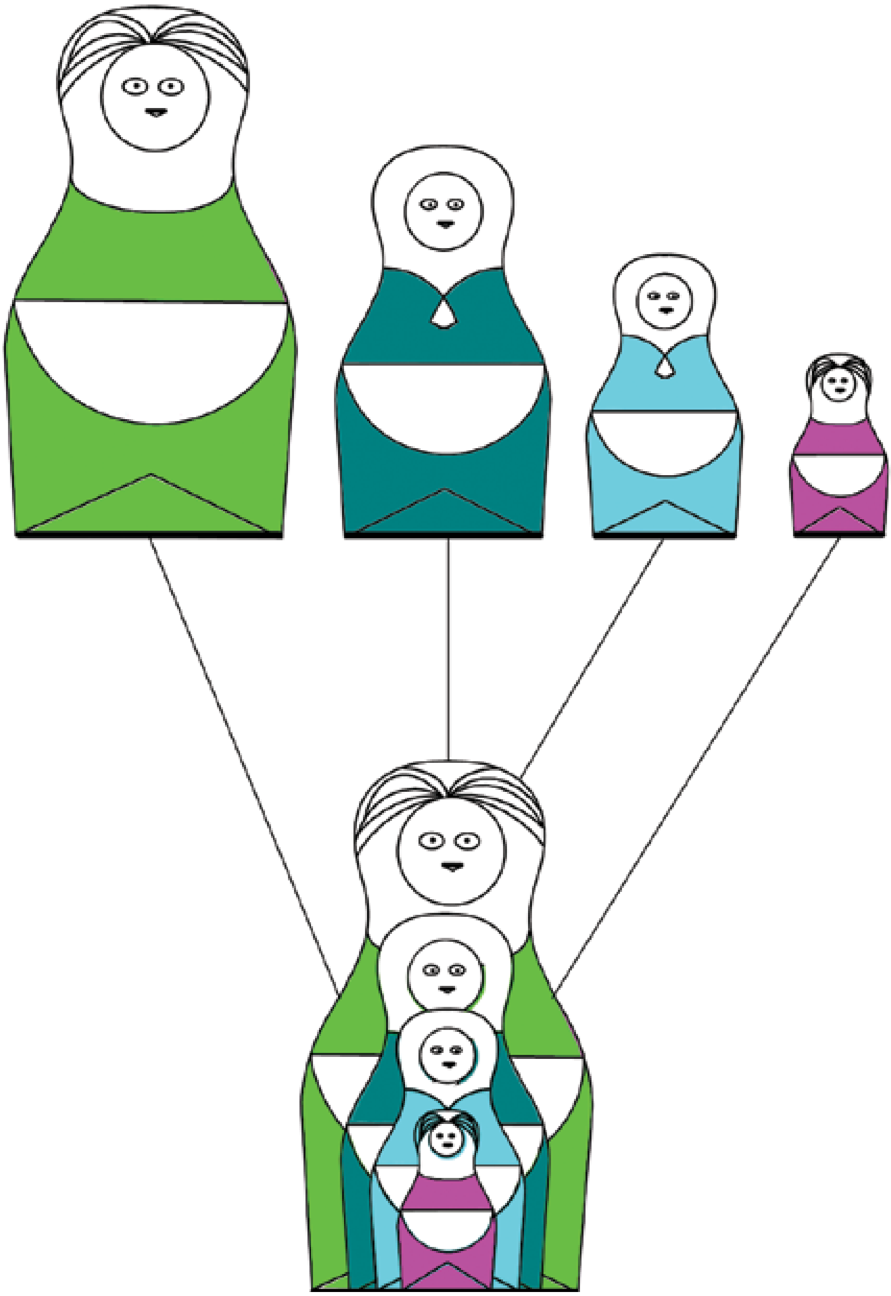
PART

3

From Concepts to Inducing Change



An illustration of nested and multiple scales dimensions using Matryoshka dolls. Image credit: Lalisa A. Duguma

CHAPTER 9

Scale considerations in landscape approaches

Peter A. Minang, Lalisa A. Duguma, Dieudonne Alemagi and Meine van Noordwijk

Highlights

- Understanding scale differences and dynamics is important for analyzing and facilitating sustainable landscapes
- Choice of, and changes in scale can significantly impact information and understanding in landscapes analysis
- When facilitating processes for sustainable solutions in landscapes, perceived scales of phenomena and interests of actors and the interactions therein are an important consideration
- No single scale is adequate for analyzing, understanding and/or facilitating effective, efficient and equitable sustainable landscapes; a considered set of nested scales is imperative

1. Introduction

Scale can be a key determinant in understanding, planning and managing landscapes. Stakeholders in a landscape will perceive the same differently, given their specific interests. Wilbanks (2006) shows that the choice of scale could determine how much detail of the landscape can be revealed, with detail observed at finer scales. Therefore, several landscape practitioners have asked the question, what is the right/appropriate landscape scale? Common answers are often along the following lines "it depends", "it depends on context", "it depends on the problem", "it depends on the system being analyzed", etc. Is "it depends" a cop-out or is it the fact that there is no straightforward answer? In this chapter, we review how scale has been interpreted and deployed in landscapes and highlight salient considerations for analyzing, understanding and facilitating landscape processes in the context of landscape approaches to sustainable landscapes.

The Millennium Ecosystem Assessment (MEA; 2003) defines scale as the physical dimension of a phenomenon or process in space or time, expressed in physical units. Given this definition, "... a level of organization is not a scale, but it can have a scale" (MEA, 2003; see also Wilbanks, 2006). This perspective is largely a geographic one. In landscape ecology, scale refers mainly to grain (resolution) and extent in space or time (Wu & Qi, 2000). Scale may be absolute (time or spatial units) or relative (expressed as a ratio). Cash et al. (2006) also recognize jurisdictional, institutional, management, network and knowledge scales in human-environment interactions (i.e., in addition to spatial and temporal scales). Scaling is usually defined as the process of extrapolating or translating information from one scale to another (Wu & Qi, 2000). An important element here is 'place'. Place represents a geographic connection to space which in itself is a mental, social and spiritual construct, often connected to institutions and therefore decision-making.

Landscapes represent a given space that is the result of functional interactions between actors, institutions (laws, rules and regulations), and multiple ecological, social and economic components (Minang et al., Chapter 1, this book). Landscape approaches refers to a set of concepts, tools, methods and approaches deployed in landscapes in a bid to achieve multiple economic, social and environmental objectives. Multifunctional landscapes in this chapter refers to landscapes that effectively provide as best possible (relative to potential), all ecosystem functions, i.e., supporting, provisioning, regulatory, cultural, as well as social and economic functions.

Scale matters in landscapes for a number of reasons. Firstly, landscape phenomena unravel differently at different scales. The unravelling is very domain and phenomena specific. Some might unravel in more familiar and complex ways at local scales and become less complex at the global level as a general rule in ecosystems (Wu & Qi, 2000; Wilbanks, 2006). In political and human systems, the gradient of complexity might be less clear. Take the example of water management in the river Nile. At sub-catchment level in the Lake Victoria Basin, to understand land use practices, soil erosion management might be most important. At the Blue or White Nile catchment levels, understanding the land tenure and water policies in Ethiopia, Uganda and Sudan might be most important. At the Nile river basin level, it would be most imperative to understand policies of all ten countries, the Nile Basin agreements and the functioning of the Nile Basin Commission (see Box 9.1).

The second reason why scale matters is the scale of agency, the direct causation of actions (Wilbanks, 2006). Agency is often localized (i.e., with clear boundaries), but inherently embedded in structure, i.e., institutions, rules, policies at local, sub-national, national and global levels. These different levels, can impact landscapes differently, hence must be taken into account.

Another reason for considering scale is potential scale mismatches. Landscapes are composites of the ecological processes and the social systems and their interactions. If the scale at which the social systems operate and the scale at which the ecological processes necessary to ensure the sustainability of the landscape are not fitting, a scale mismatch occurs (Cumming et al., 2006). Finding sustainable solutions for managing landscapes actually requires understanding the scale at which there is the strongest harmony between the social organization and ecological process that take place in the landscape. The process of seeking solutions should therefore seek scales of minimal tradeoffs at which the social system (e.g., institution) can best address the ecological processes.

The above reasons for why scales matter, i.e., differential manifestation of phenomena at various scales and agency (including scale mismatches), do coincide with two potential processes in landscapes, i.e., analyzing and understanding landscapes and facilitating processes for sustainable solutions in landscapes respectively. Analyzing landscapes in the context of multifunctionality would involve assessing and characterizing various

Box 9.1

Water management in the Nile river basin: multiple scales and multiple actors[1]

The Nile river system from its source (Lake Victoria and Lake Tana) to the point it joins the Mediterranean Sea, experiences different interventions arising from multiple actors at various scales. To start, from its source, the water supply to Lake Victoria (the main source of the White Nile) depends on the land use behaviour and land-based livelihood activities by farmers in and around the Highlands of Ethiopia. At such watershed scales, any change in the land use activity has strong implications for the water supply to Lake Victoria as it links with the hydrology, siltation/sedimentation and even water consumption behaviours. Beyond the watershed scale is the sub-basin activities, which usually are based on effects from multiple watersheds. Activities at this scale are influenced by the national and subnational water policies and such decisions may have considerable effect on the overall water supply to the basin. For instance, the decision by the Ethiopian government to build the Grand Ethiopian Renaissance Dam on the Blue Nile covering an area of 1680 km^2 was with the intention to use the river for economic growth through power generation, but it created concerns of water security for countries like Egypt. Lake Victoria presents another dimension of scale wherein multiple countries are involved in managing the water resource. The East African Community (whose member countries share parts of Lake Victoria) established the Lake Victoria Commission, an independent body responsible for ensuring equitable use and management of the water body. Any use of the water from the lake is in accordance with the agreements made between member countries. A bigger scale above all this is the Nile Basin Initiative, a regional intergovernmental partnership established in 1999 with the support of the 10 countries relying on the Nile River to ensure the sustainable management and development of the Nile Basin as a whole.

Though the activities vary between various scales (from watershed to the Nile Basin level), there is strong interdependence between them. Any activity happening at the watershed level has a considerable impact on the basin-level water quantity and quality. This interdependence effect warrants consideration of activities and processes at all scales for a sustainably managed basin. This is why the Nile Basin Initiative is having a number of small-scale projects starting at the watershed level in almost all countries.

functions and/or ecosystem services. This could serve to understand production potential, ecological processes and possibly monitoring purposes. On the other hand, facilitating the maintenance and delivery of multiple functions or ecosystem services requires working with stakeholders in finding solutions to challenges. Very often, analysis, understanding and facilitating sustainable solutions are interconnected. However, for purposes of simplicity and understanding, we will discuss these dimensions as separate streams in this chapter, only bringing them together in our concluding thoughts. But first, let us reflect on the way scale has been interpreted in practice.

2. Current practice in handling scale

Interpretations of scale in landscapes abound in the literature. These interpretations have been diverse, some focusing on size of landscapes, others based on phenomena being dealt with, and some based on institutional structures. In some instances, it is a combination of one or more. Figure 9.1 shows various representations of scale. Figure 9.1a represents a size-focused scale with a relationship to ecological dimensions, while 1b and 1c show various institutional scales.

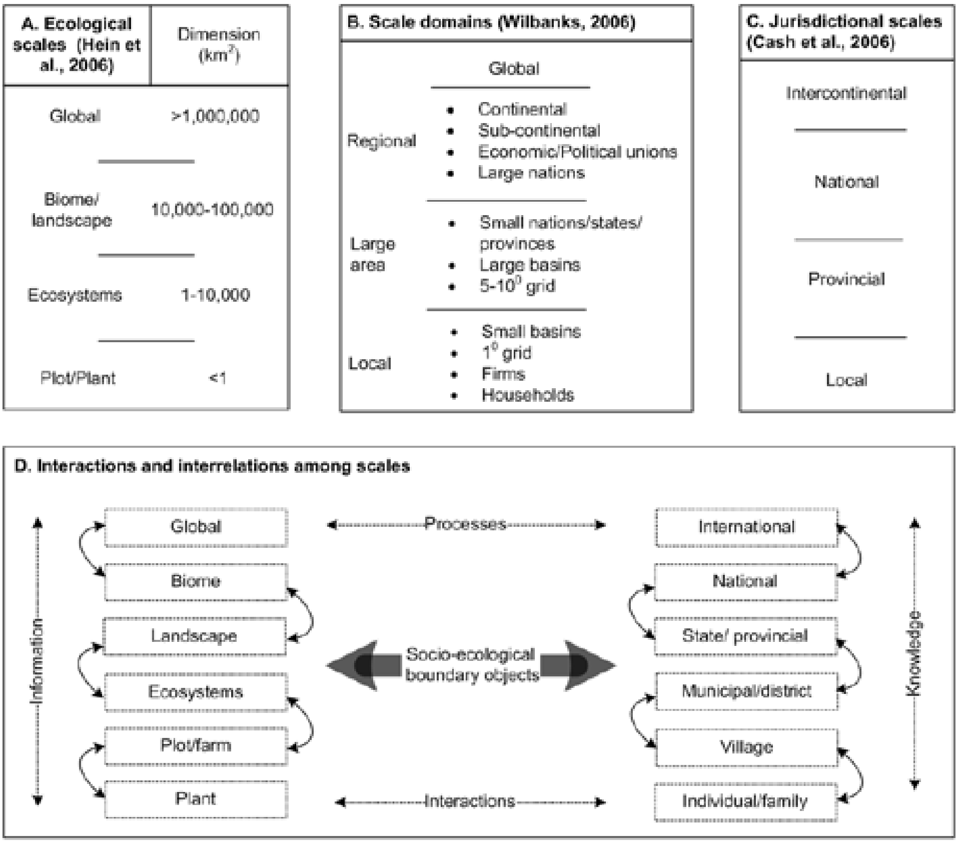


Figure 9.1 Hierarchical representations of scale and scale interactions.

2.1 Size

As part of a definition of landscapes, Forman (1995) describes the spatial extent of landscape to be approximately between 100 and 10000 km^2. The Valley of Visions Landscape Partnerships Scheme (a grants programme of the Heritage Lottery Fund (HLF) operating in the Medway Gap in Kent UK) specifies an area of between 20 and 200 km^2 as one of the many criteria for eligibility (Ahern & Cole, 2012).

2.2 Phenomena-based

Integrated conservation and development and watershed management landscape projects are among those landscape initiatives that have defined landscapes largely around the concepts of conservation areas and water systems respectively. For conservation landscapes, the geography has to constitute a core protected area (reserve, park, sanctuary etc.), a buffer zone and outer areas with rules allowing progressive increases in human activities with increased distance away from the core protected area. Integrated watershed projects have tended to work at multiple levels depending on the project concept. Mostly these projects work at the catchment level, but can also be at sub-catchment or river basin levels (see examples in Box 9.1). Some have interpreted scales in water management to include, blue water (water in lakes, dams and aquifers), green water (moisture in soil) and rainbow water (upper atmospheric transport) (van Noordwijk et al., 2014).

Table 9.1 Summary of scale interpretations in landscapes.

Scale interpretation	Examples	Scale determinants and characteristics	Comments	Source
Size	The Valley of Visions Landscape Partnerships Scheme, UK	Defined by minimum area	Scale also determined by uniqueness of area in terms of culture, ecology and management	Ahern & Cole, 2012
Phenomena based	Integrated Conservation and Development Projects (ICDP)	Boundary of protected area (which in itself may be defined by the range of a given species or forest biome/forest unit extent)	Often this goes beyond the core protected area into the buffer zone where development actions are undertaken	Brandon & Wells, 1992; Jackson et al., 2010
	REDD+ demonstration and pilot projects	Could be determined by a forest management unit such as community forest or private forest under REDD+' or jurisdiction-based pilots such as provinces (e.g., in Vietnam and the Democratic Repulic of Congo (DRC))	This may largely depend on five activity areas of REDD+, namely, Reducing Emissions from Deforestation, reducing emissions from Degradation, conservation of forest carbon stocks, sustainable management of forests and enhancement of carbon stocks.	Cerbu et al., 2009; Sills et al., 2009
	Integrated water management	River basin area *Watershed *Water catchment Sub-catchment		Swallow et al., 2002; Blomquist & Schlager, 2005
Institution based	Regional planning	Sub-national levels such as: Province *Region *District *Municipality Village	Determined by degree of decentralization, devolution and centralization of planning functions in a given country	Dalal-Clayton et al., 2003; Rudel & Meyfroidt, 2014
	Jurisdictional REDD+	State (or province) level	This is very much dependent on the degree of centralization, devolution and decentralization, hence governance dimensions	

*Denotes dominant scale

2.3 Institution-based

Regional development and jurisdictional emission reduction programmes are examples of landscape initiatives that have been shaped by institutional levels. Regional development planning and implementation often varies depending on degrees of centralization, devolution and decentralization. Such initiatives could happen at district, municipal, county, provincial or any appropriate sub-national level in a given country. The critical level in any context is likely to link to a critical decision-making level as well. Jurisdictional Reducing Emissions from Deforestation and forest Degradation (REDD+) also entails emission reduction initiatives at levels that correspond to governance and decision-making in given countries. State level jurisdictions in federal nations like Brazil (Acre), Nigeria (Cross-River) and the USA (California), are good examples of jurisdictional emission reduction programmes around the world (Asner, 2011). Still it is not always as simplistic and as clear as these three examples. Landscape initiatives can be more complex and can be defined by multiple interpretations. Table 9.1 summarizes scale interpretations from landscape initiatives.

3. Scale considerations in landscape analysis

Landscape analysis is necessary for understanding the production/supply potential of ecosystem services, valuation of ecosystem services, assessing tradeoffs, understanding the impacts of ecosystem services on livelihoods and monitoring multiple functions. However, very often scale differences can affect analysis and understanding of phenomena at the landscape level. Therefore, in seeking to answer the question, what is the appropriate scale for analyzing a phenomenon, three pre-requisite considerations might be important. These include: i) '*hierarchy in scale*'- the extent to which phenomena manifest at multiple scales and/or are hierarchical in structure; ii) '*scale effects*'- what changes in patterns and processes can be observed when the scale of analysis changes; and iii) '*scaling*'- what theories, methods and models can be used in extrapolating/translating information across scales (Wu & Qi, 2000)?

3.1 Hierarchy in scale

Hierarchy theory assumes that socio-ecological systems in landscapes are multi-scaled and manifest some kind of hierarchy or multiple levelled structure (Cash et al., 2006). If this assumption is true, identifying characteristic scales and hierarchical levels would be one of the most important starting points in analyzing, understanding and predicting landscape systems. Hein et al. (2006) argue that ecosystems services have ecological scales at which they are generated. The scale of analysis should therefore, be determined by the observer using appropriate criteria and analytical methods, e.g., power spectra, fractals, multi-scale ordination, etc. (Turner et al., 1989). While several studies exist, there is no consensus on characteristic scales and hierarchical levels for several phenomena (Wu & Qi, 2000). Hence, specific attention and justification is needed for any robust analysis of multifunctional landscapes.

3.2 Scale effect

Scale effect is an important consideration given the fact that the functioning of ecosystems could depend upon processes that take place over a range of spatial and temporal scales, e.g., from plant interactions at plot level, through meso–scale processes such as fire and insect outbreaks, to climatic and geomorphic processes at the largest macro- and ultramacro-scales (Gunderson & Holling, 2001). Therefore the question arises as to the extent to which smaller scales and shorter time processes and patterns are impacted by larger scales and longer-term processes and vice versa (Hein et al., 2006). Consequently, to what extent would a change of scale in analysis show differences in patterns and scales? Several papers have argued that there is a significant difference in the scale domains where the consequences of climate change adaptation and mitigation are focused with the former being more local while the latter is more global (MEA, 2005).

Wilbanks (2006) argues a general hypothesis would be that observations of many variables at localized scales show greater variance and volatility. In other words, there is loss of information at higher scales. Therefore, complexity is perhaps better observed at meso than at micro, macro and global scales.

3.3 Scaling

Scaling in landscape analysis presents tremendous methodological and theoretical challenges in understanding landscapes. How do we extrapolate from smaller scales to larger scales and how do we translate from larger to smaller scales? There seems to be some kind of understanding of these in homogenous ecological landscapes where the unit of analysis is understood, but less so in heterogeneous landscapes (Wu & Qi, 2000). Most landscapes in developing countries are constituted of mosaic patchworks of relatively small-sized land use units, giving them a heterogeneous nature. These characteristics may sometimes pose challenges related to minimum measurement/map-able units and hence scaling of phenomena, compared to where larger homogeneous units dominate. van Noordwijk and Mulia (2002) demonstrate the usefulness of fractal branching models for deriving tree-specific scaling rules for biomass and nutrient stocks in vegetation when shifting from plantation forestry to mixed forestry or multiple species agroforestry systems.

In terms of scale within social and human systems in landscapes, there is evidence that bottom-up or top-down assessment approaches in investigations do provide different insights and understandings (Turner et al., 1989). For example, the American Association of Geographers found that top-down assessments of potential greenhouse gases emission reduction technologies overestimated potentials because of insensitivity to local constraints while bottom-up assessments tended to underestimate due to inadequate consideration of policy and technological changes (AAG, 2003).

4. Scale considerations when facilitating processes for sustainable solutions in landscapes

Social and human systems (agency) are important components of landscapes and often interact with ecosystems as principal beneficiaries of the services ecosystems offer. These interactions with ecosystems affect these systems positively (stabilizing, enabling) and negatively (destabilizing) depending on the context (political, cultural, economic) (Sayre, 2005; Wilbanks, 2006). Given these potential effects from such interactions, facilitating processes that aim to facilitate sustainable multifunctional landscapes entails behavioural and policy changes with stakeholders in social and human systems in order to elicit the desired effect in the interactions. Hence, understanding scale dynamics and its potential influence on processes that help stakeholders find solutions to challenges in social-ecological systems and/or enhance performance through leveraging (Duguma & Minang, Chapter 10, this book), is extremely important. Such processes could include participatory decision-making, consensus building in solution identification, prioritization, planning, conflict resolution, benefit sharing, and others.

Several authors have also recognized and distinguished a hierarchy of institutions in socio-economic systems (Sayre, 2005; Cash et al., 2006). These range from individuals, family, village, municipal/commune, to province, national, and international levels. These represent levels at which decisions on the use of natural resources, labour and capital are made (Marston, 2000; Sayre, 2005). Decision-making is guided by largely localized interests, values and rules that are shaped by national and international policies and processes. Facilitating decision-making processes at the landscape level to enable sustainable multifunctionality would thus require not only the tools, but also managing interactions between the multiple hierarchical levels (from individual to global).

How actors benefit from various ecosystem functions/services, how they value these and the importance various stakeholders attach to these services determines what is prioritized at what scale. For example, Hein et al. (2006) show that selected ecosystem services in the De Wieden wetlands in the Netherlands, accrues to stakeholders at different scales. Reed cutting and fisheries are only important at the municipal level, recreation most relevant for municipal and provincial levels, and nature conservation is most important at national and international levels. These different preferences/interests at different scales would influence planning priorities and decision-making at various levels and might also reflect on the valuation of the services as well. However, in some instances tremendous tradeoffs can exist between local and external interests (van Noordwijk, 2002).

Facilitation of decision-making and negotiation processes should target either enhancing how actors enable the supply of landscape functions and service and/or reverse how actors inhibit the supply of the same. As we have seen in the case of De Wieden above, these could vary across scales and therefore inter-scales dialogue might be necessary. While the national level might be interested in the nature conservation in De Wierden, they will have to work with the municipal level to make that happen. Power dynamics and resources are extremely important in decision-making. Tools and methods that can allow cross-scale negotiations and interactions across differential power, information and resources are thus important (van Noordwijk et al., 2013).

Horizontal institutional-level interactions are also important in some cases. There is evidence in landscape approaches to REDD+ that drivers of deforestation may lie outside the REDD+ landscape, and notably from adjacent landscapes (Ekadinata et al., 2010). In such instances, horizontal interaction between adjacent landscapes is necessary for addressing the negative forces inhibiting the supply of forest and carbon related services, and in terms of managing leakage.

5. Nested scales

One truth about landscape analysis and/or facilitating processes is that focusing on one scale is not good enough for a complete picture (Sayre, 2005; Cash et al., 2006). As we have seen in preceding sections, landscapes deal with multiple socio-ecological phenomena that often require different scales of analysis as well as institutional levels that interact in decision-making and other actions. Therefore, full understanding and/or facilitation of sustainable landscapes often involves multiple nested scales and levels.

Box 9.2

Nested scales in REDD+

The Reduced Emissions from Deforestation and forest Degradation (REDD+) initiative suggests a mechanism through which countries that elect to reduce their national level of deforestation and loss of forest carbon stocks to below an agreed baseline would receive post facto compensation or rewards. Currently being negotiated within the United Nations Framework Convention on Climate Change (UNFCCC), it aims at making forests more profitable standing rather than destroyed by rewarding governments, individuals and forest managers in developing countries for keeping or restoring forests.

In terms of scale, while the UNFCCC framework provides global policy guidance, the national level is responsible for overall planning, implementation and accounting for emission reductions. At the sub-national level, REDD+ pilots have been set-up at provincial levels in Vietnam, Indonesia, DRC among others. At the local/landscape level, several demonstration projects have been set-up across the world, with a significant number of them building on integrated conservation and development strategies around community forests and protected areas (Sills et al., 2009; Cerbu et al., 2009).

Potential scale mismatches can emerge in this current REDD+ framing. On the one hand, monitoring, reporting and verification (MRV) structures and some government REDD+ pilots (e.g., Vietnam and DRC) are taking the form and dimensions of the current forestry administration or jurisdictions, for example, national, province, district (Forest Trends and Climate Focus, 2011). On the other hand, demonstration projects are built around smaller forest management units and using voluntary carbon market methodologies that may not always match official MRV methodologies (Minang et al., 2014). Furthermore, drivers of forest change transcend the institutional planning scales and current project demonstration scales for REDD+. Such potential mismatches speak to the need for clear rules for nesting across scales.

Some initial explorations of potential rules for nesting across scales in REDD+ have been identified and discussed in the literature, including:

1. Agreed land cover and land use legends for national level MRV, and rules for forest transition, based on multiple scales and reference or reference emission levels development in nested REDD+ (Pedroni et al. 2010; Dewi et al. 2012).
2. A set of rules for nested approaches related to ownership rights of emission reductions, duties and royalties to be paid based upon investments, crediting, benefit-sharing, leakage and risk management (Pedroni et al., 2009; 2010; Cortez et al., 2010; Forest Trends and Climate Focus, 2011; Minang & van Noordwijk, 2013). For example, in Vietnam, the benefit-sharing mechanism framework proposes clear rules on proportions to be retained for management and operational purposes from national, to provincial, and district levels (Hoang et al., 2013).
3. Transparent, effective and efficient procedures for negotiation, registration and validation across scales (Bernard et al., 2014; Alemagi et al., 2014).

In a nutshell, there has been progress towards frameworks and rules for nesting emission reductions in the context of REDD+. However, more research on nesting climate-smart landscapes to national and other scales is needed.

As a result, cross- and across-scale processes and interactions are often more valuable than examining one scale per se. Specific attention should be paid to non-linearities and thresholds of change in any analysis (Sayre, 2005).

An important component in understanding and applying scale concepts in landscape approaches is the fact that as phenomena manifest across scales, and institutions interact across and within levels, a complex web of horizontal and vertical interactions may be required in seeking sustainable solutions at the landscape level. Figure 9.1d shows potential interactions and interrelationships across and between scales. It has been illustrated that in integrated watershed management, specific socio-spatial scales are relevant for interconnected issues that together allow for effective, efficient and equitable management. For example, on-farm soil erosion is a plot or farm-level problem that can be mitigated through more secure property rights for individual farmers, while the sedimentation of streams and deterioration of water quality are larger-scale problems that may require more effective collective action and/or more secure property rights at the village or catchment scale (Swallow et al., 2002). Differences in social-political contexts across nations and regions also shape property rights and collective action institutions (Swallow et al., 2002).

Ostrom (2009) illustrates the need for a common framework for analyzing sustainability across multi-level, socio-ecological systems. She presents four core level sub-systems including resource systems (e.g., a designated protected area with forests, wildlife and water systems), resource units (e.g., trees, shrubs, plants in forests, types of wildlife), governance systems (e.g., institutions for management and rules), and users (e.g., individuals who use the park in multiple ways). These four systems are interacting with each other and are linked to political, social and economic settings as well as other related ecosystems. Each core system is made up of second level variables, for example, productivity of systems, size of units, level of governance. Not only would such a systems approach help guide the accumulation of knowledge required for understanding, but it would potentially help planning, monitoring and enhancement of sustainability.

An important emerging dimension of multifunctional landscapes (including climate-smart landscapes) is the potential value added of nesting landscapes to national policy frameworks such as green economic development, Nationally Appropriate Mitigation Actions (NAMA), REDD+, etc. For example, an emission reductions programme at the district or province level in Indonesia could be nested to the NAMA programme by taking on targets/shares of the national programme commitments (the national emission reduction target in Indonesia is 26% through unilateral actions alongside 7% economic growth). Efficiency gains can accrue from additional public and private investments, support in monitoring emissions reductions and possibly institutional support and capacity building. Nesting arrangements would vary from country to country depending on the governance systems, i.e., devolved or centralized. Principles, rules and methods for nesting are needed (Minang & van Noordwijk, 2013). These are necessary for scaling and actor engagement. An example of scale dynamics and nesting in REDD+ is presented in Box 9.2.

6. Conclusion

We began this chapter seeking to answer the question, what is the appropriate landscape scale? Specifically, we sought to answer this through two practical sub-questions. What is the appropriate scale for analyzing phenomena in landscapes and what scale considerations are needed in facilitating multi-stakeholder decision-making and actions in landscapes?

While evidence from current practices in conservation, integrated watershed management, spatial planning and others suggest that scale has been determined by dominant phenomena such as the protected area, the watershed and jurisdictional boundaries, respectively, in a multifunctional landscape, several factors need to be considered. Three main related dimensions of scale can be considered in the development of sustainable landscapes including: i) landscape analysis, ii) landscape facilitation and iii) nested scales.

6.1 Landscape analysis

Landscape analysis and understanding is about information and complexity differences with changes in scale. Choice of, and changes in, scale can significantly impact information and understanding in landscapes analysis. This depends on three related principles: i) '*hierarchy in scale*'- the extent to which phenomena manifest at multiple scales and/or hierarchical in structure; ii) '*scale effects*'- what changes in patterns and processes can be observed when the scale of analysis changes; and iii) '*scaling*'- what theories, methods and models can be used in extrapolating/translating information across scales. Thinking around these principles in the context of analysis is helpful.

6.2 Landscape facilitation

When facilitating processes for sustainable solutions in landscapes, perceived scales of phenomena and interests of actors and the interactions therein are an important consideration. Perceived scales of landscapes will vary according to interests of stakeholders, which are often divergent, hence a need to facilitate negotiations towards appropriate and agreed solutions. Facilitating interactions in such a manner that enables behavioural and policy changes that enhance ecosystem functions through joint knowledge generation, planning and decision-making is thus imperative.

6.3 Nested scales

Lastly, any successful sustainable multifunctional landscape is best approached from a multi- and nested-scale perspective in terms of analysis and facilitation because no single scale is sufficient for comprehensive analysis, nor for facilitating processes. It should be recognized that cross-scale processes and interactions are as important and perhaps more important than scale per se. Therefore, going beyond the vertical and horizontal interactions across scales, to ensuring landscapes are nested to national policy frameworks can be critical for success in landscape approaches.

Endnote

1 www.nilebasin.org; www.lvbcom.org

References

Ahern, K., & Cole, L. (2012). Landscape scale – towards an integrated approach. *ECOS, 33*(3/4), 6-12.

Alemagi, D., Minang, P. A., Feudjio, M., & Duguma, L. (2014). REDD+ Readiness process in Cameroon: An analysis of multi-stakeholder perspectives. *Climate Policy*, (ahead-of-print), 1-25.

Asner, G. P. (2011). Painting the world REDD: addressing scientific barriers to monitoring emissions from tropical forests. *Environmental Research Letters, 6*(2), 021002.

AAG (Association of American Geographers). (2003). *Global change and local places: Estimating, understanding, and reducing greenhouse gases.* Cambridge: Association of American Geographers GCLP Research Team, Cambridge University Press.

Bernard, F., Minang, P. A., Adkins, B., & Freund, J. T. (2014). REDD+ projects and national-level Readiness processes: a case study from Kenya. *Climate Policy*, (ahead-of-print), 1-13.

Blomquist, W., & Schlager, E. (2005). Political pitfalls of integrated watershed management. *Society and Natural Resources, 18*(2), 101-117.

Brandon, K. E., & Wells, M. (1992). Planning for people and parks: design dilemmas. *World development, 20*(4), 557-570.

Cash, D. W., Adger, W. N., Berkes, F., Garden, P., Lebel, L., Olsson, P., … Young, O. (2006). Scale and cross-scale dynamics: governance and information in a multilevel world. *Ecology and society, 11*(2), 8.

Cerbu, G., Minang, P., Swallow, B., & Meadu, V. (2009). *Global survey of REDD projects: what implications for global climate objectives?* ASB Policy Brief No. 12. Nairobi, Kenya: ASB Partnership for the Tropical Forest Margins.

Cortez, R., Saines, R., Griscom, B., Martin, M., De Deo, D., Fishbein, G., … Marsh, D. (2010). *A nested approach to REDD+: structuring effective and transparent mechanisms for REDD+ implementation at multiple scales.* Arlington, USA: The Nature Conservancy and Baker & McKenzie.

Cumming, G. S., Cumming, D. H., & Redman, C. L. (2006). Scale mismatches in social-ecological systems: causes, consequences, and solutions. *Ecology and Society, 11*(1), 14.

Dalal-Clayton, D. B., Dent, D., & Dubois, O., (2013). *Rural planning in developing countries: supporting natural resource management and sustainable livelihoods.* London: Earthscan.

Dewi, S., van Noordwijk, M., & Minang, P. A. (2012). *Reference Emission Levels (REL) in the context of REDD and land based NAMAs: forest transition stages can inform nested negotiations.* A UNFCCC submission by the World Agroforestry Centre-ICRAF. Nairobi Kenya: ICRAF. Retrieved from http://unfccc.int/resource/docs/2012/smsn/igo/63.pdf

Ekadinata, A., van Noordwijk, M., Dewi, S., & Minang, P. A. (2010). *Reducing emissions from deforestation, inside and outside the 'forest'*. ASB PolicyBrief, 16. Nairobi, Kenya: ASB Partnership for the Tropical Forest Margins.

Forest Trends and Climate Focus. (2011). Nested Projects and REDD+. Briefing Document. Retrieved from http://www.gcftaskforce.org/documents/REDD_nested_projects.pdf

Forman, R. T. (1995). *Land mosaics: the ecology of landscapes and regions.* Cambridge, UK: Cambridge University Press.

Gunderson, L. H., & Holling, C. S. (2001). *Panarchy: understanding transformations in human and natural systems.* Washington, DC: Island press.

Hein, L., van Koppen, K., De Groot, R. S., & van Ierland, E. C. (2006). Spatial scales, stakeholders and the valuation of ecosystem services. *Ecological economics, 57*(2), 209-228.

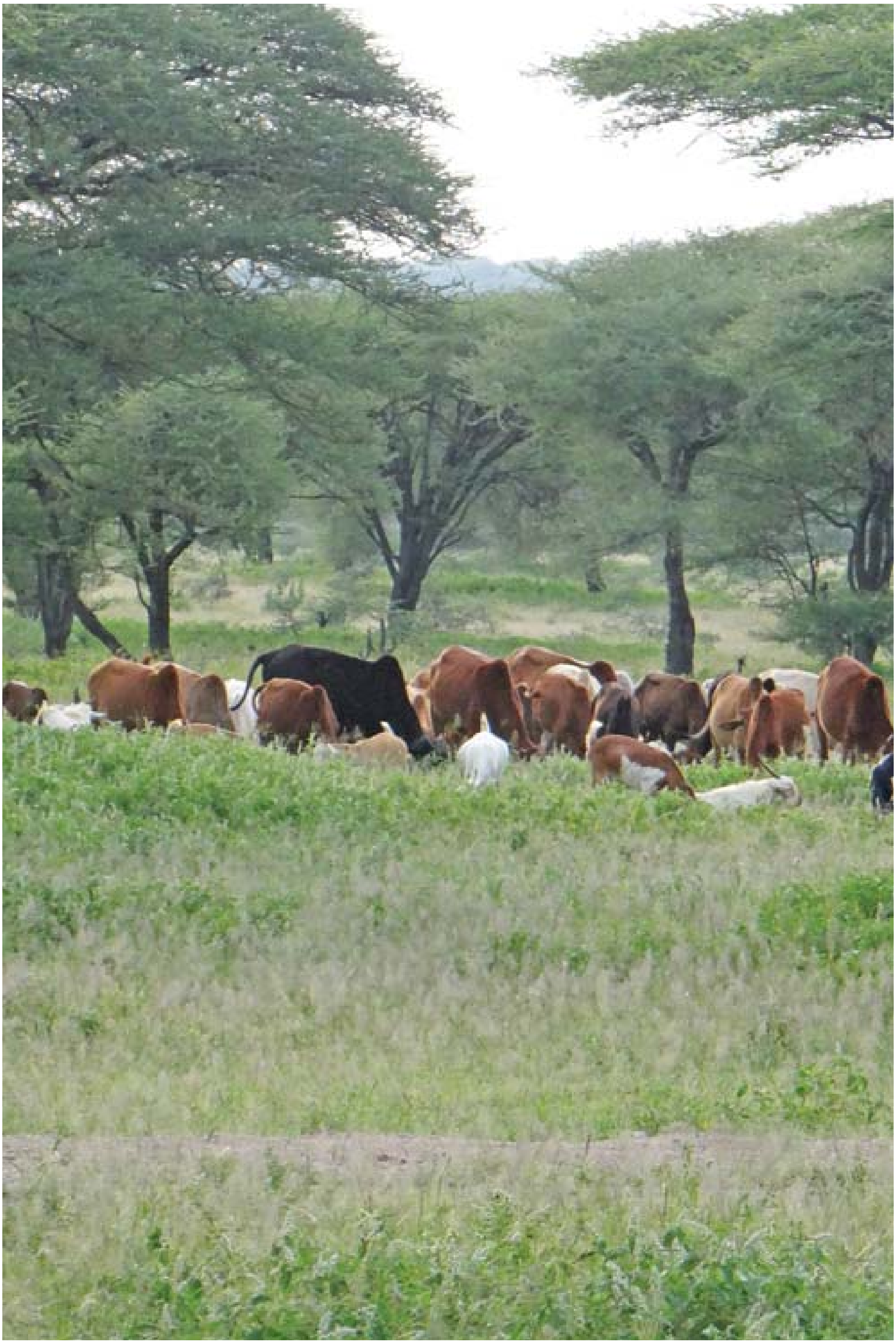
Hoang, M. H., Do, T. H., Pham, M. T., van Noordwijk, M., & Minang, P. A. (2013). Benefit distribution across scales to reduce emissions from deforestation and forest degradation (REDD+) in Vietnam. *Land Use Policy*, 31, 48-60.

Jackson, L., van Noordwijk, M., Bengtsson, J., Foster, W., Lipper, L., Pulleman, M., … Vodouhe, R. (2010). Biodiversity and agricultural sustainagility: from assessment to adaptive management. *Current Opinion in Environmental Sustainability, 2*(1), 80-87.

Marston, S. A. (2000). The social construction of scale. *Progress in human geography, 24*(2), 219-242.

MEA (Millennium Ecosystem Assessment). (2003). Dealing with scale. *Ecosystems and Human Well-being: A framework for assessment*, 107-126. Washington, DC: Island Press.

MEA. (2005). *Ecosystems and Human Well-being: Synthesis*. Washington, DC: Island Press.
Minang, P. A., & van Noordwijk, M. (2013). Design challenges for achieving reduced emissions from deforestation and forest degradation through conservation: leveraging multiple paradigms at the tropical forest margins. *Land Use Policy*, 31, 61-70.
Minang, P. A., van Noordwijk, M., Duguma, L. A., Alemagi, D., Do, T. H., Bernard, F., … Leimona, B. (2014). REDD+ Readiness progress across countries: time for reconsideration. *Climate Policy*, (ahead-of-print), 1-24.
Ostrom, E. (2009). A general framework for analysing sustainability of socio-ecological systems. *Science*, 325, 419 – 422.
Pedroni, L., Dutschke, M., Streck, C., & Porrúa, M. E. (2009). Creating incentives for avoiding further deforestation: the nested approach. *Climate Policy*, *9*(2), 207-220.
Pedroni, L., Estrada, M. P., & Cenamo, M. C. (2010). A Nested Approach to REDD+: How could it be implemented? In Zhu, X., Moller, L. R., De Lopez, T., & Romero, M. Z., (Eds.) *Pathways for Implementing REDD+*. Roskilde, Denmark: UNEP RISOE Centre.
Rudel, T. K., & Meyfroidt, P. (2014). Organizing anarchy: the food security–biodiversity–climate crisis and the genesis of rural land use planning in the developing world. *Land Use Policy*, 36, 239-247.
Sayre, N. F. (2005). Ecological and geographical scale: parallels and potential for integration. *Progress in Human Geography, 29*(3), 276-290.
Sills, E., Madeira, E. M., Sunderlin, W. D., & Wertz-Kanounnikoff, S. (2009). The evolving landscape of REDD+ projects. In Angelsen, A., Brockhaus, M., Kanninen, M., Sills, E., Sunderlin, W.D., & Wertz-Kanounnikoff, S. (Eds.) *Realising REDD+: National strategy and policy options*. Bogor, Indonesia: CIFOR, 265-280.
Swallow, B. M., Garrity, D. P., & van Noordwijk, M. (2002). The effects of scales, flows and filters on property rights and collective action in watershed management. *Water Policy, 3*(6), 457-474.
Turner, M. G., Dale, V. H., & Gardner, R. H. (1989). Predicting across scales: theory development and testing. *Landscape Ecology, 3*(3-4), 245-252.
van Noordwijk, M. (2002). Scaling trade-offs between crop productivity, carbon stocks and biodiversity in shifting cultivation landscape mosaics: the FALLOW model. *Ecological Modelling, 149*(1), 113-126.
van Noordwijk, M., & Mulia, R. (2002). Functional branch analysis as tool for fractal scaling above- and belowground trees for their additive and non-additive properties. *Ecological Modelling, 149*(1), 41-51.
van Noordwijk, M., Lusiana, B., Leimona, B., Dewi, S., & Wulandari, D. (2013). *Negotiation-support toolkit for learning landscapes*. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.
van Noordwijk, M., Namirembe, S., Catacutan, D., Williamson, D., & Gebrekirstos, A. (2014). Pricing rainbow, green, blue and grey water: tree cover and geopolitics of climatic teleconnections. *Current Opinion in Environmental Sustainability*, 6, 41-47.
Wilbanks, T. J. (2006). How scale matters: some concepts and findings. In Reid, W. V., Berkes, F., Wilbanks, T. & Capistrano, D. (Eds.) *Millennium Ecosystem Assessment*. Washington, DC: Island Press, 21-35.
Wu, J., & Qi, Y. (2000). Dealing with scale in landscape analysis: an overview. *Geographic Information Sciences*, *6*(1), 1-5.



Livestock grazing in a restored Ngitili system. Photo credit: Lalisa A. Duguma

CHAPTER 10

Leveraging landscapes: A systems approach to drivers of change

Lalisa A. Duguma and Peter A. Minang

Highlights

- Leveraging change in a landscape towards a desired state requires understanding of its history, system dynamics and political economy
- Leveraging potential depends on properly identifying the leveraging areas and the respective leveraging points
- Achieving leveraging involves considered actions, incentives and the development of appropriate enabling conditions for change

1. Introduction

"Don't remove symptoms, but deal with underlying causes", is advice easily given, but in fact symptoms, proximate and ultimate causes form a complex tangle where land use and landscapes are concerned. Landscapes are understood as dynamic results of the interactions among its different components (Meining, 1979). The way the system is described and understood influences the landscape interpretation, as the actors and stakeholders who shape the landscape do so using language, rationales and rationalizations that change over time. For instance, climate change was not a serious concern some decades ago but now it is seen to be an important driver of change happening at different scales, and negative effects due to climate change are seen, in some cases, as rationale for financial compensation. Usually, when the dynamic equilibrium is disrupted landscapes degrade. Landscape degradation refers to "… any change or disturbance to the environment, land, or soil perceived to be deleterious or undesirable" (Johnson et al., 1997). Restoring degraded landscapes requires understanding the details of factors causing the problem, how those factors are interrelated and their impact on the state of the landscape. Degradation usually happens due to either biotic interactions or abiotic limitations (Whisenant, 1999). Biotic interactions mainly are associated with degradation in the structures or components of the landscape while abiotic limitations explain the one linked to processes that affect the landscape. Restoration thus needs to take into account these two perspectives and determine what needs to be done. Hobbs and Harris (2001) argued that degradation due to biotic interactions can be corrected by putting in place measures that restore the biotic composition.

With ecosystem degradation, one of the current major global concerns (Hobbs & Harris, 2001; MEA, 2005; Hobbs et al., 2011), strategies to identify the real drivers of degradation, the interactions between the drivers and the potential leverage points to change the current degradation pathways are gaining attention in global conservation, development and restoration efforts. Efforts in the past were made but with very limited success in achieving sustainably managed natural resources. Jones and Schmitz (2009) analyzed large data sets of restoration projects and found that more than half of them reported unrestored functions after the restoration programmes. Four main reasons, which might have emanated from the limited understanding of how the landscape functions may explain such failures in restoration efforts particularly in many developing countries. First, the implementers may not have properly identified the right leverage points to address the problems in the landscape from a systems perspective. For instance, a large number of projects have emphasized specific parts of the landscape for specific functions (Whisenant, 1999) often ignoring parts of the landscape that either influence the targeted function or that may be affected by the function as these are only indirectly, and not directly, related to the functions of focus. As such, piecemeal approaches often therefore do not address the underlying drivers, they usually fail to effectively rehabilitate the landscape and instead create a number of leakages, for instance, shifting specific activities from one part of the landscape to another. Second, the compatibility of the identified leveraging options within the socio-economic and cultural context of the area under consideration is crucial. Third, in many instances, the right leveraging options are known, but the application is done in the wrong direction – opposite to its positive impact path. For instance, in the 1990s the Ethiopian government made effort to reduce wood scarcity by extensive planting of Eucalyptus species; while effective in providing wood, the intervention had significant ecological effects on water use (Bewket & Sterk, 2005) and crops grown close to it (Lisanework & Michelsen, 1993). Though planting trees was the right action to address the wood shortage, interactions with water could have been foreseen and the choice of species more locally attuned. Fourth, some leveraging options could be effective in the short-term, but may negatively affect the system in the long-term. For instance, the clearance of woodlands to eradicate tsetse fly problems in Tanzania’s Shinyanga region in the late 1920s and early 1930s resulted in wood scarcity, which led to the exploitation of the remnant forests (Mlenge, 2004; Monela et al., 2005).

Noting the complexity of processes in landscapes (Parrot & Meyer, 2012) and the need to understand the inter-linkages among landscape components, approaches that are capable of capturing issues of such sort are of utmost importance. Properly managing a landscape therefore requires a systems approach to understand the processes and practices that take place in it. To manage a system it is crucial to know where the options for leveraging lie. Once such options are known, it is necessary to apply the required force (e.g., incentives, disincentives and actions) to make the change process take place. But remaining key issues include: 1) How do we identify potential leveraging areas in a landscape? and 2) Do we have a pragmatic framework that is easily understood and used by practitioners dealing with landscape management in the field where the change of state is a practical concern? This chapter builds on a leveraging options framework/concept and combines it with a number of other useful frameworks with the aim to improve approaches for facilitating change processes in landscapes. The framework disaggregates the landscape management context into manageable units. Using a particular case study (the HASHI programme in Tanzania), we give insights on how the framework could be used in leveraging landscapes facing degradation problems.

2. The concepts of leveraging, leverage points and associated frameworks

Leveraging is a process of facilitating the progressive transformation of the landscape from its current state (perceived to be not sufficient) to a desired state often defined by taking into account the local contexts and available resources required to bring the desired change. It requires an in-depth understanding of what is going on within the landscape at its current state in a bid to identify where potentials exist for progressive changing of states.

Levers are actions that change the trajectory of processes happening in a given spatial and temporal context. When they are significantly effective, they are like 'game changers' in many instances stopping/changing negative impacts and pathways, i.e., neutralizing the aggregate effects or converting negative processes into beneficial ones. Applying the right levers requires knowing where the action could be effective in making the desired changes. This point of force in systems science is called a leverage point (Meadows, 1999). A system with no opportunities for change has no leverage points and thus is difficult to change in principle unless it is re-established/recreated (Meadows, 1999).

Three key frameworks that link with understanding the problems and identifying leveraging areas exist. These are the DPSIR (driver-pressure-state-impact-response; Wei et al., 2007; Omann et al., 2009), opportunities framework (UNEP, 2006), and Meadows's recommendations for leveraging points (Meadows, 1999). DPSIR is a widely used tool to analyze environmental problems. It is thus very helpful to understand what went wrong in the landscape due to what factors. DPSIR also helps to understand how changes in a landscape due to a given driver could affect the local environmental conditions and thus triggering either beneficial or detrimental response actions after the impact. Critics argue that DPSIR is more of a deterministic causal model, which may not properly capture the uncertainty and complexity in resource management systems (Maxim et al., 2009).

The opportunities framework, an extended form of DPSIR, helps to understand the available opportunities and the resource potentials of a system. Meadows's leverage points look at the options for leveraging systems performance taking into account the complexity (complex interrelations and interdependencies in systems components) and hence capturing the less emphasized uncertainty and complexity elements that the DPSIR and the opportunities framework do not accommodate. It helps to identify the points where to place efforts to bring about change in the way the system operates.

In general, DPSIR, the opportunities framework and Meadows's leveraging points are complementary especially in cases where tackling degradation is a priority issue. The first one helps to understand the problems, the impacts and the responses; the second helps to identify opportunities for change and the existing potentials, and the third helps in identifying leveraging options to move towards the desired state.

3. Leveraging at the landscape level

The process of leveraging landscapes involves four basic elements. First, is understanding the underlying drivers causing the degradation problem in the landscape; second, targeting the leveraging areas and soliciting the levers by exploring the potentials for change; third, recognizing the associated tradeoffs; and lastly, taking into account the leakages in the whole process as feedbacks that could help as balancing or reinforcing loops. Each of these elements is described in more detail below.

3. 1 Understanding the drivers of change

In the case of landscape degradation, there are always drivers which are at the root of the problem. Any effort to leverage such a landscape should start from understanding what the drivers are and how they interact with each other. This need for understanding is also stressed by scholars like Hobbs and colleagues (Hobbs et al., 2011) who ask "…do we know enough to intervene?". In the developing county context, where there is usually a strong livelihood element in landscape management, there is often a complex set of drivers that interact with each other to varying degrees. Unless we have an in-depth understanding of the drivers that are responsible for the degradation of the landscape, efforts and resources are often spent on solving superficial issues rather than the fundamental problems, i.e., the root causes. Treating superficial issues is easier than solving the fundamental problems, and surprisingly, in addressing sustainability challenges emphasis is often put on the first one (Harich et al., 2012) as it is cheaper, but less effective. Second, one of the major limitations in most of the existing driver analyses (e.g., in deforestation cases) is failing to take into account the interactions and interdependencies between the drivers. This could probably be one of the reasons why tropical deforestation has remained a challenge despite the considerable investments made to avert it for decades. It is also necessary to know the impact magnitude of the drivers to be able to prioritize the most important ones to tackle the degradation process. An additional strategy is to also prioritize drivers that are linked to many other drivers. This can be through understanding the path dependency among the drivers and the strength of the paths linking the drivers to one another. Once the key drivers are known, it is necessary to associate them with leveraging areas that can help to systematically address them.

3.2 Targeting leveraging areas

For leveraging to be effective, the levers should be applied at points where they impose a significant force to change the state of the landscape. Some levers are targeted towards a certain element of the landscape, which in this chapter is referred to as leveraging areas (Table 10.1).

Meadows's system-leveraging options apply at higher-level systems and could be a good basis to start from in framing the potential leveraging options at the landscape level. For a practitioner working at the landscape level though, a one-to-one matching of the elements in Meadows's recommendations could be complicated. To facilitate the leveraging process, it is necessary that the frameworks and procedures of leveraging used are as simple as possible to be applied by the practitioners. Basing on the contexts of DPSIR, the opportunities framework and Meadows's leverage points, we therefore propose a simplified framework composed of six key elements: actors, practices, processes, policies and institutions, inputs and goals. Below potential leveraging options within each of the elements of the framework are described.

Actors: Individuals, groups or institutions that are directly or indirectly active in the landscape are referred to as actors. They could be farmers, governmental and/or non-governmental organizations operating within the landscape. In multi-actors landscapes, improving the state of the landscape requires a negotiation process among the stakeholders to ensure that there is an agreement on the desired state of the landscape. Agreements

Table 10.1 Meadows (1999)'s recommendation for leverage points in a system with corresponding examples of leveraging options at the landscape level.

Meadows's 12 recommendations for leveraging a system (in increasing order of effectiveness)	**Corresponding potential leveraging areas in a landscape**	**Potential levers applicable at the landscape level**
Numbers - Constants, parameters (e.g., subsidies, taxes, standards)	Policies	Enforce standards such pollution caps, greenhouse gases emission levels, maximum allowable cuts for forests, etc.
Buffers - The size of buffers and other resource stocks relative to their flows	Practices/policies	Maintain the right proportions of the landscape components (production, conservation, water bodies, residence, cultural areas, etc.) to avoid collapse in some functions
The structure of material stocks and flows	Practices/policies	Regulate consumption patterns, regulate marketing of products, minimize losses through illegal exploitations
Delays - The length of delays relative to the rate of system change	Processes/inputs	Take timely actions to restore a function in a landscape when a degradation problem is identified; share the necessary information for action to tackle problems in the landscape
Balancing feedback loops - The strength of negative feedback loops relative to the impacts they try to correct against	Processes/ practices	Introduce fines for illegal activities, for example: penalties for illegal logging and forest clearance, fines for poaching, or pollution taxes (Meadows, 1999)
Reinforcing feedback loops - Gains around positive feedback loops	Processes/ practices	Incentives such as technical support and free tree seedling supply for farmers adopting sustainable farming techniques, tax waivers and input subsidies for actors investing in sustainable land use practices
Information flows	Processes/inputs	Promote bottom-up and top-down consultations; participatory processes; awareness creation about the state of the landscape; consultative decision-making processes
The rules of the system (e.g., incentives, punishments, constraints)	Policies	Fines and punishments for illegal activities (e.g., illegal access, illegal logging, etc.); incentives (e.g., tax exemptions, rewards, cash incentives, etc.); define how and when the incentives, fines, punishments are implemented

Self-organization - The power to add, change and evolve	Policies/ processes	Decision-making power distribution, roles, responsibilities and resources of actors as well as goodwill, trust and relationships between actors.
The goals of the system	Goals	Change from commercial farming to a multifunctional landscape
Paradigms - The mindset out of which the system emerged	Goals	Advocate for sustainability and multifunctionality rather than short-term profits/benefits
The power to transcend paradigms	Goals	Be flexible to emerging opportunities and new knowledge and understanding that adds value to the efforts of achieving the intended goals

reached through various participatory consultations could help to define the change paradigm to be implemented in the landscape. Such participatory chosen paradigms often lead to setting more context appropriate goals that can be achieved through the aggregate effect of different objectives associated with different practices. However, in landscapes with no common management structure, often each actor has its own objectives of maximizing its own benefits without concerns for the effects of his/her actions on its neighbour or others in the landscape.

Practices: Practices are interventions or activities to be implemented in a landscape to change the *status quo* to a desired state, i.e., a sustainable functional landscape. Sutherland et al. (2014) proposed 'solution scanning' as a tool to identify management interventions that can be taken to resolve resource management problems in various ecosystems to maintain or enhance their regulating services. The nature of the practices to be implemented in the landscape is often determined by the needs of the actors and the goals and objectives set to be achieved through the actions. Thus, practices are results of negotiation processes from the actors/stakeholders in the landscape and are carefully selected in such a way that they conform to the specific set of goals defined. The negotiation and consultation processes can also help in delineating parts of the landscape that should be allocated for different uses, for example, production function, conservation, water source management, etc.

Processes: Two main categories of processes are important here. The first category arises from the interactions between actors (e.g., through negotiations and participation processes). Such processes are the basis for defining bylaws, rules and regulations at the landscape level that determine the level of actions and responsibilities of the different actors. The main leverage point here is making the processes of decision-making inclusive, i.e., representing the voices of all actors, to reduce resource destruction and/ or landscape degradation. The second category of processes involves biophysical and ecological processes such as nutrient cycling, water cycling, energy cycle, biodegradation and soil remediation, etc. Facilitating both categories of processes is necessary to achieve the desired state.

Policy and institutional contexts: Policy is among the key elements that feature strongly in exploring the opportunities to identify leverage points at the landscape level. For instance, land tenure, a widely mentioned obstacle for not pursuing sustainable land management practices in agrarian communities in Africa, can be tackled through policy changes or modifications (UNECA, 2004; Abdulai et al., 2011). For instance, the Tanzanian Land and Village Land Acts of 1999 allowed locals a title deed for village lands thus motivating farmers to engage in restoration programmes (UNDP, 2012). Policies also define the rules and standards that need to be followed when doing a number of practices and can pose a number of incentives (e.g., tax exemptions and subsidies for farm inputs) and disincentives (e.g., fines and penalties) for detrimental actions that affect the processes in the landscape.

Inputs: Two major categories of inputs exist, in-kind and monetary inputs. The first involves infrastructure, human capital (skills) and materials required to run the institutions that spearhead the move towards a sustainable landscape. The monetary inputs are financial resources required to design, implement and monitor the projects over a given period. Such inputs can include government budget allocation, bilateral and multilateral grants and financing in the form of development aid, and support from the private sector through corporate social responsibility or direct investment. Considering the current global financial problems felt at all scales, any leveraging through inputs could be a strong point of intervention to facilitate the move towards sustainable landscapes particularly in the developing world.

Goals: Changing goals could be one strong leverage point as suggested by Meadows (1999). Hobbs and Harris (2001) also strongly emphasize the importance of proper goal setting for the success of restoration programmes. The authors also state that goal setting is an iterative process, which requires proper considerations of the ecological potentials of the landscape and the societal needs in the area. Changing goals can be possible when the actors agree that the current state is not satisfactory, is causing harmful effects or the desired target is not achievable within the existing biophysical, climatic and policy contexts and needs to be revised. It is believed that changing a goal or modifying it based on the prevailing context offers a great leverage point.

3.3 Recognizing tradeoffs in the leveraging process

Though levers and leveraging can help change the trajectories of the system progression, tradeoffs could emerge particularly in a system where strong interdependence among the components exist. Under such conditions, the actors should be able to decide on what type and what extent of tradeoffs can be accommodated in the process while trying to achieve a given goal. The level to which tradeoffs can be accommodated in the system varies with the type of landscape, and hence, is context specific. Thus, in managed landscapes, the current and future states of the landscape are functions of the decisions made by the actors on what to do/not to do, where to do what and how to do.

3.4 Leakage as a feedback

Positive effects of interventions on target state variables of a landscape can be partially offset by negative effects elsewhere, typically because of cross-scale feedback effects that were not recognized in the designed intervention. Where degradation-causing activities satisfy market demand for some products, local solutions tend to shift rather than resolve problems. For instance, in cases where there is a strong market demand for wood and other forest products, protecting only a parcel of a forest does not stop illegal cutting because as far as the demand is there, locals and other suppliers could engage in cutting trees from adjacent forests and hence continue the trend of deforestation. Such efforts can create activity shifts from one location to another without significant net effect in reducing deforestation. In some cases positive leakages (Schwarze et al., 2002) can also occur, which even contribute to achieving the desired state. For instance, if soil conservation practices are adopted in a landscape, there could be horizontal dissemination of knowledge to neighbouring landscapes and thus creating positive behavioural change.

4. The application of the framework on leveraging landscapes: the case of the Shinyanga restoration programme in Tanzania

To illustrate the application of the proposed framework to identify the leveraging options at the landscape scale, we used an ex-post analysis of the Shinyanga Soil Conservation Programme (HASHI) that was carried out in Northern Tanzania from the early 1980s until 2004. Figure 10.1 indicates processes and practices that took place in the area. We examined the state before the intervention based on existing project documents. When this framework is applied in ex-ante conditions, it helps to understand the causes behind the observed changes and hence helping to identify the main drivers.

In cases where ex-ante analysis is done following the procedures in Table 10.2, it is easier to identify the leverage points in the system based on the responses to the key diagnostic questions. The strength of the leveraging options, however, depends on the context in which the interventions at the landscape scale are to be implemented. Some leveraging options may be strong enough to change the system trajectory under a given socio-economic and political contexts while they may be weak under other contexts.

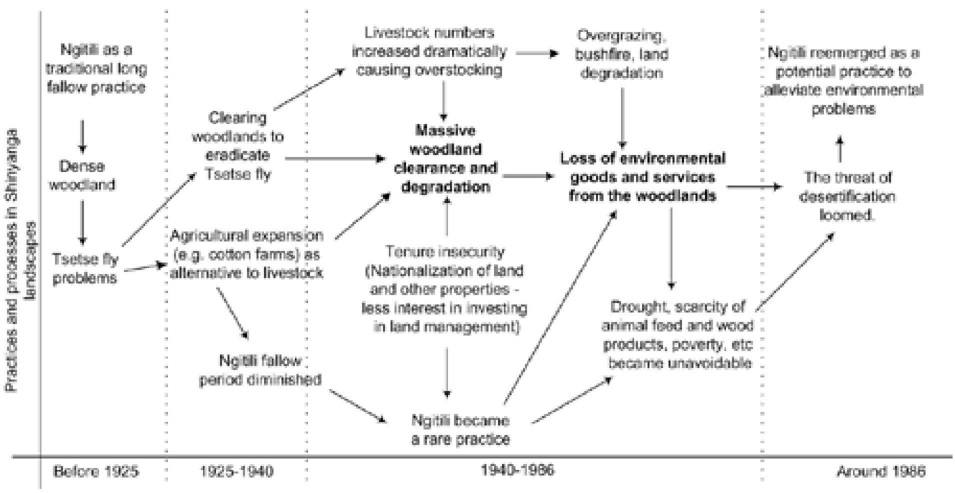


Figure 10.1 Understanding the processes that led to ecosystem degradation in the Shinyanga Region (adapted from Duguma et al., 2014). The figure is based on analysis using some elements of DPSIR.

Table 10.2 Leveraging areas and preliminary diagnostic questions to identify the levers in a landscape. The HASHI related experiences were compiled from Mlenge (2004), Monela et al. (2005), Barrow and Shah (2011) and Duguma et al. (2013; 2014). The number of diagnostic questions could change depending on the local context.

Leveraging areas	**Key preliminary diagnostic questions to identify levers**	**Assessment responses in the Shinyanga Region case study**
1. Policy and institutional contexts	1a. Do favourable policy frameworks exist in the area?	Land tenure was a major obstacle to pursue sustainable land management practices.
	1b. Are there appropriate institutions to support achieving the desired landscape state?	No strong institution capable of undertaking the restoration existed before HASHI was established.
	1c. Are there any policy and institutional barriers that need to be tackled?	Local communities did not have the title deeds granting them land rights.
	1d. Any moves or promises to make the necessary changes to policy and institutional barriers (if any) to make the desired goal achievable?	1. The Tanzanian government enacted the 1997 Land Policy and the Land and Village Land Acts of 1999 that enabled villages to hold land title deeds enabling the formal establishment of the Ngitili systems (UNDP, 2012). 2. The government of Tanzania created a new institution called the Shinyanga Soil Conservation Programme (HASHI) in the 1980s.
2. Goals	2a. What is the reference state (starting point) of the landscape?	Severely degraded with frequent drought, extensive land degradation and highly overgrazed.
	2b. What is the desired state of the landscape?	A properly managed landscape that provides the necessary ecosystem services, particularly water, livestock feed, wood and other non-timber forest products.
	2c. Is the defined goal realistic in relation to the biophysical, policy and institutional contexts and resources available?	With sincere engagement of the key actors the restoration was believed to be achievable.

3. Actors	3a. Who are the actors in the landscape? What are their roles?	Local communities who relied on the landscape for feed, wood, water and other services, village environmental committees (responsible for enforcing local rules and regulations); local authorities (provide local government support for the programme); the HASHI programme office (main implementer of activities); NORAD[1] (the main donor for the HASHI programme); Government of the Republic of Tanzania (policy and legal support at national and subnational levels).
	3b. Are most of the actors involved in the decision-making processes (e.g., in goal setting etc.)? Do they agree to the proposed desired change in the landscape?	During the early phases of HASHI there was strong emphasis on empowering the local communities and other actors through participatory project engagement. All actors agreed on the desired state.
	3c. What is the interest (objective) of each actor?	For the local communities the objective was to have access to a sustainable supply of resources including feed for their livestock, water and other forest products. For the government and donors it was to ensure sustainable management of the natural resources and reversing the looming desertification threat.
	3d. Is there any communication channel among the actors to keep them informed?	There was a specific communication strategy for all engaged in the programme through the village environmental committees and the local authorities.
4. Practices	4a. What are the different practices in the landscape (e.g., land uses, resource use behaviours, etc.)?	Woodland clearance due to tsetse flies problem, cotton and other cash crop expansion, cutting down trees for housing purposes during resettlement (villagization), overgrazing, etc.
	4b. Any expected behavioural change anticipated by the actors in the move towards the desired state?	Local communities were the ones to ensure the sustainable use of the resources. The village environmental committees set the harvesting limits and determined who was allowed to use what and to what extent.
	4c. Any proposed practices (and their roles) to help move towards the desired state?	Restoration of the Ngitili systems, boundary planting of trees, on-farm tree growing, etc.

5. Inputs	5a. Is there sufficient skilled and non-skilled manpower to derive the change?	Institutions like ICRAF[2] provided technical support on sustainable management practices to be implemented in the area. The local communities implemented the activities in the landscapes with the support of the HASHI staff.
	5b. Is there sufficient financial resources to derive the desired change?	NORAD, with support of other international donors and national government was providing the financial resources required for the programmes.
6. Processes	6a. What is the state of ecological processes in the landscape before intervention?	Most ecological processes were strongly affected by the biophysical state of the landscapes, for instance, water cycle, nutrient cycle, vegetation dynamics, etc.
	6b. Were there any negotiation processes in defining the desired goal to avoid conflicts among the primary actors in the landscapes?	The focus was empowering the local community to reinstate their informal institutional structures, such as the Dagashida and Sungusungu, for more sustainable natural resources management. The donors, the government and the local community representatives were keenly involved.
	6c. Was there any monitoring process in place?	Before the HASHI programme there was no formal monitoring process in place, which changed after HASHI was established with monitoring being one of the project components.

1 NORAD – Norwegian Agency for Development Cooperation; 2 ICRAF – World Agroforestry Centre

4.1 Key leveraging areas and levers used in the HASHI programme

1. *Leveraging through actor engagement:* The design process of the restoration programme started with intense local community consultation to ensure a participatory and people-driven process. This resulted in empowerment of local institutions such as the Dagashida and Sungusungu both of which were important in local decision-making and in enforcing the rule of the law at local levels. Another strong actor-focused leveraging was the creation of village environmental committees that were supported by the village leaders. The committees were the main link between the local community and the District and higher-level representatives taking part in the programme.
2. *Leveraging through proper practices choice:* In selecting practices for the restoration programme, local communities had a strong voice that led to the decision that their traditional fodder management system (Ngitili) become a priority one. Ngitili was complemented with agroforestry practices such as rotational woodlots, boundary tree plantings and on-farm tree growing.
3. *Leveraging through policies and institutional setups:* A number of policy leverages were implemented to ensure the restoration programme became effective in the Shinyanga region. Some of them include a reform in tenure rights for the local people, institutionalization of the restoration programme, strong engagement of the national government through ministries working on the environment and natural resources, and securing and channelling the long-term support of international donors for the programme.
4. *Leveraging through input facilitation:* The government of Tanzania liaised with NORAD, other donors, and ICRAF to facilitate the financial and technical inputs required for the success of the programme. Through this, it was possible to secure long-term support for the programme.
5. *Leveraging through goal changing:* To stop the threat of desertification in the region due to natural resources degradation, it was necessary to change the goal of managing the landscapes from a landscape that was facing degradation due to overuse to the desired state of a multifunctional landscape. Most of the actors in the landscape were part of the decision-making process and were thoroughly consulted.

5. Summary

This chapter has introduced how the leverage points assessment used in different disciplines can also be applied to landscape management to move a landscape from its current state to a desired state, usually a more sustainable one. Leveraging landscapes comprises at least four basic elements: 1) understanding the drivers of change and thus critically analyzing the priorities to address them, 2) targeting the leveraging areas and identifying the levers by understanding the potential areas of change, 3) recognizing the tradeoffs that emerge due to the leveraging processes, and 4) recognizing leakages in the system as feedbacks. Six key areas of leveraging were identified: actors, practices, processes, inputs, policies and institutional setups, and goals. Critically looking at these leveraging areas can help practitioners to identify leveraging options to nudge landscapes to move from their current state to a different desired state. We believe this approach is sufficiently simple and practical for practitioners managing landscapes at various scales.

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References

Abdulai, A., Owusu, V., & Goetz, R. (2011). Land tenure differences and investment in land improvement measures: Theoretical and empirical analyses. *Journal of Development Economics, 96*(1), 66-78.

Barrow, E., & Shah, A. (2011). Restoring woodlands, sequestering carbon and benefiting livelihoods in Shinyanga, Tanzania. Retrieved 20 Aug 2014 from www.TEEBweb.org

Bewket, W., & Sterk, G. (2005). Dynamics in land cover and its effect on stream flow in the Chemoga watershed, Blue Nile basin, Ethiopia. *Hydrological Processes, 19*(2), 445-458.

Duguma, L. A., Minang P. A., & van Noordwijk, M. (2014). Climate Change Mitigation and Adaptation in the Land Use Sector: From Complementarity to Synergy. *Environmental Management, 54*(3), 420-432.

Duguma, L. A., Minang, P. A., Kimaro, A., Mpanda, M., & Otsyna, R. (2013). *Climate smart landscapes: Integrating mitigation, adaptation and development in Shinyanga region Tanzania.* ASB Policy Brief No. 40. Nairobi, Kenya: ASB Partnership for the Tropical Forest Margins.

Harich, J., Bangerter, P., & Durlacher, S. (2012). Solving the sustainability problem with root cause analysis. Retrieved 13 Aug 2014 from www.thwink.org

Hobbs, R. J., & Harris, J. A. (2001). Restoration ecology: repairing the earth's ecosystems in the new millennium. *Restoration Ecology, 9*(2), 239-246.

Hobbs, R. J., Hallett, L. M., Ehrlich, P. R., & Mooney, H. A. (2011). Intervention ecology: applying ecological science in the twenty-first century. *BioScience, 61*(6), 442-450.

Johnson, D. L., Ambrose, S. H., Bassett, T. J., Bowen, M. L., Crummey, D. E., Isaacson, J. S., … Winter-Nelson, A. E. (1997). Meanings of environmental terms. *Journal of Environmental Quality, 26*(3), 581-589.

Jones, H. P., & Schmitz, O. J. (2009). Rapid recovery of damaged ecosystems. *PLoS One, 4*(5), e5653.

Lisanework, N., & Michelsen, A. (1993). Allelopathy in agroforestry systems: the effects of leaf extracts of *Cupressus lusitanica* and three Eucalyptus spp. on four Ethiopian crops. *Agroforestry systems, 21*(1), 63-74.

Maxim, L., Spangenberg, J. H., & O'Connor, M. (2009). An analysis of risks for biodiversity under the DPSIR framework. *Ecological Economics, 69*(1), 12-23.

Meadows, D. (1999). *Leverage point: places to intervene in a system.* Hartland, VT: The Sustainability Institute.

Meinig, D. W. (1979). The beholding eye: Ten versions of the same scene. *The interpretation of ordinary landscapes: Geographical essays,* 33-48.

MEA (Millennium Ecosystem Assessment). (2005). *Ecosystems and Human Well-being: Synthesis.* Washington, DC: Island Press.

Mlenge, W. (2004). *Ngitili: An indigenous natural resources management system in Shinyanga, Tanzania.* Nairobi, Kenya: Nairobi, Arid Lands Information Network - Eastern Africa.

Monela, G. C., Chamshama, S. A. O., Mwaipopo, R., & Gamassa, D. M. (2005). *A study on the social, economic and environmental impacts of forest landscape restoration in Shinyanga Region, Tanzania.* Final Report, 223. International Union for Conservation of Nature (IUCN).

Omann, I., Stocker, A., & Jäger, J. (2009). Climate change as a threat to biodiversity: An application of the DPSIR approach. *Ecological Economics, 69*(1), 24-31.

Parrott, L., & Meyer, W. S. (2012). Future landscapes: managing within complexity. *Frontiers in Ecology and the Environment, 10*(7), 382-389.

Schwarze, R., Niles, J. O., & Olander, J. (2002). Understanding and managing leakage in forest–based greenhouse–gas–mitigation projects. *Philosophical Transactions of the Royal Society of London. Series A: Mathematical, Physical and Engineering Sciences, 360*(1797), 1685-1703.

Sutherland, W. J., Gardner, T., Bogich, T. L., Bradbury, R. B., Clothier, B. Jonsson, M. … Dicks, L. V. (2014). Solution scanning as a key policy tool: identifying management interventions to help maintain and enhance regulating ecosystem services. *Ecology and Society, 19*(2): 3. Retrieved from http://dx.doi.org/10.5751/ES-06082-190203

UNDP (United Nations Development Programme). (2012). *Shinyanga Soil Conservation Programme (HASHI). Tanzania.* New York, USA: Equator Initiative Case Study Series.

UNECA (United Nations Economic Commission for Africa). (2004). *Land tenure systems and their impacts on Food security and sustainable development in Africa.* Addis Ababa, Ethiopia: Economic Commission for Africa.

UNEP (United Nations Environment Programme). (2006). *Africa Environment Outlook 2 – Our environment, Our wealth.* UNEP.

Wei, J., Zhao, Y., Xu, H., & Yu, H. (2007). A framework for selecting indicators to assess the sustainable development of the natural heritage site. *Journal of Mountain Science, 4*(4), 321-330.

Whisenant, S. (1999). *Repairing damaged wildlands: a process-orientated, landscape-scale approach (Vol. 1)*.Cambridge, U.K.: Cambridge University Press

Landcarers, supported through the Expanded Publics Works Programme in South Africa – Bergville, 2014. Photo credit: Alice Muller

CHAPTER 11

Landcare - a landscape approach at scale

Delia Catacutan, Clinton Muller, Mary Johnson and Dennis Garrity

Highlights

- Landcare is an approach based on the notion of caring for your landscape as a community
- The model uses a grassroots socio-political lens to find technical solutions to landscape-level land degradation
- The modality of the Landcare model has evolved to suit the land management issues and governance environment in which it operates
- The approach has demonstrated its extensive capacity to operate in various contexts and in multiple scales through adhering to the key principles that make it distinctive, yet adaptive to differing conditions
- Landcare exemplifies that an effective landscape approach is as much about an investment in people as it is in technical solutions

1. Introduction

With an increasing focus on people-centred approaches to integrated landscape management (Sayer et al., 2013), there is demand for models that strike a social-ecological balance to engage disconnected communities and to support strengthened institutional arrangements. One such approach is Landcare, a method centred on community-based collective action in addressing land degradation and natural resource management issues within the landscape.

Landcare is an approach based on the notion of caring for your landscape as a community. The model is based on the values of community empowerment and collective action to develop and apply innovative solutions to natural resource management challenges, networking farmers with the broader community and promoting sustainable land management practices. The Landcare model, which has often been identified as 'bottom-up' rather than the conventional programme design approach of 'top-down', is founded on four basic cornerstones: community driven, appropriate technologies and land management practices, partnership development and institution building. These foundations are based on farmers' interest in gaining and sharing knowledge about practices that can improve income generation whilst conserving and protecting natural resources. This approach is underpinned by the acknowledgement that land management issues do not exclusively impact or occur at the farm scale, but also ramify into the surrounding landscape.

Subsequently, to minimize the risk of the notion of Landcare being a synonym for natural resource management, the South African government, as part of their national Landcare programme, developed six core principles of Landcare to aide in defining the landscape approach (Prior & Holt, 2006):

1. *Integrated sustainable natural resource management* embedded within a holistic policy and strategic framework where the primary causes of natural resource decline are recognized and addressed
2. Fostering *community-based and led* natural resource management within a participatory framework that includes all land users, both rural and urban, so that they take ownership of the process and the outcomes
3. The development of *sustainable livelihoods* for individuals, groups and communities utilising empowerment strategies
4. Government, community and individual *capacity building* through targeted training, education and support mechanisms
5. The development of active and *true partnerships* between governments, Landcare groups and communities, non-government organisations and industry
6. The blending together of appropriate upper-level *policy processes* with *bottom-up feedback mechanisms*

This chapter explores the Landcare approach, from its early beginnings to scalability as a global movement in landscape management, with the intent of presenting the importance of community-based natural resource management as underpinned by the above six principles of Landcare.

2. The development of Landcare

In Australia, Landcare has for 25 years played a major role in raising awareness and influencing farming and land management practices with the intent of achieving environmental outcomes across the landscape. Landcare first emerged in 1986 as a distinctive entity in the state of Victoria (Lockwood, 2000) and was initiated by the then, state government, in response to worsening land degradation. Initial focus was on property and farm planning to address salinity issues. Through the alliance of the National Farmers Federation and Australian Conservation Foundation, bipartisan support was secured from the Australian government and the National Landcare Programme (NLP) and the Decade of Landcare was launched in 1990. From the government perspective, Landcare was a catalytic programme that attempted to engage the rural population and produce more aware, engaged, informed, skilled, and adaptive resource managers with a stronger stewardship ethic (Curtis & De Lacy, 1996*a*).

Landcare captured the broad spectrum of technical and social aspects in natural resource management (Johnson et al., 2009); hence, it quickly spread as a grassroots-led movement, and a new discourse entered into environmental policy that included partnerships, reciprocity, community building and inclusiveness. Community-based natural resource management (CBNRM) was then, emerging as a powerful idea and a central organizing platform for public policy.

Landcare now exists in more than 30 countries with varied social conditions and political environments, alongside a myriad of government and non-government projects, programmes and initiatives (Figure 11.1). It has also been mainstreamed within the missions and work programmes of multilateral organizations, for example, the World

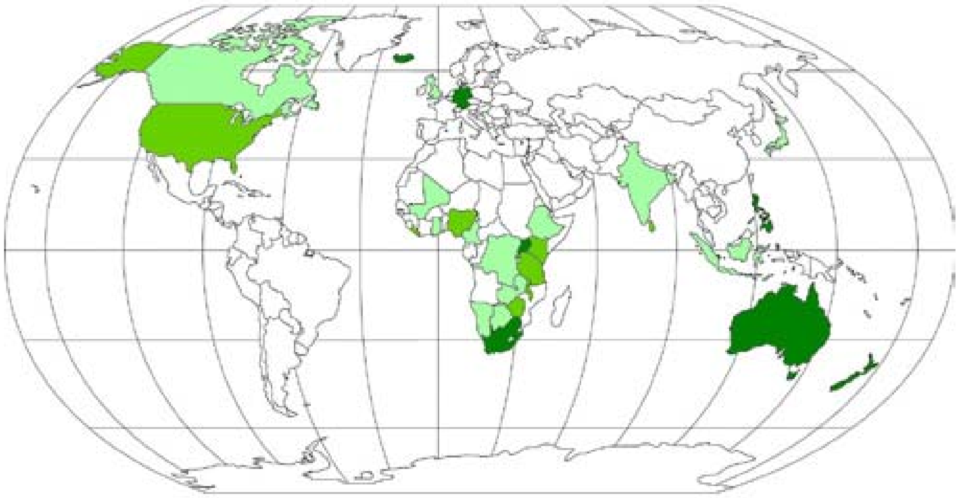


Figure 11.1 Countries where there is an interest in Landcare and where Landcare initiatives currently exist.

Agroforestry Centre (ICRAF) has explicitly adopted a Landcare approach with support from various donors in the Philippines, Kenya and Uganda. The spread of Landcare has occurred primarily by word of mouth through Landcare champions and networks, without any formalized systematic scaling-up strategy. With a focus on empowering communities and farmers, Landcare has been explored as a viable and complementary approach to existing activities and programmes addressing sustainable livelihoods and natural resource management (Prior & Johnson, 2009).

Landcare programmes at the local and country level are both different, and similar, as each approach has been adapted to meet local conditions and local needs. However, wherever Landcare is implemented, implementers, supporters and advocates remain committed to the key principles of Landcare (Catacutan et al., 2009). This approach recognizes the value of information sharing and the use of social pressure amongst land managers for change. This encompasses all land users within the landscape (including rural and urban areas), allowing them to take ownership of the process and outcomes to facilitate sustainable adoption of the change in practices. Additionally, the Landcare model recognizes the importance of simultaneously improving peoples' livelihoods and natural resource base upon which they depend, paying particular attention to social, economic, environmental and cultural sustainability. Finally, Landcare is about integrated sustainable natural resource management programmes in which the resource components are linked in time and space.

3. Landcare at work

3.1 Addressing local problems

While staying true to the central objective of local communities developing, sharing and implementing more sustainable ways of managing land and water resources, conserving biodiversity and creating sustainable livelihoods, the global spread of the Landcare model has demonstrated many different approaches and adaptations. The modality in which the

Figure 11.2 Community members working through a Landcare project to repair the erosion of Mafidhi gully with gabion walls in Chivi District, Masvingo Province in Zimbabwe (Photo courtesy of Anold Musoki, CARE Zimbabwe).

model has evolved within various landscapes is paramount to the relevance of community participatory processes that drive Landcare.

Evidence of these drivers can be seen in the locally relevant issues for Landcare communities. For instance, community groups in Nigeria have prioritized conservation efforts to protect an indigenous primate, *Cercopithecus sclateri*, through awareness raising and re-vegetation activities with local farmers (The Tropical Research and Conservation Centre, 2012). Conversely, issues surrounding soil erosion and abatement through the adoption of farmer innovations, including natural vegetation strips, facilitated the developments of the Landcare initiative in the Philippines (Landcare Foundation of the Philippines, 2009). Such examples highlight the role of community groups in identifying and addressing locally relevant natural resource and land management priorities. This role of community at the forefront of managing natural resources through collective action has not gone unnoticed from government initiatives.

3.2 Networking

Landcare also espouses a community scale philosophy to land management. This is particularly evident in landscapes where the presence alone of Landcare activities within the community has been attributed to farmers not affiliated with any specific Landcare group still adopting practices promoted through Landcare initiatives. Information sharing, awareness raising and redefining the 'norm' are all important aspects of Landcare, in addition to activities on-the-ground. Two such examples of Landcare networks are the Claveria Landcare Association, which is a network of village-based Landcare groups in the southern Philippines, and the African Landcare Network (ALN). The ALN was founded in 2006 as part of the third South African Landcare Conference, with the purpose of building a network of country Landcare programmes as a general strategy to support the delivery of the Millennium Development Goals (MDGs) in Africa. At the global level, Landcare International, represents numerous local Landcare networks that all aim to promote the Landcare approach internationally.

3.3 Financing

Funding for Landcare activities and facilitation comes from different sources and in various amounts. For example, the South African Landcare Programme is government-led and funded whereas the Philippines and Uganda programmes are funded through multi-lateral research projects. German Landcare in contrast receives both local government and European Union funding. Landcare in Australia is exceptionally well-resourced as the NLP received federal and state funding, enabling it to support a nation-wide network of Landcare facilitators in addition to investments at the national, regional and local level. This funding has facilitated farmers, landholders and community groups to undertake locally identified and relevant on-the-ground action. The collective impact of these activities has resulted in landscape transition across rural and urban Australia. Through Landcare, millions of trees, shrubs and grasses have been planted, riparian zones restored and water quality improved through fencing out of stock and controlling erosion on riverbanks, protected tracts of remnant vegetation and regenerated areas of bushland to provide habitat for native wildlife, and improved ground cover, grazing practices and soil management (Australian Framework for Landcare Reference Group, 2010).

3.4 Social norms of landscape management

Landcare has been credited with acting as an agent that creates social capital, bringing neighbours together to share ideas and implement cooperative projects. In turn, social capital has been credited with positively influencing natural resource management outcomes particularly through people working collectively and cooperatively to manage resources and improve natural capital (Compton & Beeton, 2012). Linking social capital to environmental and livelihood improvement is based on the premise that social capital can make other forms of capital (e.g., cultural, human, political) more efficient through increasing the productivity of individuals and groups (Putnam, 2000).

The idea of social capital for conservation originates from the beginning of the 20th century. Hanifan (1916) observed that, as a whole, a community will benefit by the cooperation of all its parts, while the individual will find in his associations the advantages of the help, the sympathy, and the fellowship of his neighbours.

As investing in and building social capital becomes a social norm, this leads to long-term commitment and benefits. When people are well connected in groups and networks, and when their knowledge is sought, incorporated, and built upon during planning and implementation of conservation and development activities, then they are more likely to sustain stewardship and protection over the long term (Uphoff, 2002; McNeely & Scherr, 2003).

Landcare in the Philippines is a good example of where farmers and their communities have taken control of their own problems regarding degraded landscapes through the implementation of locally relevant solutions. In the 1990s, ICRAF had been conducting research on contour hedgerow technologies in northern and central Mindanao, Philippines. The extension focus was on addressing key technical constraints of the contour hedgerow system, but adoption by farmers was low. The low adoption of the conventional hedgerow system was due not only to technical capacities, but also socio-economic and institutional constraints faced by poor farmers in the uplands (Catacutan & Mercado, 2001). ICRAF took another approach and supported the establishment of Landcare groups where farmers shared knowledge, skills, leadership and experiences. Through this approach, Landcare was able to achieve the necessary change in attitudes and adoption of new farming systems 'from the inside out' (Landcare Foundation of the Philippines, 2009).

In a different context, the adoption of Landcare in Germany has experienced similar processes in establishing social norms on what good landscape management is, and making it economically attractive to do so. The approach was established as a process to improve cooperation between farmer groups, conservation groups and government agencies. Driven from by the community, the multi-stakeholder approach of Landcare in Germany has been paramount in raising awareness within the community of what appropriate land management practices are, to support the conservation values of cultivated landscapes.

As the Landcare model has developed, a natural evolution has occurred in the model, projects no longer just involve planting trees or hedges, but are focused on integrated approaches to maintain the diversity within landscapes for production and conservation. New economically motivated strategies have also emerged, for the betterment of the environmental values within the landscape. Products produced through environment-friendly production systems are being labelled, promoted and marketed to attract a premium in the market. These products are often associated with particular regions or landscapes, such as lamb from dry limestone pastures in Germany, which has prompted farmers to implement sustainable grazing management strategies to ensure continuous product supply to the market (Bluemlein, 2009).

The Landcare model has also had evidence of providing a link to conservation values, whilst addressing land management challenges within the landscape. In the Kapchorwa District Landcare Chapter (outlined in Box 11.1), a Landcare by-law, sponsored by the International Union for Conservation of Nature (IUCN), was developed to specify rules and regulations for land use, as a means of capitalizing on the community interest in addressing degraded lands as a collective problem, through support from the local government and district authorities. The Landcare by-law mainly focused on unrestricted grazing and the resulting tree destruction, but was expanded to integrate other management aspects such as restricting farming and grazing in riparian zones. The by-law was also instrumental in enabling other actions such as soil conservation terracing and tree planting. Success of this by-law was seen in the consolidation of community demand for policy support aimed at addressing land degradation issues, but also the application of the by-law as surrogate management plans for the farmland and fostering trust in the interactions between the Mount Elgon National Park and the indigenous Benet people who were displaced from the protected area (Barrow et al., 2012).

Landcare in these examples is seen as an enabler of achieving landscape scale change through ensuring community identification and ownership of land management issues. Through collective awareness of land management challenges at the grassroots level, government and other stakeholders are effectively coerced to make appropriate policy responses for the betterment and protection of land and natural resource assets across the landscape, benefiting both human and natural communities. Furthermore, approaching these issues through a Landcare mindset is critical for the sustainability of these initiatives.

Box 11.1

Kapchorwa District Landcare Chapter: managing the landscape for livelihoods

Prior to the formation of the Kapchorwa District Landcare Chapter (KADLACC), community members in the Kapchorwa District along the northern slopes of Mount Elgon in Uganda, had been struggling with a myriad of complex and linked landscape management issues including:

- Indiscriminate removal of vegetation cover
- Declining soil fertility as a result of eroding soils, exacerbated by steep slopes
- Conflict in the protected areas of Mt. Elgon National Park, including the displacement of the indigenous Benet people
- Forest encroachment into the protected areas for firewood collection, grazing and hunting
- Land abandonment in lowland areas of the district due to cattle rustling, displacing the population to the highlands
- Gender inequality with women providing 90% of the agriculture labour, but with no decision-making power
- Poor governance around natural resource management resulting in policy contradictions and compliance with limited local enforcement capacity and budget allocation

The combined effect of these challenges was nowhere more evident than in the challenge of effectively managing excessive run-off and landslides, which destroyed crops, property, infrastructure and even lives. Through the support and facilitation of the African Highland Initiative, KADLACC, an indigenous platform of smallholder groups was formed in 2003 with a shared vision for integrated natural resource management. Through convening discussions on the challenges faced in Kapchorwa, the local community and other stakeholders were engaged in realizing that the long-term solution to their landscape challenges would only materialize through a holistic approach that harmonized livelihoods and conservation efforts. Through inculcating Landcare principles and building partnerships, the community was at the forefront of the establishment of the KADLACC platform to spearhead the adoption of an integrated landscape management approach.

By empowering the community in the decision-making process under the auspices of the Landcare approach, KADLACC has facilitated a multi-stakeholder platform across the landscape to take ownership and accountability of individual actions under the common vision for improving the natural resource base. This has included partnership creation and collaborations with stakeholders at a range of levels within the community, supporting training, cross-learning and knowledge-sharing activities, whilst promoting a conducive policy environment for these activities within the district level government.

Specific socio-economic and wellbeing achievements made by the groups have included increased production, such as average milk production increase per household from 2.5 litres to 6.5 litres and maize production increases from 13 to 25, 100 kg bags/acre per season. Fundamental to the objectives of KADLACC is realizing sustainable natural resource management outcomes for the community by addressing landscape-level challenges through soil and water conservation, agroforestry and watershed management whilst maintaining productive farming systems. Subsequently, bio-physical achievements have been made such as forest protection, nature-based enterprises including apiary, zero grazing initiatives, and soil fertility and watershed management activities through practices such as agroforestry. These initiatives have positively supported social outcomes such as income generation and improvements in food security, including fuel sources and crop diversification, they have also modified the landscape evident by the reduction in landslides within the district (Mowo et al., 2009).

4. Landcare and monetization of conservation

An emerging challenge for the role of community-based natural resource management through Landcare is the growing prominence of rewards, incentives or payments for ecosystem services. These incentive-based programmes (IBPs), which include monetary compensation, revenue-sharing schemes, and conservation concessions, in which direct economic incentives are tied to the conservation behaviours of local people, raises some concerns about the driving factors of voluntary collaborative action for conservation, as modelled by Landcare. Practitioners seek to make conservation economically attractive and commonplace, routine in the decision-making of individuals, communities, corporations, and governments (Daily & Ellison, 2002). However evaluations of incentive-based conservation programmes indicate that the approach continually falls short of the rhetoric (Spiteri & Sanjay, 2006). Specific issues for IBPs include the inability to generate uniform community support, deficiencies in the development and implementation, distribution of benefits (inequities), and maintaining benefits over a longer time frame. IBPs do have their place in a suite of approaches that communities can utilise, and can be designed to consider the complexities of heterogeneous communities, including marginalized communities, but it needs to ensure that social norms of conservation are not completely replaced by monetization of conservation.

5. The landscape approach at scale—insights from Landcare

Minang et al. (Chapter 1, this book), highlights the multi-scale dimension of landscape approaches. The fact that Landcare has expanded across the world from its roots in Australia, and has been adapted to such a diverse array of cultures and societies, with only minor external support, suggests that the Landcare approach has broad value and appeal for landscape management at multiple scales. Landscapes are of interest to multiple stakeholders. Thus, it has been extremely challenging to imagine how the global environment, constituting of thousands to millions of landscapes, might be managed. Using different entry points, various international environmental conventions (e.g., Desertification, Biodiversity and Climate Change) and programmes such as Reduced Emissions from Deforestation and forest Degradation (REDD) all attempt to provide a basis for doing so. International frameworks sign-posted by global leaders provide implementation guidance to achieve global goals of reduced emissions, biodiversity conservation and combating desertification. Guidelines, targets, funding, compliance and reporting, among others, are the focus of these international frameworks, whilst aspiring to mobilize local actions, empowering communities, and developing effective partnerships and genuine participation from beyond the local level. Landcare provides a platform to facilitate such strong participatory and empowering processes connecting the local to the global, by addressing the landscape scale.

The main point of difference between countries with Landcare projects or programmes is the socio-economic context; some countries shoulder a greater proportion of the world's environmental and socioeconomic problems, yet have the least capacity to face these challenges (Catacutan et al., 2009). What this means for a landscape approach at scale is that while adhering to key principles, adjustments have to be made to address specific local contexts. Landcare too is viewed as both a technical and social approach to landscape management, although the latter is given more weight in its initial approach.

Emphasis on capacity development and building a landscape management ethic amongst local communities has been the defining feature of Landcare locally, and globally. The emphasis on people and communities in finding and implementing solutions for natural resources management made Landcare especially unique amongst its contemporaries. Today, no social norms of grassroots conservation are pursued in such a universally networked approach as is Landcare, even though it has yet to be fully mainstreamed into the global agencies responsible for fostering sustainable land management worldwide.

The trajectory of Landcare in the developing world can be greatly enhanced if the major international organizations now become active partners in its advancement. It would be ideal to have major global agencies' support for the Landcare approach, actively promoted by global development organizations and global and regional development banks. These organizations control vast resources deployed through hundreds of land management projects. Landcare could provide a common platform and agenda for these organizations to more effectively and comprehensively address integrated landscape management challenges in synchrony and in partnership with local communities.

The Landcare movement is positioned to work more closely with such key global organizations, particularly to identify and support Landcare champions and create supportive platforms within each of them. Embedding the Landcare approach in their project portfolios can stimulate a convergence in their approaches to sustainable land management, with a view of accelerating the successful advance of Landcare at the local, national, regional and global levels.

One of the most effective ways that Landcare can be more effectively mainstreamed into development is by also gaining recognition as a superior way to achieve the objectives of the global environmental conventions. As this chapter has highlighted, Landcare is gradually emerging as a global norm for effective landscape management at scale. Throughout history and across the globe, local communities have always been, and should continue to be, the primary social unit for achieving sustainable landscape management.

References

Australian Framework for Landcare Reference Group. (2010). *Australian Framework for Landcare*. Canberra, Australia: Australian Government Department of Agriculture, Fisheries and Forestry.

Barrow E., Fisher, R., & Gordon, J. (2012). *Improving ecosystem functionality and livelihoods: Experiences in forest landscape restoration and management*. Gland, Switzerland: IUCN.

Bluemlein, B. (2009). Landcare in Germany. In Catacutan, D., Neely, C., Johnson, M., Poussard, H., & Youl, R. (Eds.). *Landcare: Local action – global progress*. Nairobi, Kenya: WorldAgroforestry Centre.

Catacutan, D., & Mercado, A. (2001). Technical Innovations and Institution Building for Sustainable Upland Development: Landcare in the Philippines. The International Conference on Sustaining Upland Development in Southeast Asia: Issues, Tools and Institutions for Local Natural Resource Management. Makati City, Philippines: ACCEED.

Catacutan, D., Neely, C., & Youl, R., (2009). Globalising local actions an introduction to the ever expanding story. In Catacutan, D., Neely, C., Johnson, M., Poussard, H., & Youl, R. (Eds.), *Landcare: Local action – Global progress*. Nairobi: Kenya: World Agroforestry Centre.

Compton, E., & Beeton, R. J. S. (2012). An accidental outcome: Social Capital and its implications for Landcare and the "status quo". *Journal of Rural Studies, 28*(2), 149-160.

Curtis, A., & De Lacy, T. (1996). Landcare in Australia: Does it make a difference?. *Journal of Environmental Management*, 46, 119-137.

Hanifan, L. J. (1916). The Rural School Community Center. *Annals of the American Academy of Political and Social Science*, (67), 130–138.

Johnson, M., Poussard, H. & Youl, R. (2009). Landcare in Australia. In Catacutan, D., Neely, C., Johnson, M., Poussard, H., & Youl, R. (Eds.), *Landcare: Local action – Global progress*, Nairobi, Kenya: World Agroforestry Centre.

Landcare Foundation of the Philippines. (2009). *Landcare in the Philippines: a practical guide to getting it started and keeping it going*. ACIAR Monograph No. 138. Canberra: Australia: Australian Centre for International Agricultural Research.

Lockwood, A. C. M. (2000). Landcare and Catchment Management in Australia: Lessons for State Sponsored Community Participation. *Society & Natural Resources, 13*(1), 61-73.

McNeely, J. A., & Scherr, S. J. (2003). *Ecoagriculture: strategies to feed the world and save biodiversity*. Washington, D.C: Island Press.

Mowo, J., Tanui, J., Masuki, K., Nyangas, S., & Chemangei, A. (2009). The Landcare approach to sustainable land management in the highlands of eastern Africa: the case of Kapchorwa, Uganda., Limpopo, South Africa: 4th Biannual Landcare Conference, 12-16 July.

Prior, J., & Holt, R. (2006). Tools for International Landcare – Lessons Learnt from South Africa and Australia. Melbourne, Australia: Landscapes, Lifestyles, Livelihoods, International Landcare Conference, 8-11 October 2006.

Prior, J., & Johnson, M. (2009). The rise, and rise, of international Landcare: what trajectory could be possible?. Sydney, Australia: National Landcare Conference.

Putnam, R. D. (2000). *Bowling Alone: The Collapse and Revival of American Community*. New York, USA: Simon and Schuster.

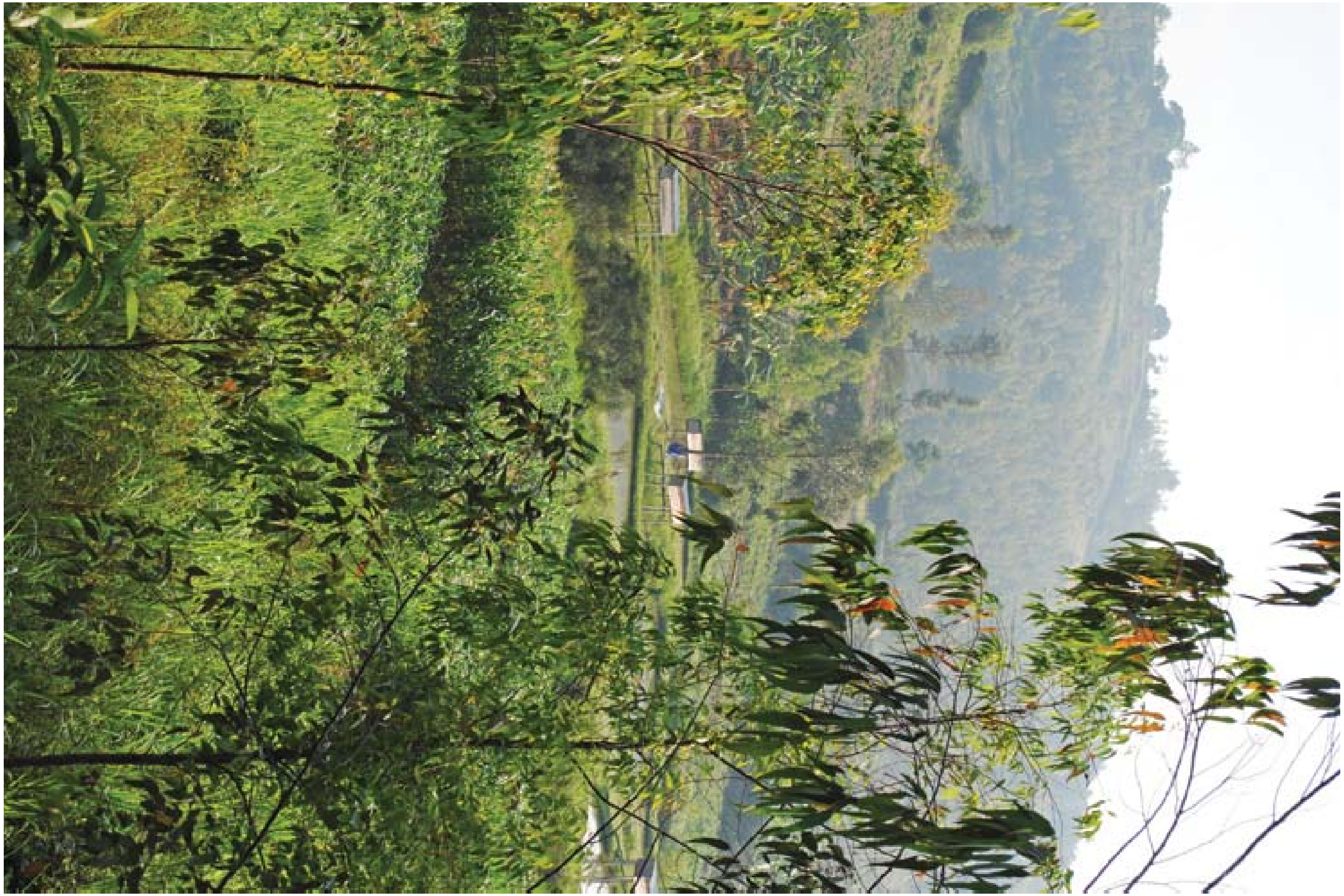
Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J. L., Sheil, D., … Buck, L. (2013). Ten principles for a landscape approach to reconciling agriculture, conservation and other competing land uses. *Proceedings of the National Academy of Sciences of the United States of America, 110*(21), 8349-8356.

Spiteri, A., & Sanjay, K. (2006). Incentive based conservation programs in developing countries: A review of some key issues and suggestions for improvements. *Environmental Management, 37*(1), 1-14.

The Tropical Research and Conservation Centre. (2012). *An overview of the Nigeria Landcare initiative*. Nigeria: Akwa Ibom State.

Uphoff, N. (2002). *Agroecological innovations*. London, U.K.: Earthscan.

Landscape-level constraints and opportunities for sustainable intensification in smallholder systems in Kamonyi District, Southern Rwanda. Constraints in the form of sloping land requiring terracing for cultivation and opportunities in the form of fertile valley floors enabling more demanding crops and production of fish, poultry and rabbits. Photo credit: A. Sigrun Dahlin



CHAPTER

12

Landscape-level constraints and opportunities for sustainable intensification in smallholder systems in the tropics

Ingrid Öborn, Shem Kuyah, Mattias Jonsson, A. Sigrun Dahlin, Hosea Mwangi and Jan de Leeuw

Highlights

- A landscape approach can add value to options for sustainable intensification of smallholder farming
- Management practices applied to intensify these systems are often benefitting from and utilizing landscape functions and services
- Landscapes determine the water yield, and its spatial and temporal availability thus affecting irrigation and associated farm-level productivity
- Agriculture is utilizing nutrient flows and stocks in the landscape with the sustainability of the practices being site dependent
- Biological pest control in agriculture is more effective in diversified landscapes

1. Introduction

Landscape-level benefits to the functioning of agricultural systems have been taken for granted, until a change of that context made clear what had been lost. In many landscapes a recovery of functions and services proved to be more difficult and take more time than the loss that had occurred. A first step in the direction of recovering such functions is the recognition of how landscapes were traditionally utilized and to acknowledge the services these systems provided, for example, in regulating the provision of surface and ground water, in serving as areas for grazing and fodder collection, in hosting perennial vegetation for firewood, medicinal use, etc., and being biotopes for pollinators and insect pest predators.

A heterogeneous landscape with mixed land uses can serve as a buffer to cope with environmental and economic challenges. Progressive climate change, with increasingly irregular rainfall and extreme weather events, provide an additional rationale to position agricultural intensification firmly into the landscape context, as trees, wetlands and other landscape components surrounding fields can modify the micro- and meso-climate (van Noordwijk et al., 2014*a*).

However, agricultural intensification has reduced the space for the landscape areas surrounding farmland to provide services. Increased pressure on land is widely seen as driving intensification. Land sizes in highly populated areas of Sub-Saharan Africa are possibly approaching the limit of what can sustain a living for small holders (Masters et al., 2013; Hengsdijk et al., 2014). The decrease in farm sizes in Sub-Saharan Africa is expected to continue for some decades, whereas the trend in Asia is towards larger units of land (Masters et al., 2013).

Agricultural intensification through the increased fraction of cropland is frequently associated with loss of landscape heterogeneity (simplification) and the associated loss of landscape related benefits. Intensification in this respect is considered a major driver of global loss of biodiversity and associated ecosystem services (Tilman et al., 2001). At the landscape level, agricultural intensification has been characterized by enlargement of agricultural fields, a reduction in crop and non-crop diversity and shortened crop rotations, leading to a homogenized landscape that is simple in structure and species composition (Margosian et al., 2009).

For example, ecosystem services such as biological pest control, pollination, and nutrient cycling through dung burial, are delivered by mobile organisms such as insects and birds (Kremen et al., 2007). Landscape simplification due to agricultural intensification has repeatedly been shown to have detrimental effects on ecosystem services delivered by such species (Tscharntke et al., 2005). This is because the abundance and diversity of the mobile species are largely determined by land-use patterns at the landscape scale, while the primary benefits of the ecosystem services they deliver are to the crops or pastures of local farmers. A landscape perspective is therefore critical to effectively manage ecosystem services (e.g., those that relate to movements in the landscape, i.e., 'lateral flows'), which is one prerequisite for turning agricultural intensification into sustainable intensification.

In this chapter we will discuss how on-farm intensification benefits from, utilizes and relies on the surrounding landscape and the services it provides. Our first hypothesis is that a landscape approach can be beneficial for intensification of smallholder farming. Secondly, that most of the management practices applied to intensify these systems today are benefitting from, and utilizing landscape functions and services. Thirdly, that sustainable intensification of smallholder farming cannot be achieved without taking a landscape approach and that the sustainability of the intensified systems needs to be understood, assessed and developed in that context. The objectives of the chapter are, as steps towards the three hypotheses, i) to review landscape benefits to agriculture focusing on water regulation, nutrient cycling and control of insect pests, and ii) to put forward examples illustrating the role and benefits of landscapes for sustainable intensification of smallholder farming.

2. Review of landscape benefits to agriculture

Intensification of agricultural systems in the tropics relies on benefits from the surrounding landscape. Some benefits are related to the landscape topography, land cover and hydrology whereas other benefits are dependent on a diversified landscape with a diversity of trees and other perennial plants, and the connectivity between these biological landscape elements. In this section we review some of these landscape benefits and their relation to intensification of on-farm productivity.

2.1 Landscapes provide and regulate water for agriculture

Landscapes support important hydrological services such as provision of freshwater, regulation of water quality, partitioning of rainwater into blue (to surface and ground water) and green (to plant and evapotranspiration) water fluxes, and flood water control (Gordon et al., 2010). The supply of these services is influenced by changes in land use and land cover where landscape functions are modified by humans, for example, through deforestation and intensification of crop cultivation. Agricultural intensification may result in land degradation such as soil compaction, erosion and loss of soil organic matter, which negatively affects the soil hydrologic properties such as permeability and water holding capacity (Lal, 1996; Stoate et al., 2001; Recha et al., 2012). Decreased soil permeability reduces water infiltration in favour of erosive quick runoff while reduced water holding capacity reduces water available for crops. Research has shown that agricultural practices that enhance water infiltration and minimize soil disturbance, for example, conservation agriculture, enhance water availability for crops and thus increase crop yield in low rainfall areas (e.g., Ngigi et al., 2006; Makurira et al., 2011). Ecological functions offered by the presence of wetlands, grasslands and forests in the landscape such as groundwater recharge, stream flow regulation (peak runoff attenuation) and water quality regulation by trapping of pollutants, can be lost with agricultural intensification (Lal, 1997; Dixon & Wood, 2003; Calder, 2005). Recha et al. (2012) found that generation of surface runoff increased with time since the conversion of forest to agricultural cropland, implying land degradation, impeded infiltration and decreased water retention.

The structure of a landscape determines the water yield in an ecosystem, both the total (i.e., annual water yield), and the spatial and temporal distribution of available water. The magnitude and the frequency of the dry season stream flow is a very important measure of water availability. Infiltration of rainwater into the ground to recharge aquifers ensures the sustainability of stream flow. The base flow component of stream flow is primarily determined by the groundwater. Reduced infiltration may increase the frequency and the length of low flows (Lal, 1997) which imply less available water for agriculture (irrigation) and other uses for extended periods. Therefore, landscape elements such as wetlands, grasslands and primary forests act as groundwater recharge areas which ensure sustainability of stream flows throughout the year (Lal, 1997; Bruijnzeel, 2004; Farley et al., 2005).

Trees in the landscape modify microclimatic conditions by shading and thus reducing potential evaporation (van Noordwijk et al., 2014*b*). Trees also reduce wind speeds and thus minimize vapour exchange which also lower the evaporation. This minimizes unproductive green water (evaporation) in favour of productive (transpiration) green water (Falkenmark & Rockström, 2004).

Landscapes regulate the quality of surface water bodies. Suspended sediments, nutrients and pesticides from agriculture are major causes of diffuse water pollution (Stoate et al., 2001; Gordon et al., 2010). Field experiments showed that the sediment yield from cultivated land under maize was 64-200% more than that from grassland in the Upper Mara River Basin, Kenya (Defersha & Melesse, 2012). A mosaic of different land uses in predetermined spatial arrangement (e.g., grass strips along the rivers, hedgerows along contours) offers multiple benefits while maintaining the hydrological functions of the landscapes. Grass strips, hedgerows, tree lines, etc., in agricultural landscapes, enhance water infiltration, minimize soil erosion and trap eroded pollutants, while the land is not taken out of agricultural use. For example, Mwangi et al. (2014) found that application of 5 m wide grass strips and 14 km grassed waterways in Sasumua watershed, Kenya, would reduce the sediment load to the Sasumua reservoir by 30% and 23%, respectively.

Multifunctional agricultural systems managed for a number of products and services would improve water management at a landscape level (Gordon et al., 2010; Liniger et al., 2011). Managing upstream and downstream water use is essential to achieve sustainable agricultural production at the landscape scale, as illustrated in a study of two villages in Embu on the slope of Mt. Kenya (Hoang et al., 2014). Good management of resources at field and farm scale will further increase the water and nutrient use efficiency and improve on-farm productivity (Gordon et al., 2010).

2.2 Landscape nutrient stocks supply nutrients for farm production

The utilization of landscapes for supporting nutrient supply in agriculture can take place with differing intensities and intentionality. The aim of this section is to illustrate the movement and utilization of nutrients in the landscape. Thus on-farm nutrient cycling and deliberate import of nutrients to farms in the form of chemical or organic fertilizers are outside the scope of this chapter.

Interactions between the landscape and the cultivated fields are fundamental in production systems such as slash and burn cultivation. In these systems, resources are transferred from other landscape elements (virgin or secondary forest, bush, fallows) to agricultural lands. This transfer takes place mostly over time when land is transformed into fields, and nutrients that have accumulated in biomass and soil organic matter during forest or fallow periods are liberated. However, nutrient use efficiency is low since losses are high through volatilisation during burning, and erosion and leaching over the subsequent years (Juo & Manu, 1996; Hölscher et al., 1997).

More permanent cropping systems may also utilize, or be affected by, other landscape components, through spatial transfer of nutrients and organic matter, for instance, by nutrient-rich sediments deposited on periodically inundated river valleys or via fine soil redistribution to low-lying areas of hilly landscapes. Although crop productivity in individual ‘receiving’ fields may through these transfers be sustained at moderate levels in the medium- to long-term, these systems may not be sustainable at the larger spatial scale because of the disadvantage to other parts of the landscape, and are unviable at higher population densities.

Higher productivity may be achieved through direct and intentional human manipulation to increase flows to the cultivated fields from other landscape components, and to decrease nutrient and organic matter losses from farms. Introducing di-nitrogen (N_2) fixing trees, bushes and herbaceous plants onto farms can strongly increase N availability at the field- and landscape-level. Species suitable as livestock fodder (e.g., *Desmodium spp, Mucuna pruriens, Calliandra calothyrsus, Sesbania sesban, Leucaena leucocephala, Faidherbia albida*) may, for example, be planted along boundaries and along contours to stabilise slopes and terraces. These fodder types can increase livestock weight gain and milk production (Gutteridge & Shelton, 1994; Place et al., 2009) compared with a grass-only diet, and the higher N concentration of the produced livestock manure can contribute to enhanced crop productivity (Delve et al., 2001). The N_2-fixers may also be used viably as green manures if fitted to the production system in a way that minimises costs and maximises benefits; for example, green manure cut and carry systems (where biomass is produced in one place and transferred to fertilize a crop in another place) are mainly economically viable for production of high-value crops (Jama et al., 2000). Apart from N_2-fixation, inflows of nutrients (and organic matter) from other landscape components to cultivated fields are largely via fodder collected or purchased for stalled animals and via grazing animals. For example, van den Bosch et al. (1998) found that purchased feeds and grazing off farm corresponded to an average inflow of 42 kg N/ha/yr on farms in Kakamega, Kenya. In the communal areas of Northeastern Zimbabwe, livestock manure is applied preferably to home-fields. The use of harvest residues from outfields for fodder or supplementary grazing thus leads to net nutrient transfer from the outfields to home-fields, and also from the fields of non-livestock owners to those of livestock owners (Rufino et al., 2011). Corresponding flows arise when livestock graze on grasslands (Rufino et al., 2011), and also when forest litter is collected and used as surface mulch.

Preventing nutrient losses from farms is another aspect of sustainable intensification. Annual nutrient losses through erosion in low-input systems in Sub-Saharan Africa are often in the range of 10 kg N/ha, 2 kg P (phosphorous)/ha, and 6 kg K (potassium)/ha (Stoorvogel & Smaling, 1990). They are thus often larger than fertiliser inputs averaging 6-7 kg NPK/ha/yr (Reij & Smaling, 2008); hence, much could be gained by reducing nutrient losses through erosion control. Also redistribution of nutrients by uptake of deep-rooted plants and trees from deeper soil layers may help retain nutrients in the farming system (Aweto & Iyanda, 2003; Gindaba et al., 2005). However, with the exception of N_2-fixation, management options that direct nutrients from the surrounding landscape to arable fields or from deeper soil layers to surface soils imply that nutrients are mined at the source site. While such nutrient transfers are one way to replenish nutrients exported and may also increase the nutrient stocks on-farm, the sustainability of this approach is strongly dependent on the magnitude of the flows, the proportion of the landscape that is cultivated, and the weathering capacity and aerial deposition of nutrients to replenish soil fertility at the source site. Knowledge is lacking in this respect but the net outcomes are bound to be highly site-specific. Nevertheless, taking nutrient flows between crop fields and other components of the landscape into consideration is needed when developing management options for sustainable intensification.

2.3 Biological pest control is relying on diversified landscapes

Many pests and their natural enemies are able to disperse over large distances and the damage they cause in a particular field is therefore often strongly affected by the composition and structure of the surrounding landscape. The effects of landscape composition on natural enemies of insect pests have been particularly well studied during recent years. It has repeatedly been shown that the diversity and abundance of natural enemies such as parasitoid wasps, predatory beetles and spiders are higher in diverse landscapes with a comparatively low proportion of crop habitats (studies reviewed by Chaplin-Kramer et al., 2011; Veres et al., 2013). A few studies have also shown that this can result in enhanced pest suppression (Östman et al., 2001; Gardiner et al., 2009; Rusch et al., 2013). A modelling study suggested that landscape simplification in a temperate area would reduce the biological control potential of natural enemies of cereal aphids with about 35% (Jonsson et al., 2014*a*). Similar studies in tropical environments are still scarce (but see Box 12.1).

Box 12.1

Landscape management of coffee berry borer to sustain productivity on smallholder farms

Careful landscape management can help to reduce pest infestations. This has been clearly shown by work from Costa Rica and East Africa on coffee berry borer management. The coffee berry borer is currently considered to be the most important insect coffee pest worldwide (Jaramillo et al., 2006). Trees planted and maintained at multiple spatial scales in and around coffee plantations can help reduce coffee berry borer infestations via a range of different mechanisms (Figure 12.1). The abundance of the pest is lower in shaded compared to sun-exposed coffee plantations (Jonsson et al., 2014*b*). This may be due in part to natural enemies such as ants, parasitoids and birds benefiting from and being attracted by trees (Perfecto et al., 1996; Karp et al., 2013). Borers also experience reduced development rates in shaded conditions (Jaramillo et al., 2009), and shade can modify biochemical composition and emission of chemical compounds from coffee berries that make them more difficult to locate for ovipositing borer females (Jaramillo et al., 2013). Landscape composition may also have strong effects on infestation rates. Karp et al. (2013) recently found that forested coffee plantations hosted more predatory birds in Costa Rica than plantations lacking trees, and the damage by coffee berry borers was therefore 50% lower at the forested coffee plantations. This prevented US$75–310/ha/yr in damage. Railsback and Johnson (2013) furthermore suggested that introducing trees within coffee farms will be more effective at increasing predation by birds on coffee berry borers than preserving patches of forest. In contrast, landscapes with a high connectivity between coffee patches will have a higher infestation rate of coffee berry borers than more fragmented coffee landscapes (Avelino et al., 2012).

Figure 12.1 Trees in and around coffee plantations in Costa Rica have significantly reduced coffee berry borer infestations via different mechanisms, e.g., hosting predators such as birds. Photo credit: Daniel Karp (to whom we are very thankful)

However, even though landscape simplification on average leads to increased pest pressure (Veres et al., 2013), this is not a uniform pattern. Some pests find alternative host plants and other resources in non-crop habitats, and this may counteract the positive effects of enhanced predation pressure. One example are stemborer moths that use native grasses in East Africa as alternative hosts; a high cover of such grasses in the landscape have been shown to enhance stemborer colonization to maize crops (Midega et al., 2014).

In most cases it is not clear exactly how the landscape should best be designed to most effectively reduce pest pressure. This is because we know little about the mechanisms explaining observed correlations with landscape components. For example, it is often assumed that positive effects of landscape complexity on natural enemies are due to the presence of key resources present in the landscapes, such as alternative food or hibernation sites (Tscharntke et al., 2008), but it may also be due to variation in mortality factors induced by habitat disturbances and pesticide application (Jonsson et al., 2012), or by changes in connectivity (Perovic et al., 2010).

One reason for the often poor understanding of the mechanisms underlying landscape effects is that correlations with coarse landscape metrics, such as the proportion of non-crop vegetation, are used. While these metrics may be relevant predictors of biodiversity, they are probably less effective at predicting occurrence of individual pests and key natural enemies that have specific habitat requirements. If more specific landscape metrics motivated by species biology are used in future studies this may not only lead to a better understanding of the drivers of landscape effects, but may also improve the ability to identify landscape parameters that selectively enhance natural enemies while reducing crop pests.

Using a more specific landscape approach has, for example, shown that trees in the landscape can help reduce coffee berry borer abundances through enhanced biological pest control by birds, while highly connected coffee plantations are likely to increase coffee berry borer abundances by facilitating coffee berry borer movement (Box 12.1) (Avelino et al., 2012; Karp et al., 2013; Railsback & Johnson, 2013).

A further reason for using a landscape approach is that the impact of local management measures on biodiversity and ecosystem services often depends on the landscape context. The 'intermediate landscape complexity hypothesis' states that the effect of local management measures such as intercropping should be highest in moderately complex landscapes, but less effective both in highly simplified landscapes dominated by crops and in highly complex landscapes dominated by non-crop habitats (Tscharntke et al., 2012). Empirical support for this hypothesis is mounting, especially for the moderately to highly complex part of the relationship (Schmidt et al., 2005; Haenke et al., 2009) even though such effects are not universal (Winqvist et al., 2011).

As illustrated in this section, many pests and their natural enemies are able to disperse over large distances and thus elements in the surrounding landscape can provide these organisms with resources such as hosts, food, shelter from disturbances, and can enhance or reduce their immigration to crop fields (Tscharntke et al., 2008; Avelino et al., 2012). This clearly highlights the importance of taking the landscape scale into account when designing and testing practices for sustainable pest management.

3. Sustainable intensification

Sustainable agricultural intensification focuses on its defined goal of "... producing more output from the same area of land while reducing the negative environmental impacts and at the same time increasing contributions to natural capital and the flow of environmental services" (Pretty et al., 2011). In contrast, the process is the emphasis of those putting forward the concept of 'ecological intensification' as a means to reach sustainable intensification (Bommarco et al., 2013; van Noordwijk & Brussaard, 2014). Garnett and

Box 12.2

Forest gardens sustain livelihoods when variable weather hits intensified crop cultivation in Central Vietnam

Globally, Vietnam is among the five countries most affected by sea level rise caused by climate change, as its major rice production areas are close to the sea (Wassmann et al., 2004; Dasgupta et al., 2009). The low coastal area of Central Vietnam is characterized by high poverty, extensive forest and a high dependence on agriculture (Nguyen et al., 2013). Cam My Commune in Ha Tinh Province is an example where dependence on intensified agriculture dominated by paddy rice is jeopardized by strong climate variability and frequent weather hazards. Farmers in Cam My are utilizing resources in the surrounding forest landscape and drawing on the benefits that different trees provide. In addition to home gardens, they have developed 'forest gardens' in the forest area adjacent to the village where they grow a diversity of vegetables and trees (fruit, tea, timber, etc.) for household consumption and the market (Figure 12.2). The 'forest gardens' are established in land designated as forest (belonging to the State Forestry Enterprise). Policy allowing agroforestry in forest land in vulnerable areas is needed and would further improve the life of the farmers in Cam My (Hoang et al., 2014). Such legitimization would officially recognize the benefits of landscape resources (land, trees, etc.) gained by smallholder farmers through their forest garden activities, which are needed to complement their on-farm crop cultivation.

Figure 12.2 Establishment of forest gardens in Cam My Commune, Central Vietnam, contributes to sustainable livelihoods of local, smallholder farmers. Photo credit: Quan Nguyen

Box 12.3

Enclosures contribute to sustainable intensification of livestock production in semi-arid West Pokot, Kenya

Population increases and less access to sufficient land for grazing in semi-arid pastoral areas have resulted in reduced per capita livestock assets that underpin traditional pastoralism. This pressure has led to the introduction of cropland, the concentration of livestock, and constrained seasonal migration resulting in overgrazing and land degradation. In West Pokot in northwest Kenya, decades of increased land degradation have been followed by the emergence of community-based institutional change and more sustainable land management practices (Nyberg et al., 2014). These innovative practices, including trees, shrubs and other plants forming live fences and enclosures, have been widely adopted (Figure 12.3). The vegetation does not only provide fodder, fences and other products but also ecosystem services such as reduced erosion, improved water infiltration and carbon sequestration in biomass and the soil. The farmers are now rotating the livestock grazing between paddocks, which are enclosed and interspersed with crop fields. During the same period there has been a change in land tenure towards privatization and individual land use rights.

The above chronosequence of population pressure leading to land degradation, land use change and a subsequent emergence of institutions to support greater land care is a trajectory common to many semi-arid areas and offers excellent scope for research (Triple L, 2014). Analysis of the role of population pressure in driving this trajectory reveals that land use changes in West Pokot with lower initial population occurred several decades later than in more densely populated districts such as Machakos, Kenya (Tiffen et al., 1994; Zaal & Oostendorp, 2002; Nyberg et al., 2014).

Figure 12.3 West Pokot, a semi-arid area of Kenya: degraded landscape (left), restored landscape with enclosures (centre), livestock grazing in enclosure (right). Photo credits: A. Sigrun Dahlin (left), Gert Nyberg (centre), Ingrid Öborn (right)

Godfray (2012) broadened the concept to also include nutrition, health and animal welfare aspects. Although the target of sustainable intensification has considerably advanced and broadened the thinking beyond increasing inputs to close yield gaps, the specific steps needed to increase outputs in any given context remain site-specific. The main focus still is very much at the farm level, on scaling up in terms of adoption, value chain development, and market linkages, but there is a lack of awareness of the dependence on the landscape context and the degree to which intensification opportunities and constraints relate to landscape properties, functions and services.

In Section 2 we reviewed some of the landscape benefits to agriculture. The examples we chose for this section highlight the potential of integrated studies to illustrate benefits from landscapes and the necessity to integrate a landscape perspective in research and development activities dealing with agricultural intensification (Box 12.2-12.3). In these examples the distinctions between coping strategies and intensification may be hard to make. The first example is from the low land areas of Central Vietnam where the landscape plays a significant role in making the intensified farming systems more sustainable (Nguyen et al., 2013; Hoang et al., 2014). Development of forest gardens on adjacent land, officially being designated as forest, has provided measures to cope with rainfall variability and extreme weather events that jeopardize crop production and make it possible for the local farmers to buffer household food security and other livelihood needs (Box 12.2). The second experience is from livestock farmers in West Pokot in semi-arid Kenya where enclosures have been established to regulate and intensify the livestock grazing since the increased population and pressure on the land makes it difficult to continue communal grazing and pastoralism (Nyberg et al., 2014; Box 12.3).

4. Conclusion

The review of landscape benefits to agriculture brought up several examples and aspects of landscapes functions and services that can be further utilized for sustainable intensification of agriculture, contributing to increased productivity, food security and income. Examples are measures to improve water regulation, reduce nutrient losses through erosion control and to promote biological pest control. In order to restore lost and degraded functions and services a more complex landscape combining different land uses and landscape components is needed. This is particularly the case for water and pest regulation. However when it comes to nutrient supply, enrichment in one part of the landscape leads to nutrient mining somewhere else, except for nitrogen that can be captured through biological N_2-fixation. Trees and shrubs in cultivated landscapes together with grasslands and wetlands are core elements providing and supporting landscape benefits and services required for sustainable agriculture.

However, agricultural intensification, intending to be sustainable, in practice, is concept specific. When this is taken into account, agricultural research and development will be able to contribute to large-scale development impacts (Coe et al., 2014). Policies and policy changes are also required, for example, to enable sustainable farming at the agricultural-forestry interface (Hoang et al., 2014), or linking agriculture and improved on farm-productivity to development of human nutrition and health (Garnett & Godfray, 2012). Sustainable intensification, as discussed here, is not about maximizing short-term production but optimising long-term productivity and a range of environmental and other possible outcomes (Garnett & Godfray, 2012).

This chapter identified opportunities, but also challenges, to find a site-specific landscape approach that is beneficial for sustainable intensification of smallholder farming. A landscape perspective needs to be brought in to further develop the concept and practices of sustainable intensification of smallholder agriculture in the tropics. Management practices applied to intensify these systems can benefit from and utilize landscape functions and services, but they are knowledge intensive and not always easily 'scaled up'.

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References

Avelino, J., Romero-Guardiá, A., Cruz-Cuellar, H. F., & DeClerck, F. A. J. (2012). Landscape context and scale differentially impact coffee leaf rust, coffee berry borer, and coffee root-knot nematodes. *Ecological Applications*, 22, 584-596.

Aweto, A. O., & Iyanda, A. O. (2003). Effects of Newbouldia laevis on soil subjected to shifting cultivation in the Ibadan area, south western Nigeria. *Land Degradation and Development,* 14, 51-56.

Bommarco, R., Kleijn, D., & Potts, S. G. (2013). Ecological intensification: harnessing ecosystem services for food security. *Trends in Ecology and Evolution,* 28, 230-238.

Bruijnzeel, L. A. (2004). Hydrological functions of tropical forests: not seeing the soil for the trees. *Agriculture, Ecosystems and Environment*, 104, 185–228

Calder, I. R. (2005). *Blue revolution – integrated land and water resources management* (2nd ed.). London, UK: Earthscan.

Chaplin-Kramer, R., O’Rourke, M. E., Blitzer, E. J., & Kremen, C. (2011). A meta-analysis of crop pest and natural enemy response to landscape complexity. *Ecology Letters*, 14, 922-932.

Coe, R., Sinclair, F., & Barrios, E. (2014). Scaling up agroforestry requires research ‘in’ rather than ‘for’ development. *Current Opinion in Environmental Sustainability*, 6, 73–77.

Dasgupta, S., Laplante, B., Meisner, C., Wheeler, D., & Yan, J. (2009). The impact of sea level rise on developing countries: a comparative analysis. *Climatic Change*, 93, 379–388.

Defersha, M. B., & Melesse, A. M. (2012). Field-scale investigation of the effects of land use on sediment yield and runoff using runoff plot data and models in the Mara River Basin, Kenya. *Catena*, 89, 54-64.

Delve, R. J., Cadisch, G., Tanner, J. C., Thorpe, W., Thorne, P. J., & Giller, K. E. (2001). Implications of livestock feeding management on soil fertility in the smallholder farming systems of sub-Saharan Africa. *Agriculture, Ecosystems and Environment*, 84, 227–243.

Dixon, A. B., & Wood, A. P. (2003). Wetland cultivation and hydrologic management in Eastern Africa: matching community and hydrological needs through sustainable wetland use. *Natural Resources Forum,* 27, 117-129.

Falkenmark, M., & Rockström, J. (2004). *Balancing water for humans and nature. The new approach in ecohydrology*. London, U.K.: Earthscan.

Farley, K. A., Obbagy, E. G., & Jackson, R. B. (2005). Effects of afforestation on water yield: a global synthesis with implications for policy. *Global Change Biology*, 11, 1565–1576.

Gardiner, M. M., Landis, D. A., Gratton, C., DiFonzo, C. D., O’Neal, M., Chacon, J. M., … Heimpel, G. E. (2009). Landscape diversity enhances the biological control of an introduced crop pest in the north-central U.S. *Ecological Applications*, 19, 143-154.

Garnett, T., & Godfray, C. (2012). *Sustainable intensification in agriculture. Navigating a course through competing food system priorities.* Food Climate Research Network and the Oxford Martin Programme on the Future of Food. U.K.: University of Oxford.

Gindaba, J., Rozanov, A., & Negash, L. (2005). Trees on farms and their contribution to soil fertility parameters in Badessa, eastern Ethiopia. *Biology and Fertility of Soils*, 42, 66-71.

Gordon, L. J., Finlayson, C. M., & Falkenmark, M. (2010). Managing water in agriculture for food production and other ecosystem services. *Agricultural Water Management*, 97, 512–519

Gutteridge, R. C., & Shelton, H. M. (Eds.) (1994). *Forage Tree Legumes in Tropical Agriculture.* Retrieved from http://www.fao.org/ag/agp/AGPC/doc/Publicat/Gutt-shel/x5556e0n.htm

Haenke, S., Scheid, B., Schaefer, M., Tscharntke, T., & Thies, C. (2009). Increasing syrphid fly diversity and density in sown flower strips within simple vs. complex landscapes. *Journal of Applied Ecology*, 46, 1106-1114.

Hengsdijk, H., Franke, A. C., van Wijk, M. T., & Giller, K. E. (2014). *How small is beautiful? Food self-sufficiency and land gap analysis of smallholders in humid and semiarid sub Saharan Africa.* Plant Research International, part of Wageningen UR, Report number 562.

Hoang, M. H., Namirembe, S., van Noordwijk, M., Catacutan, D., & Öborn, I. (2014). Farmer portfolios, strategic diversity management and climate change vulnerability - comparative studies in Vietnam and Kenya. *Climate and Development*, 6, 216-225.

Hölscher, D., Möller, R. F., Denich, M., & Fölster, H. (1997). Nutrient input-output budget of shifting agriculture in Eastern Amazonia. *Nutrient Cycling in Agroecosystems*, 47, 49-57.

Jama, B., Palm, C. A., Buresh, R. J., Niang, A., Gacheng, C., Nziguheba, G., & Amadalo, B. (2000). *Tithonia diversifolia* as a green manure for soil fertility improvement in western Kenya: A review. *Agroforestry Systems*, 49, 201–221.

Jaramillo, J., Borgemeister, C., & Baker, P. (2006). Coffee berry borer *Hypothenemus hampei (Coleoptera: Curculionidae)*: searching for sustainable control strategies. *Bulletin of Entomological Research*, 96, 223-233.

Jaramillo, J., Chabi-Olaye, A., Kamonjo, C., Jaramillo, A., Vega, F. E., Poehling, H.-M., & Borgemeister, C. (2009). Thermal tolerance of the Coffee berry borer *Hypothenemus hampei*: predictions of climate change impact on a tropical insect pest. *PLoS ONE, 4*(8), e6487. doi: 10.1371/journal.pone.0006487

Jaramillo, J., Setamou, M., Muchugu, E., Chabi-Olaye, A., Jaramillo, A., Mukabana, J., … Borgemeister, C. (2013). Climate change or urbanization? Impacts on a traditional coffee production system in East Africa over the last 80 years. *PLoS ONE, 8*(1), e51815. doi: 10.1371/journal.pone.0051815

Jonsson, M., Buckley, H. L., Case, B. S., Wratten, S. D., Hale, R. J., & Didham, R. K. (2012). Agricultural intensification drives landscape-context effects on host-parasitoid interactions in agroecosystems. *Journal of Applied Ecology*, 49, 706-714.

Jonsson, M., Bommarco, R., Ekbom, B., Smith, H. G., Bengtsson, J., Caballero-Lopez, B., … Olsson, O. (2014*a*). Ecological production functions for biological control services in agricultural landscapes. *Methods in Ecology and Evolution*, 5, 243-252.

Jonsson, M., Raphael, I. A., Ekbom, B., Kyamanywa, S., & Karungi, J. (2014b). Contrasting effects of agroforestry shade levels and altitude on two important coffee pests. *Journal of Pest Science*. Retrieved from http://link.springer.com/article/10.1007/s10340-014-0615-1

Juo, A. S. R., & Manu, A. (1996). Chemical dynamics in slash-and-burn agriculture. *Agriculture, Ecosystems and Environment*, 58, 49-60.

Karp, D. S., Mendenhall, C. D., Sandi, R. F., Chaumont, N., Ehrlich, P. R., Hadly, E. A., & Daily, G. C. (2013). Forest bolsters bird abundance, pest control and coffee yield. *Ecology Letters*, 16, 1339-1347.

Kremen, C., Williams, N. M., Aizen, M. A., Gemmill-Herren, B., LeBuhn, G., Minckley, R., … Ricketts, T. H. (2007). Pollination and other ecosystem services produced by mobile organisms: a conceptual framework for the effects of land-use change. *Ecology Letters*, 10, 299-314.

Lal, R. (1996). Deforestation and land-use effects on soil degradation and rehabilitation in western Nigeria. I. Soil physical and hydrological properties. *Land Degradation and Development*, 7, 19-45.

Lal, R. (1997). Deforestation effects on soil degradation and rehabilitation in western Nigeria. IV. Hydrology and water quality. *Land Degradation and Development*, 8, 95-126.

Liniger, H., Studer, M., Hauert, C., & Gurtner, M. (2011). *Sustainable Land Management in Practice - Guidelines and best Practices for Sub-Saharan Africa*. Rome, Italy: TerrAfrica, World Overview of Conservation Practices and Technologies (WOCAT) and Food and Agriculture Organization of the United Nations (FAO).

Makurira, H., Savenije, H. H. G., Uhlenbrook, S., Rockström, J., & Senzanje, A. (2011). The effect of system innovations on water productivity in subsistence rainfed agricultural systems in semi-arid Tanzania. *Agricultural Water Management*, 98, 1696-1703.

Margosian, M. L., Garrett, K. A., Shawn Hutchinson J. M., & With, K. A. (2009). Connectivity of the American agricultural landscape: assessing the national risk of crop pest and disease spread. *Bioscience*, 59, 141-151.

Masters, W. A., Andersson Djurfeldt, A., DeHaan, C., Hazell, P., Jayne, T., Jirström, M., & Reardon, T. (2013). Urbanization and farm size in Asia and Africa: Implications for food security and agricultural research. *Global Food Security*, 2, 156–165

Midega, C. A. O., Jonsson, Khan, Z. R., & Ekbom, B. (2014). Effects of landscape complexity and habitat management on stemborer colonization, parasitism and damage to maize. *Agriculture, Ecosystems and Environment*, 188, 289-293.

Mwangi, H. M., Feger, K. H., Julich, S., Gathenya J., & Mati, B. (2014). *A model-based approach to assess the effects of sustainable land management practices on hydrological ecosystem services – Case studies from Eastern Africa.* Forum für Hydrologie und Wasserbewirtschaftung Heft 34.14- Wasser, Landschaft, Mensch in Vergangenheit, Gegenwart und Zukunft- Beiträge zum Tag der Hydrologie, Kartholische Universtät Eichstätt-Ingolstadt 20-21 March 2014.

Ngigi, S. N., Rockström, J., & Savenije, H. H. G. (2006). Assessment of rainwater retention in agricultural land and crop yield increase due to conservation tillage in Ewaso Ng'iro river basin, Kenya. *Physics and Chemistry of the Earth*, 31, 910–918.

Nguyen, Q. H., Hoang, M. H., Öborn, I., & van Noordwijk, M. (2013). Multipurpose agroforestry as a climate change adaptation option for farmers - an example of local adaptation in Vietnam. *Climatic Change*, 117, 241–257.

Nyberg, G., Said, M., Wredle, E., Kifugo, S., Mwangi, P., & de Leeuw, J. (2014). Enclosures – a productive, C sequestering and sustainable alternative to pastoralism? Abstracts of the 3rd World Congress on Agroforestry: Trees for life: accelerating the impact of agroforestry, 243 (PP4.3.5).

Östman, Ö., Ekbom, B., & Bengtsson, J. (2001). Landscape heterogeneity and farming practice influence biological control. *Basic and Applied Ecology*, 2, 365-371.

Perfecto, I., Rice, R. A., Greenberg, R., & van der Voort, M. E. (1996). Shade coffee: A disappearing refuge for biodiversity. *Bioscience*, 46, 598-608.

Perovic, D. J., Gurr, G. M., Raman, A., & Nicol, H. I. (2010). Effect of landscape composition and arrangement on biological control agents in a simplified agricultural system: A cost-distance approach. *Biological Control*, 52, 263-270.

Place, F., Roothaert, R., Maina, L., Franzel, S., Sinja, J., & Wanjiku, J. (2009). *The impact of fodder trees on milk production and income among smallholder dairy farmers in East Africa and the role of research*. ICRAF Occasional Paper No. 12. Nairobi, Kenya: World Agroforestry Centre.

Pretty, J., Toulmin, C., & Williams, S. (2011). Sustainable intensification in African agriculture. *International Journal of Agricultural Sustainability, 9*(1), 5-24. Retrieved from http://dx.doi.org/10.3763/ijas.2010.0583

Railsback, S. F., & Johnson, M. D. (2013). Effects of land use on bird populations and pest control services on coffee farms. *Proceedings of the National Academy of Sciences of the United States of America*, 111, 6109-6114.

Recha, J. W., Lehmann, J., Walter, M. T., Pell, A., Verchot, L., & Johnson M. (2012). Stream Discharge in Tropical Headwater Catchments as a Result of Forest Clearing and Soil Degradation. *Earth Interact* ,16 Paper No. 13, 1-18.

Reij, C. P., & Smaling, E. M. A. (2008). Analyzing successes in agriculture and land management in Sub-Saharan Africa: is macro-level gloom obscuring positive micro-level change? *Land Use Policy*, 25, 410–420.

Rufino, M. C., Dury, J., Tittonell, P., van Wijk, M. T., Herrero, M., Zingore, S., … Giller, K. E. (2011). Competing use of organic resources, village-level interactions between farm types and climate variability in a communal area of NE Zimbabwe. *Agricultural Systems*, 104, 175-190.

Rusch, A., Bommarco, R., Jonsson, M., Smith, H. G., & Ekbom, B. (2013). Flow and stability of natural pest control services depend on complexity and crop rotation at the landscape scale. *Journal of Applied Ecology*, 50, 345-354.

Schmidt, M. H., Roschewitz, I., Thies, C., & Tscharntke, T. (2005). Differential effects of landscape and management on diversity and density of ground-dwelling farmland spiders. *Journal of Applied Ecology*, 42, 281-287.

Stoate, C., Boatman, N. D., Borralho, R. J., Carvalho, C. R., de Snoo G. R., & Eden P. (2001). Ecological impacts of arable intensification in Europe. *Journal of Environmental Management*, 63, 337–365.

Stoorvogel, J. J., & Smaling, E. M. A. (1990). *Assessment of soil nutrient depletion in Sub-Saharan Africa: 1983-2000*. Winand Staring Centre for Integrated Land, Soil and Water Research Report 28. Netherlands: Wageningen.

Tilman, D., Fargione, J., Wolff, B., D'Antonio, C., Dobson, A., Howarth, R., … Swackhamer, D. (2001). Forecasting agriculturally driven global environmental change. *Science*, 292, 281-284.
Tiffen, M., Mortimore, M., & Gichuki, F. (1994). *More people less erosion: environmental recovery in Kenya*. Chichester, U.K.: John Wiley & Sons.
Triple L. (2014). *Triple L - Land, Livestock and Livelihood Dynamics in Dryland Systems, West Pokot, Kenya*. Retrieved 1 Sept 2014 from http://www.slu.se/Documents/externwebben/overgripande-slu-dokument/samverkan-dok/agric-sci-global-dev/PDF/Restoration/Triple%20L%20Concept%20note.pdf
Tscharntke, T., Klein, A.-M., Kruess, A., Steffan-Dewenter, I., & Thies, C. (2005). Landscape perspectives on agricultural intensification and biodiversity - ecosystem service management. *Ecology Letters*, 8, 857-874.
Tscharntke, T., Bommarco, R., Clough, Y., Crist, T. O., Kleijn, D., Rand, T. A., … Vidal, S. (2008). Conservation biological control and enemy diversity on a landscape scale. *Biological Control*, 45, 238-253.
Tscharntke, T., Tylianakis, J. M., Rand, T. A., Didham, R. K., Fahrig, L., Batáry, P., … Westphal, C. (2012). Landscape moderation of biodiversity patterns and processes - eight hypotheses. *Biological Reviews*, 87, 661-685.
van den Bosch, H., Gitari, J. N., Ogaro, V. N., Maobe, S., & Vlaming, J. 1998. Monitoring nutrient flows and economic performance in African farming systems (NUTMON). III. Monitoring nutrient flows and balances in three districts in Kenya. *Agriculture, Ecosystems and Environment*, 71, 63-80.
van Noordwijk, M., & Brussaard, L. (2014). Minimizing the ecological footprint of food: closing yield and efficiency gaps simultaneously? *Current Opinions on Environmental Sustainability*, 8, 62–70.
van Noordwijk, M., Bayala, J., Hairiah, K., Lusiana, B., Muthuri, C., Khasanah, N., & Mulia, R. (2014*a*). Agroforestry solutions for buffering climate variability and adapting to change. In Fuhrer, J., & Gregory, P. J. (Eds.), *Climate Change Impact and Adaptation in Agricultural Systems.* Wallingford, U.K.: CAB-International, 216-232.
van Noordwijk, M., Namirembe, S., Catacutan, D., Williamson, D., & Gebrekirstos, A. (2014*b*). Pricing rainbow, green, blue and grey water: tree cover and geopolitics of climatic teleconnections. *Current Opinion in Environmental Sustainability*, 6, 41-47.
Veres, A., Peteit, S., Conord, C., & Lavigne, C. (2013). Does landscape composition affect pest abundance and their control by natural enemies? A review. *Agriculture, Ecosystems and Environment*, 166, 110-117.
Wassmann, R., Hien, N., Hoanh, C., & Tuong, T. (2004). Sea level rise affecting the Vietnamese Mekong delta: water elevation in the flood season and implications for rice production. *Climatic Change*, 66, 89–107.
Winqvist, C., Bengtsson, J., Aavik, T., Berendse, F., Clement, L.W., Eggers, S., … Bommarco, R. (2011). Mixed effects of organic farming and landscape complexity on farmland biodiversity and biological control potential across Europe. *Journal of Applied Ecology*, 48, 570-579.
Zaal, F., & Oostendorp, R. H. (2002). Explaining a Miracle: Intensification and the Transition Towards Sustainable Small-scale Agriculture in Dryland Machakos and Kitui Districts, Kenya. *World Development*, 30, 1271–1287.

Stream in West Java (Indonesia) upstream of the capital Jakarta, in a landscape providing bottled drinking water, tourism options and horticulture.
Photo credit: Meine van Noordwijk

CHAPTER 13

Water-focused landscape management

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Highlights

- Water and watershed management are among the oldest 'landscape approaches'
- The way land and land cover interacts with the full hydrological cycle is still 'science in progress'
- The blending of local and external knowledge is essential for effective management
- Beyond rules and economic incentives, the social basis for collective action is key to success
- Current integrated watershed projects may need stronger performance-based management

1. Introduction: water, landscapes and collective action

The way water flows and shapes the surface of the Earth, interacting with all forms of life, is often used as the defining element of a landscape. Landscapes are 'lifescapes': the space within which human lives can run their course; without access to water no humans can live. The archetypical landscape that we see as beautiful includes clean water, trees in an accessible, half-open terrain, and sources of food and physical security (Dutton, 2010). Beyond artistic beauty, sense of place and identity, water is of key importance to many aspects of human life.

Several elements have gradually been added to what became a need for 'integrated water management' (van Noordwijk et al., 2007), dealing with many tradeoffs among interests. In many types of terrain, water courses are preferred entry routes into landscapes as well as supporting transport for trade with the outside world. Changes to water flows and quality also became one of the first obvious environmental impacts of human land use, and as such, the basis for conflicts and social institutions to contain these. With increasing scale, the physical and social concepts dealing with water range through a

valley, the land around a single stream and the links between land tenure and water access that gave rise to a

landscape (in this case, a sub-watershed), the wider area in which all requirements for local livelihoods, except for 'external' trade, are found and can be controlled, and a

watershed, all the land contributing water to a river system, from headwaters to outflow into oceans or large inland lakes (large watersheds are sometimes called 'basins') to a

precipitationshed, all land plus ocean that contributes water vapour to the precipitation (rainfall) over a defined area (for example, a watershed or country) (Keys et al., 2012).

Collective action to modify water flows (Steps 1–4 in Figure 13.1) was the basis for two iconic examples of landscape management: the 'subak' system of regulating use of irrigation water for paddy rice in Bali, Indonesia, fully intertwined with religion and social norms (Lansing, 1987) and the 'polders' of northwest Europe. Effort to keep water out from polders required collective action with attention to the weakest part of the chain (dyke); this has been interpreted as the basis of a non-hierarchical society that seeks consensus in managing landscapes (van de Ven, 1996; Delsen, 2002). Interest in the subak—now recognized as a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage landscape—and its institutions arose from the obvious failure of exogenous models of water management supported by development banks (Lansing, 2009). These had focused on individual gains but ignored ecological feedback through pests and diseases that the subak controlled by imposing synchrony at the landscape scale. Interestingly, simple agent-based rules can account for the emergence of what seems to be complex patterns at the landscape scale and outperform top–down planning based on 'expert' knowledge (Lansing & Miller, 2005). For a similar discussion for an area in Lao, see Coward (1976).

Landscapes integrate a 'theory of place' (understanding of the current situation) and a 'theory of change' (understanding of a dynamic system of how change can be influenced).

A landscape approach emerges when a socio-ecological system is understood as a feedback loop, integrating answers to six key questions (van Noordwijk et al., 2013). Water and watershed management are good examples of how answering these questions, singly and in combination, can contribute insights. A coherent set of methods to help with the various steps of diagnosis and planning for interventions has emerged (Table 13.2) and at the process level, the replicability has been confirmed.

Building on existing syntheses (Agus et al., 2004; Bruijnzeel, 2004; van Noordwijk et al., 2007; Descheemaeker et al., 2013), we briefly introduce six synthetic topics that all inform water-focussed landscape approaches:

1. **So What?**: Basic understanding of the hydrological cycle as captured in 'the colours of water'
2. **Who Decides?**: The basic policy tools for inducing collective action and public benefits: 'carrots, sticks and sermons'
3. **Who Decides? ⇒ Who?**: The interactions between local communities and scientists/experts
4. **Where, What?**: Forest protection versus engineering for restoration and prevention of degradation
5. **Who Cares?**: Have participatory approaches and social objectives in watershed management gone too far?
6. **So What?**: 'Rainbow water' and climatic teleconnections as the new frontier for water-focused land management

Table 13.1 Six questions that in combination lead to a basic understanding of water management at the landscape scale and the interactions with other ecosystem services (modified from van Noordwijk et al., 2014*b*)

Theory of place			Theory of change		
Who?	***What?***	***Where?***	***So what?***	***Who cares?***	***Who decides?***
Demography, social stratification in historical and political perspectives	Land-use practices, profitability and water requirements	Landscape structure, water flows and gradients of land-use intensity	Consequences for ecosystem services: water quantity, water quality, flow buffering	Stakeholders of ecosystem services and the way they are organized	Leverage on drivers of change ('carrots, sticks and sermons')

Table 13.2 Methods for various stages of negotiating integrated water management at the landscape scale, referring to the six questions of Table 13.1 (methods are described in van Noordwijk et al., 2013).

Topic Questions	**Exploration** What?, Where?, So what?	**Multiple stakeholder knowledge mapping** Who?, Who cares?, Who decides?	**Scenarios** What?, Where?, So what?, Who cares?	**Negotiations** Who cares?, Who decides?	**Monitoring change** Where?, So what?
Basic context	Participatory Landscape Appraisal (PaLA)				
Water flows in relation to climate		Rapid Hydrological Appraisal (RHA)	Flow persistence analysis (FlowPer)		
Land use effects, interventions		Rapid Landslide Mitigation Appraisal (RaLMA)	Land-use change scenarios (GenRiver)	Conservation auction (Con$erv)	
Incentive systems for inducing land-use change				Multi-scale payments for environmental service paradigms (MuScaPES)	
Water quality monitoring in relation to land-use change					Participatory water quality monitoring (PaWaMo)

2. Insights into water and watershed management

2.1 Colours of water and land-cover management

There is a tradition of describing different parts of the hydrological cycle as different colours. Hydrology started with concerns over, and measurements of, water in rivers and other surface waters, subsequently known as 'blue water' issues. Regularity of flow (avoiding floods and droughts) along with quality (microbial concentrations causing human diseases (*Escherichia coli*), sediment load, biological oxygen demand, nutrient contents, and contaminants) were the first issues to get attention. Where reservoirs were constructed for inter- and intra-annual storage, the total water yield became an additional issue. Urban and industrial water use led to a return flow of polluted ('grey') water to rivers and a need for waste-water treatment. On average, only 40% of rainfall reaches the blue-water stage, with the remainder returning to the atmosphere through plants at, or close by, the location of rainfall. This 'green water' became an issue first when fast-growing trees such as eucalyptus became known for their water consumption, proportional to their growth rate. 'Green-water' use by forest plantations became taxed in South Africa and rules against eucalyptus near watercourses were adopted in East African countries out of concern for dry-season flows of streams and rivers. Full understanding of the hydrological cycle, in which no losses occur, only transfers between pools, led to the re-emergence of interest in, and new methods for, quantifying the role of evapotranspiration over land in contributing to rainfall on the same continent (van der Ent et al., 2010). van Noordwijk et al. (2014*a*) coined the term 'rainbow water' for water vapour in the sky, whether from oceanic or terrestrial origin, that potentially becomes rainfall.

Blue, grey, green and rainbow water can be influenced by land cover, depending on its seasonal pattern of water use, its direct protection of soil from the effects of rainfall and sunshine, and its rooting pattern and associated depth of actively buffering soil profile (van Noordwijk et al., 2014b). The primary step in managing both blue and green water is still the choice and management of land cover because it influences canopy interception, water use and litter-layer dynamics as protectors of soil from splash erosion and as primary filters for incoming overland flow (Hairiah et al., 2006). While forests generally use more water than other vegetation, partial forest cover has a more than proportional effect in reducing annual stream flow: at 20% and 40% forest cover (van Dijk et al., 2012) reported 35% and 55% of the reduction of stream flow that full forest cover would induce. Lateral resource flows cause such non-linear response functions to changes in forest cover (van Noordwijk et al., 2004). Increased water use and increased infiltration related to forest cover lead to lower flooding risks at stream or sub-catchment levels, but the often presumed role of forests in protecting from large floods remains debated (van Dijk et al., 2009; see Box 13.1 on flow buffering).

Deep-rooted vegetation protects slopes from shallow landslides (Sidle et al., 2006), but increased infiltration in forests can increase the risk of deep landslides. The early years after deforestation have a high landslide risk, further enhanced by road construction; increased land degradation reduces infiltration and hence a greater risk of landslides. Verbist et al. (2010) compared the processes that control sediment transport (as a result of erosion and sedimentation) at various scales in a sub-watershed and found that riverbank stability and road-based erosion were prominent in processes at the medium

Box 13.1

Buffering of river flow: combining local and hydrological understanding?

The most common explanation people living downstream give of what watershed degradation means to them is that river flow becomes less predictable (more erratic), that even moderate rainfall leads to 'flash floods', and that streams dry up more rapidly in the dry season. This synthetic description of water flow dynamics is captured in the 'flow persistence' or buffering indicator (van Noordwijk et al., 2011).

An algorithm is now available for estimating this flow persistence parameter (p) from even a limited time series of daily river discharge (Q) measurements:

$$Q_{t+1} = p\,Q_t + (1\text{-}p)\text{ Rainfall}$$

The fraction of rainfall that reaches the river on the first day equals 1 minus the flow persistence factor.

Table 13.1 Fraction of rainfall that reaches the river on the day of rainfall and in the first week after rain.

P	0.99	0.98	0.95	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
% Day 1	1	2	5	10	20	30	40	50	60	70	80	90
% 1st week	5.9	11.4	26.5	46.9	73.8	88.2	95.3	98.4	99.6	99.9	100.0	100.0
Rating	Well-functioning upper watersheds						Degraded watersheds			Severely degraded		

Note: Expressed as a function of the flow persistence factor (p) and a tentative rating of well-functioning ($p > 0.7$) versus degraded ($p < 0.7$) watersheds (van Noordwijk et al., 2011).

If the flow persistence index changes from 0.8 to 0.6 peak flows directly after rain double (from 20 to 40% of rainfall). The index is a good candidate for performance-based contracts for watershed rehabilitation. It monitors decline and recovery but between-year variation, due to specific rainfall patterns, can be about 0.1, implying that data for several years are needed before a trend (downward or upward) can be firmly established.

scale, replacing hill-slope erosion as the primary explanation for sediment loads in rivers. Exclosure areas protected from grazing downhill of eroding areas can be substantial sediment filters. Descheemaeker et al. (2006) found that in Tigray, Ethiopia, mean sediment deposition rates ranged between 26 and 123 ton (t)/hectare (ha)/year (yr), with dark soils rich in organic matter being formed. Nyssen et al. (2014) documented changes in land cover over a 100-year period in northern Ethiopia and found that more trees and conservation structures occurred where there was high population density. Overall, the northern Ethiopian highlands are greener than at any time in the last 145 years.

Initial problems with many of the watershed functions when natural forests are converted may, over time, be largely resolved if appropriate perennial vegetation, including trees, is established. However, the experience with reforestation based on monoculture tree plantations is mixed at best (Scott et al., 2005). A recent study of reforestation in Nepal demonstrated negative effects not only on total water yield, but also on dry season flows (Ghimire, 2014; Ghimire et al., 2014). Increased 'green-water' use can, however, now be interpreted as increased rainbow-water contributions to rainfall elsewhere.

2.2 Sticks, carrots and sermons as governance instruments for inducing collective action and public benefits

Governance systems have three basic types of instruments: 1) regulations that establish rights and require enforcement, 2) economic incentives to partially internalize externalities when making decisions (based on payments, fines, taxes, tax rebates, market mechanisms), and 3) moral suasion aimed at internalization into the basic value systems and social norms of behaviour.

The primary level deals with rights and regulation. Most of the existing 'water policy' is in fact blue-water policy, even though globally only about 40% of rainfall reaches the blue-water stage. Depending on the historical roots of existing legislation in a country (Bate & Tren, 2002; van Noordwijk, 2005), the rules for access to, and sharing of, surface water are primarily based on a combination of concepts that define water as either a

private good, which is often associated with land rights where a 'settler' principle assigns the rights to water to the first user (or their inheritors) and which might be restricted to stagnant water and periodic streams; a

club good, which is riparian rights to share access to water along with obligations to jointly manage water quality by all countries, communities or private landowners harbouring, or bordering, a river; or a

public good, in which rights to clean water for all inhabitants of a country (or the planet) are being articulated as a part of human rights.

Within the public-goods perspective, incentives for behaviour that respects the rights and interests of others follow the general aspects of 'altruism': they require, and further enhance, a sense of joint identity and shared interests at the interface of public and club goods (van Noordwijk et al., 2012). There is some empirical evidence for crowding out social norms of behaviour when financial payments are introduced, with a risk of negative long-term effects if payments cannot be maintained.

Negotiations can shift aspects of water policy between these categories (Bruns & Meinzen-Dick, 2000). The gradual emergence of markets for tradable rights of use (Rosegrant & Binswanger, 1994) with associated rights to pollute has become part of a set of public-policy experiments in 'payments for environmental services' (PES), with rather mixed results on achieving a desirable level of collective action for protecting and managing water as a public good (Landell-Mills & Porras, 2002).

Three conceptual underpinnings of the broader PES concept are now recognized (van Noordwijk & Leimona, 2010), which are:

commoditization, which is mostly linked to tradable private rights;

compensation, which is mostly linked to club goods (but can also be private) and voluntary or mandatory restrictions of land use; and

co-investment, which is aimed at establishing trust and potentially leading to stronger articulation of rights and other instruments.

Existing payments or rewards for watershed services' schemes in Asia and Africa are mostly of the co-investment type (Lopa et al., 2012; Minang & van Noordwijk, 2013; Namirembe et al., 2014; see Box 13.2 on River Care). Across all PES-related instruments, a balancing act is needed to secure both fairness and efficiency (Table 13.3).

Table 13.3 Four key dimensions to understand the spectrum of governance instruments for enhancing watershed functions of landscapes in ways that are both efficient and fair (modified from van Noordwijk, 2005; van Noordwijk & Leimona, 2010).

Efficiency	⇔		Fairness
Conditional	**Realistic**	**Voluntary**	**Pro-poor**
Performance-based at various levels: • watershed outcome • condition of land • activity and inputs • planning & management	Avoided degradation and/or active restoration that improves water quality and increases flow buffering, dry-season flows and/or total water yield at specified, strategic locations within a targeted area	Free and prior informed consent at the community level and negotiated contracts with individuals directly involved and/or affected; mandatory where large public interests justify such, with adequate compensation	Recognition of perceptions, preferences and interests of all stakeholders regardless of wealth, gender, ethnicity; preferential treatment for underprivileged

Box 13.2

River Care

The Way Besai hydroelectricity power company ('PLTA') operates in Sumberjaya, Sumatra, Indonesia. The PLTA has problems with high sediment flow into its relatively small reservoir, as do many other hydroelectric dams around the world. In this case, an annual budget of USD 1 million a year was needed to clean sediment from the reservoir. Therefore the mother company was open to suggestions that there might be cheaper ways to prevent sediment from reaching the reservoir in the first place.

The Rewarding Upland Poor for Environmental Services (RUPES) project coordinated by the World Agroforestry Centre set up a pilot project with the community in one sub-catchment at Buluh Kapur village. Farmers identified current sources of sediment flow, and constructed check dams and drainage along pathways. RUPES helped with the technical sediment monitoring and calculations. The principle underlying the contract between the two parties was 'conditionality', which meant that the River Care group would receive payments if they met the condition of reducing the load of sediment in the river: the target was a reduction of 30% with a reward of USD 1000. But lesser achievements would also be recognised: USD 700 for a 20–30% reduction; USD 500 for 10–20%; and USD 250 for less than 10%.

By the time the project reached its agreed end, the community had executed the contract with an 86% activity success rate, which was high, demonstrating the villagers' commitment. Analysis of sediment concentration by the RUPES team, however, showed only a 20% decrease by comparison with the initial baseline. The PLTA nevertheless appreciated the community's efforts in reducing the sediment concentration in the Air Ringkih River and provided a micro-hydropower unit as a reward, bringing electricity to the village. This appreciation had a big impact on the community. They were inspired to continue to improve their watershed. A next round was also successful in securing co-investment and the programme is currently being scaled-up to all watersheds with hydropower generation in Sumatra.

2.3 Scientists and experts interaction with local communities

Within the 'realistic' dimension of governance instruments, the target is to achieve activities that lead to avoided degradation or active restoration of, preferably measurable, watershed services that matter. At the start of engagement there may be a wide divergence between the various knowledge systems. As a first step, an exploration of how different the knowledge and knowledge systems (which include pathways to learning) are between various groups of local stakeholders, the public discourse and associated policy debates, and scientists from a wide range of disciplines is needed (Jeanes et al., 2006). A recent summary of such scoping studies in Indonesia (Leimona, 2011) concluded that there were indeed considerable knowledge and perception gaps. Local community members sought location-specific solutions while public/policy stakeholders referred to generic solutions, such as 'reforestation'. The attention policymakers gave to the role of 'forest' in providing beneficial watershed services and to 'deforestation' as the cause of problems did not match the perception of those living in the landscape (Joshi et al., 2004; Verbist et al., 2010). Cross-site analysis showed that the reality check provided by the knowledge-integration approach presented rich information on causes of location-specific watershed problems and fine-tuned solutions that allow people to continue to live in the landscape.

In the past, governments relied primarily on technical expertise to advise on the most effective and efficient course of action to achieve publicly stated goals. This approach led to conflicts in many landscapes as well as to wrong decisions especially when the vested interests of the technical advisors (for example, advising on the feasibility of dam projects) were not recognized by subsequent decision-makers. In response to conflicts, a negotiation-system approach emerged that includes a multistakeholder negotiation platform (van Noordwijk et al., 2001). To overcome a history of distrust and misunderstanding, the co-creation of 'boundary objects' that can function across multiple knowledge systems and stakeholder groups, are recognized scientifically and yet understandable locally, is now seen to be an essential ingredient for success (Clark et al., 2011). Such boundary objects include agreed methods for monitoring the initial condition and subsequent change (Rahayu et al., 2013).

Sabatier et al. (2005) and Bulkley (2011) analyzed how a more integrative, consensus-oriented approach to watershed management evolved in parts of Europe and North America, replacing a set of technical agencies that had been set up to handle specific aspects (such as various types of pollution and water flow regulation), often in competitive mode. Collaborative approaches, including multiple stakeholders and sources of information, are increasingly used to address challenging environmental problems; building social capital helps in reaching agreements but subsequent implementation is not guaranteed without funding and effective coordination (Koontz & Newig, 2014). A similar process may have been slower to emerge in a developing country context (Gupta, 2014), where social gaps are wide and bureaucracies well entrenched.

2.4 Forester plus engineer

Watershed management has interacted with many scientific disciplines but an important historical debate that still resonates is that between the forester and the engineer (Galudra & Sirait, 2009). Foresters emphasized the paramount role that forests play in watershed services and used concerns about watershed functions as a support for their political control over a large part of a landscape. Engineers saw many technical opportunities to regulate and improve water flows and buffering with canals, dams, reservoirs, diversions and modifications of the riverbed. They offered two very different 'theories of change', aimed at the common goal of supporting intensified agriculture with full access to technical irrigation and drainage.

In the early 20th century a magic number emerged of '30% forest' as a requirement for a healthy watershed (initially based on research on gradual snowmelt in the Alps, with forests delaying water flows in spring), which served as a political compromise. It is still quoted in legislation even though there was, and is, no substantiation of this (or any other) number.

It took time for both foresters and engineers to appreciate and understand the positive roles that partial tree cover in agroforestry systems managed by smallholders can play for measurable watershed functions (Agus et al., 2004). Current progress in integrated watershed management has roles for both the forester and the engineer and there is progress in methods to dissect their respective contributions to watershed restoration and improvement (Ma et al., 2014).

2.5 Have participatory approaches and social objectives gone too far?

India and China probably have between them by far the most experience with forms of 'integrated watershed management' but have taken different routes. The destructive Yangtze floods of 1998 (Yu et al., 2009) gave rise to the world's largest PES scheme in the form of the sloping land conversion programme, although it has been challenged on all the axes of whether it is realistic, conditional, voluntary and pro-poor (Bennett, 2008). Initially using rice surpluses from the lowlands, farmers in the uplands were compensated with annual rice supplies if they agreed to reconvert their farms on steep sloping land to forest. Technical challenges in project implementation concerned the choice of tree species (monocultures or mixtures), rules against intercropping with annual crops (with biannual medicinal ones accepted as a borderline case) and the need to accommodate, post-hoc, local initiatives and preferences within a rigid top–down form of project implementation (however, location-specific variation proved to be possible where local officials developed relationships with local communities; Xu et al., 2010).

Meanwhile, the experience in India with watershed management projects started from a much more participatory and multi-sectoral basis. Covering a large part of the country, the programme shifted more and more towards addressing local needs. However, a recent evaluation of actual changes in land cover could not find any evidence of the effectiveness of the programme and the opinion was expressed that the programme had shifted too far towards satisfying social goals, ignoring hydrological restoration (Bhalla et al., 2013). Conversely, in China, the country with the strongest top–down governance tradition, programmes allowing conversion of sloping forest lands without trees to agroforests based on the initiative of local farmers' groups proved to be a major success (Xu et al., 2012), satisfying local needs as well as achieving environmental improvements.

2.6 Rainbow water as the new frontier

Evapotranspiration implies a local 'loss' of water for areas 'downstream' but the water vapour might return as rainfall in neighbouring 'upwind' areas and ultimately as river flow, depending on topography. Recent recognition of rainbow water adds another dimension to the scale at which the hydrological cycle can, and must, be managed.

Including downwind beneficiaries of recycled rainfall in discussions on how to balance blue-and-green water needs will certainly add to the complexity (Keys et al., 2012; van Noordwijk et al., 2014*a*) but ignoring the complexity does not reduce the influence. The issue has long since been debated for the Amazon basin but similar relationships appear to hold between East, Central and West Africa, between Myanmar and China, and possibly on the island of Borneo, in contrast with the rest of the Indonesian archipelago.

Williamson et al. (2014) provided an example where a change in more local rainfall recycling by loss of forest cover from an East African watertower shifted water over a watershed boundary, reducing availability on one side and increasing it on the other. Once such hydrological effects become known, the political consequences and conflicts may be substantial. It is important that the scientific basis of such claims is quickly investigated.

3. Discussion

Integrated watershed management as one of the main pillars on which a new landscape approach can build, needs simultaneous answers to the six questions of Table 13.1. Over time, water-focussed landscape management has learned to deal with these six aspects of the management cycle for the increasing complexity of issues, as a quick summary in Figure 13.1 suggests.

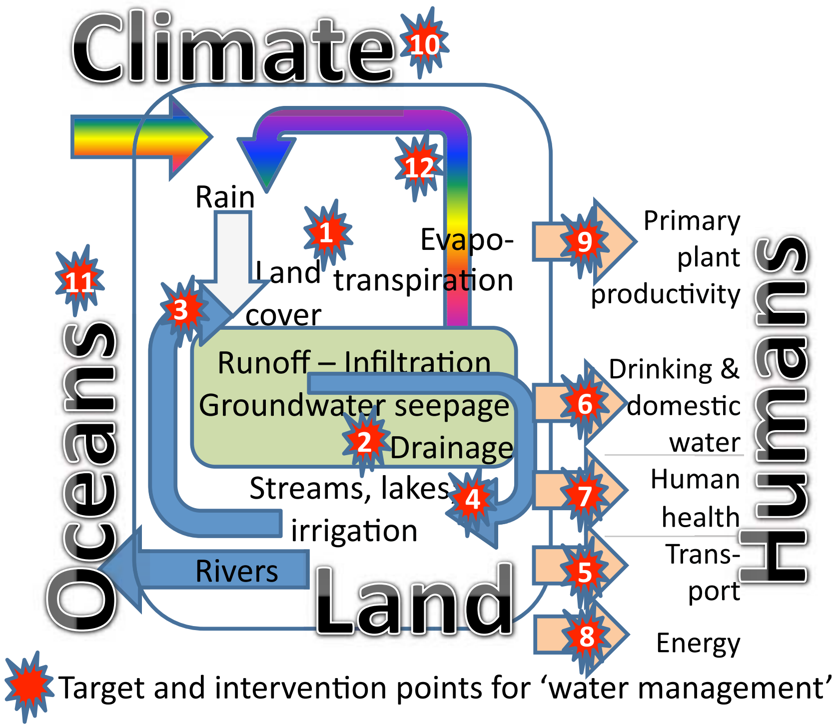

Figure 13.1 Schematic representation of the hydrological cycle between oceans and land with twelve targets and intervention points that have over time been included in 'integrated water management' discussions.

Points 1-4 are related to the way the watershed managers intervene to achieve desirable watershed management outcomes.

1. Modifying land cover to increase harvestable vegetation, hunting, homesteads/villages/cities/roads, with impacts on surface runoff, erosion, sedimentation, annual water balance and plant growth.
2. Drainage, making land more suitable for desirable plants, controlling disease pressures, etc.
3. Irrigation, providing water when needed for the growth of desirable plants.
4. Modifying riverbeds, associated wetlands, lakes, creating artificial reservoirs, to increase water availability for other uses (see points 3, 6, 9).

Points 5-9 are desired outcomes of integrated watershed management focusing on the goal of improving quality and increasing quantity of water for specific users.

5. Surface water as a means of transport, with all its military, political and commercial implications.
6. Water for domestic and industrial use, with associated pollution concerns ('grey water').
7. Human health, concerning safe drinking water, hygiene and control of water-borne diseases.
8. Use of flowing water as a source of mechanical and electrical power.
9. Increased plant productivity for agriculture and forestry and associated concerns over the 60% of rainfall that recycles to the atmosphere as 'green water' without reaching the 'blue water' stage.

Points 10-12 are more recent additions that relate the watershed to the global hydrological cycle.

10. Concern over global climate change, with parts of the world getting wetter, others drier, and all parts more uncertain about future rainfall, and warming implying an increase in the need for water.
11. Concern over the health of oceans in relation to land (marine productivity, pollution) and associated climate effects.
12. 'Rainbow-water' relationships between terrestrial evapotranspiration and its recycling in rainfall elsewhere ('teleconnections'), as well as meso-scale climatic effects (van Noordwijk et al., 2014*a*).

The processes of water flow through landscapes are relatively well understood (with the exception of the atmospheric part of the hydrological cycle contributing to rainfall). Yet standard recipes for watershed management and default values, such as "we need at least 30% forest cover" or "reforestation always helps", have not contributed to positive change. More fine-tuning in local contexts is needed, with an active learning loop that builds on local experience, beyond generic methods and concepts that can be borrowed from elsewhere.

The current challenge is to ensure that water is always included as a 'co-benefit' when other concerns (such as climate-change adaptation, biodiversity, greenhouse gas emissions) drive the process or, vice versa, include such concerns into an ever-more integrated approach to watershed management at the landscape scale.

References

Agus, F., Farida, & van Noordwijk, M. (Eds.) (2004). Hydrological Impacts of Forest, Agroforestry and Upland Cropping as a Basis for Rewarding Environmental Service Providers in Indonesia. Proceedings of a workshop in Padang/Singkarak, West Sumatra, Indonesia. 25-28 February 2004. Bogor, Indonesia: ICRAF-SEA.

Bate, R., & Tren, R. (2002). The cost of free water: *The global problem of water misallocation and the case of South Africa.* Johannesburg: Free Market Foundation.

Bennett, M. T. (2008). China's sloping land conversion program: Institutional innovation or business as usual? *Ecological economics, 65*(4), 699-711.

Bhalla, R. S., Devi Prasad, K. V., & Pelkey, N.W. (2013). Impact of India's watershed development programs on biomass productivity. *Water Resources Research, 49*(3), 1568-1580.

Bruijnzeel, L. A. (2004). Hydrological functions of tropical forests: not seeing the soil for the trees?, *Agriculture, Ecosystems & Environment*, 104, 185–228.

Bruns, B. R., & Meinzen-Dick, R. S. (Eds.) (2000). *Negotiating water rights.* New Delhi: Vistaar Publications.

Bulkley, J. W. (2011). Integrated watershed management: past, present, and future. *Journal of Contemporary Water Research and Education, 100*(1), 3.

Clark, W. C., Tomich, T. P., van Noordwijk, M., Guston, D., Catacutan, D., Dickson, N. M., & McNie, E. (2011). Boundary work for sustainable development: natural resource management at the Consultative Group on International Agricultural Research (CGIAR). *Proceedings of the Natural Academy Sciences*. doi:10.1073/pnas.0900231108

Coward, Jr. E. W. (1976). Indigenous organisation, bureaucracy and development: The case of irrigation. *The Journal of Development Studies, 13*(1), 92-105.

Delsen, L. (2002). *Exit polder model?: socioeconomic changes in the Netherlands.* USA: Greenwood Publishing Group.

Descheemaeker, K., Nyssen, J., Rossi, J., Poesen, J., Haile, M., Raes, D., ... & Deckers, S. (2006). Sediment deposition and pedogenesis in exclosures in the Tigray Highlands, Ethiopia. *Geoderma, 132*(3), 291-314.

Descheemaeker, K., Bunting, S. W., Bindraban, P., Muthuri, C., Molden, D., Beveridge, M., ... & Jarvis, D. I. (2013). Increasing water productivity in agriculture. In Boelee, E. (Ed.) *Managing water and agroecosystems for food security*, CABI,104-123.

Dutton, D. (2010). A Darwinian theory of beauty. TED talk. Retrieved 20 September 2014 from http://www.ted.com/talks/denis_dutton_a_darwinian_theory_of_beauty?language=en

Galudra, G., & Sirait, M. (2009). A discourse on Dutch colonial forest policy and science in Indonesia at the beginning of the 20th century. *International Forestry Review, 11*(4), 524-533.

Ghimire, C. P. (2014). Hydrological impacts of reforesting degraded pasture land in the Middle Mountain Zone, Central Nepal, Ph.D. Dissertation. Amsterdam: Vrije Universiteit (FALW-VUA).

Ghimire, C. P., Bruijnzeel, L. A., Lubczynski, M. W., & Bonell, M. (2014). Negative trade-off between changes in vegetation water use and infiltration recovery after reforesting degraded pasture land in the Nepalese Lesser Himalaya. *Hydrology and Earth System Sciences Discussions, 11*(3), 3437-3479.

Gupta, S. (2014). Worlds apart? Challenges of multi-agency partnership in participatory watershed development in Rajasthan, India. *Development Studies Research, 1*(1), 100-112.

Hairiah, K., Sulistyani, H., Suprayogo, D., Widianto, Purnomosidhi, P., Widodo, R. H., & van Noordwijk, M. (2006). Litter layer residence time in forest and coffee agroforestry systems in Sumberjaya, West Lampung. *Forest Ecology and Management*, 224, 45-57.

Jeanes, K., van Noordwijk, M., Joshi, L., Widayati A., Farida, & Leimona, B. (2006). Rapid *Hydrological Appraisal in the context of environmental service rewards*. Bogor, Indonesia: World Agroforestry Centre - ICRAF, SEA Regional Office.

Joshi, L., Schalenbourg, W., Johansson, L., Khasanah, N., Stefanus, E., Fagerström, M. H., & van Noordwijk, M. (2004). Soil and water movement: combining local ecological knowledge with that of modellers when scaling up from plot to landscape level. In: van Noordwijk, M., Cadisch, G., & Ong, C.K. (Eds.) *Belowground Interactions in Tropical Agroecosystems*. Wallingford, UK: CAB International, 349-364.

Keys, P. W., van der Ent, R. J., Gordon, L. J., Hoff, H., Nikoli, R., & Savenije, H. H. G. (2012). Analyzing precipitation sheds to understand the vulnerability of rainfall dependent regions. *Biogeosciences*, 9, 733–746.

Koontz, T. M., & Newig, J. (2014). From Planning to Implementation: Top-Down and Bottom-Up Approaches for Collaborative Watershed Management. *Policy Studies Journal, 42*(3), 416-442.

Lansing, J. S. (1987). Balinese “water temples” and the management of irrigation. *American Anthropologist, 89*(2), 326-341.

Lansing, J. S. (2009). *Priests and programmers: technologies of power in the engineered landscape of Bali*. USA: Princeton University Press.

Lansing, J. S., & Miller, J. H. (2005). Cooperation, games, and ecological feedback: some insights from Bali. *Current Anthropology, 46*(2), 328-334.

Landell-Mills, N., & Porras, I. T. (2002). *Silver bullet or fools' gold?: a global review of markets for forest environmental services and their impact on the poor.* London: International Institute for Environment and Development.

Leimona, B. (2011). Fairly efficient or efficiently fair: success factors and constraints of payment and reward schemes for environmental services in Asia. PhD Thesis. Wageningen, Netherlands: Wageningen University.

Lopa, D., Mwanyoka, I., Jambiya, G., Massoud, T., Harrison, P., Ellis-Jones, M., ... & Burgess, N. D. (2012). Towards operational payments for water ecosystem services in Tanzania: a case study from the Uluguru Mountains. *Oryx, 46*(01), 34-44.

Ma, X., Lu, X., van Noordwijk, M., Li, J. T., & Xu, J. C. (2014). Attribution of climate change, vegetation restoration, and engineering measures to the reduction of suspended sediment in the Kejie catchment, southwest China. *Hydrology Earth System Sciences*, 18, 1979–1994. Retrieved from www.hydrol-earth-syst-sci.net/18/1979/2014/

Minang, P. A., & van Noordwijk, M. (2013). Design challenges for achieving reduced emissions from deforestation and forest degradation through conservation: Leveraging multiple paradigms at the tropical forest margins. *Land Use Policy*, 31, 61-70.

Namirembe, S., Leimona, B., van Noordwijk, M., Bernard, F., & Bacwayo K. E. (2014). Co-investment paradigms as alternatives to payments for tree-based ecosystem services. *Current Opinion in Environmental Sustainability*, 6, 89–97.

Nyssen, J., Frankl, A., Haile, M., Hurni, H., Descheemaeker, K., Crummey, D., ... Poesen, J. (2014). Environmental conditions and human drivers for changes to north Ethiopian mountain landscapes over 145 years. *Science of The Total Environment,* 485, 164-179.

Rahayu, S., Widodo, R. H., van Noordwijk, M., Suryadi, I., & Verbist, B. (2013). *Water monitoring in watersheds*. Bogor, Indonesia: World Agroforestry Centre (ICRAF) SEA Regional Program.

Rosegrant, M.W., & Binswanger, H. P. (1994). Markets in tradable water rights: potential for efficiency gains in developing country water resource allocation. *World development, 22*(11), 1613-1625.

Sabatier, P., Focht, W., Lubell, M., Trachtenberg, Z., Vedlitz, A., & Matlock, M. (2005). *Swimming Upstream: Collaborative Approaches To Watershed Management.* Cambridge, MA: Massachusetts Institute of Technology.

Scott, D. F., Bruijnzeel, L. A., & Macksensen, J. (2005). The hydrological and soil impacts of forestation in the tropics. In Bonell, M., & Bruijnzeel, L. (Eds.) *Forest, Water and People in the Humid Tropics.* Cambridge, UK: Cambridge University Press, 622–650.

Sidle, R. C., Ziegler, A. D., Negishi, J. N., Nik, A. R., Siew, R., & Turkelboom, F. (2006). Erosion processes in steep terrain – truths, myths, and uncertainties related to forest management in Southeast Asia. *Forest Ecology and Management,* 224, 199–225.

van de Ven, G.P. (1996). Man-made lowlands: history of water management and land reclamation in the Netherlands. Utrecht, Netherlands: Uitgeverij Matrijs.

van der Ent, R. J., Savenije, H. H. G., Schaefli, B., & Steele-Dunne, S. C. (2010). Origin and fate of atmospheric moisture over continents. *Water Resources Research*, 46, W09525.

van Dijk, A. I. J. M., van Noordwijk, M., Calder, I. R., Bruijnzeel, S. L. A., Schellekens, J., & Chappell, N .A. (2009). Forest-flood relation still tenuous – comment on 'Global evidence that deforestation amplifies flood risk and severity in the developing world' by C.J.A. Bradshaw, N.S. Sodi, K. S-H. Peh and B.W. Brook. *Global Change Biology*, 15, 110-115.

van Dijk, A., Peña-Arancibia, J. L., & Bruijnzeel, L. A. (2012). Land cover and water yield: inference problems when comparing catchments with mixed land cover. *Hydrology and Earth System Sciences, 16*(9), 3461-3473.
van Noordwijk, M. (2005). *RUPES typology of environmental service worthy of reward*. Bogor, Indonesia: World Agroforestry Centre.
van Noordwijk, M., & Leimona, B. (2010). Principles for fairness and efficiency in enhancing environmental services in Asia: payments, compensation, or co-investment? *Ecology and Society, 15*(4), 17. Retrieved from http://www.ecologyandsociety.org/vol15/iss4/art17/
van Noordwijk, M., Tomich, T. P., & Verbist, B. (2001). Negotiation support models for integrated natural resource management in tropical forest margins. *Conservation Ecology, 5*(2): 21. Retrieved from http://www.consecol.org/vol5/iss2/art21
van Noordwijk, M., Poulsen, J., & Ericksen, P. (2004). Filters, flows and fallacies: Quantifying off-site effects of land use change. *Agriculture, Ecosystems and Environment*, 104, 19-34.
van Noordwijk, M., Agus, F., Verbist, B., Hairiah, K., & Tomich, T. P. (2007). Managing Watershed Services in Ecoagriculture Landscapes. In Scherr, S. J., & McNeely, J. A. (Eds.) *Farming with Nature: The Science and Practice of Ecoagriculture*. Washington, DC: Island Press, 191 - 212.
van Noordwijk, M., Widodo, R. H., Farida, A., Suyamto, D., Lusiana, B., Tanika, L., & Khasanah, N. (2011). *GenRiver and FlowPer: Generic River and Flow Persistence Models. User Manual Version 2.0.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.
van Noordwijk, M., Leimona, B., Jindal, R., Villamor, G. B., Vardhan, M., Namirembe, S., ... & Tomich, T. P. (2012). Payments for environmental services: evolution toward efficient and fair incentives for multifunctional landscapes. *Annual Review of Environment and Resources, 37*, 389-420.
van Noordwijk, M., Lusiana, B., Leimona, B., Dewi, S., & Wulandari, D. (Eds.) (2013). *Negotiation-support toolkit for learning landscapes*. Bogor, Indonesia. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.
van Noordwijk, M., Namirembe, S., Catacutan, D. C., Williamson, D., & Gebrekirstos, A. (2014a). Pricing rainbow, green, blue and grey water: tree cover and geopolitics of climatic teleconnections. *Current Opinion in Environmental Sustainability*, 6, 41-47.
van Noordwijk, M., Bayala, J., Hairiah, K., Lusiana, B., Muthuri, C., Khasanah, N., & Mulia, R. (2014b). Agroforestry solutions for buffering climate variability and adapting to change. In: Fuhrer, J., & Gregory, P. J. (Eds.) *Climate change Impact and Adaptation in Agricultural Systems*. Wallingford, UK: CAB-International, 216-232.
Verbist, B., Poesen, J., van Noordwijk, M., Suprayogo, D., Agus, F., & Deckers, J. (2010). Factors affecting soil loss at plot scale and sediment yield at catchment scale in a tropical volcanic agroforestry landscape. *Catena, 80*(1), 34-46.
Williamson, D., Majule, A., Delalande, M., Mwakisunga, B., Mathé, P. E., Gwambene, B., & Bergonzini, L. (2014). A potential feedback between landuse and climate in the Rungwe tropical highland stresses a critical environmental research challenge. *Current opinion in environmental sustainability*, 6, 116-122.
Xu, J., Tao, R., Xu, Z., & Bennett, M. T. (2010). China's sloping land conversion program: does expansion equal success? *Land economics, 86*(2), 219-244.
Xu, J., van Noordwijk, M., He, J., Kim, K. J., Jo, R. S., Pak, K. G., ... Ho, M. H. (2012). Participatory agroforestry development for restoring degraded sloping land in DPR Korea. *Agroforestry systems, 85*(2), 291-303.
Yu, F., Chen, Z., Ren, X., & Yang, G. (2009). Analysis of historical floods on the Yangtze River, China: Characteristics and explanations. *Geomorphology, 113*(3), 210-216.

A charcoal burner carbonizing charcoal with an earth mound kiln whose efficiency is as low as 10% in a landscape consisting of farmland, grazing land and woodland remnants in Bugesera, Rwanda. Photo credit: Miyuki Iiyama

CHAPTER 14

Opportunities and challenges of landscape approaches for sustainable charcoal production and use

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Highlights

- As charcoal is among the most commercialized resources in Sub-Saharan Africa, many stakeholders are competing for profit margins at different stages of the value chain from rural supply centres to urban demand centres
- Current charcoal production and use presents serious tradeoffs of socio-economic and environmental outcomes across landscapes, namely, meeting urban energy demands and supporting livelihoods at the cost of multifunctionality of rural landscapes
- Poverty-induced charcoal production and resource degradation are reinforcing each other in the landscape context where counterproductive regulations and non-exclusive tenure conditions intersect to provide incentives for the overexploitation of natural trees
- Resolving tradeoffs and achieving synergies of economic development and sustainable energy provision calls for integrating charcoal into a landscape approach to provide incentives to protect natural resources through inter-sectoral/multi-stakeholder coordination
- Providing a diagnosis through the concept of charcoal economics discussed in this chapter, we propose a landscape approach to address sustainable charcoal production and use through the application of Sayer et al. (2013)'s ten principles for landscape approaches

1. Introduction

The production and use of woodfuel – firewood and charcoal – is an important socio-economic activity in Sub-Saharan Africa (SSA), as over 90% of the population rely on it as primary energy source (Schure et al., 2014*a*; Iiyama et al., 2014*a*). It is also responsible for most of total household energy-related greenhouse gas (GHG) emissions in SSA (Kammen & Lew, 2005). Population growth and urbanization during last few decades has seen a surge in commercial demand for charcoal, as a popular and convenient fuel in urban settlements. Charcoal is perceived to be cleaner and more usable compared with firewood, and more affordable in comparison with modern alternatives such as kerosene and liquid petroleum gas (LPG; Ellegård, 1996; Girard, 2002).

Currently charcoal production and use results in serious tradeoffs between socio-economic and environmental outcomes. Charcoal helps to meet urban energy demands and supports livelihoods of people across the value chain, but at the cost of many functions of rural landscapes. Charcoal is mainly sourced from rural landscapes where alternative economic opportunities are limited. Thus urban charcoal demand has significantly contributed to rural livelihoods through providing income and employment (Schure et al., 2014*a*). In 2011, the charcoal sector in Africa was estimated to produce income of over US$10 billion, against the firewood's US$ 3.7 billion (World Bank, 2011; FAO, 2014). At the same time, as charcoal requires more wood per unit of energy than firewood, it has driven rural land use changes, which depending on the intensity of harvest, either shapes or degrades productive multifunctional landscapes (Chidumayo & Gumbo, 2012; Iiyama et al., 2014*a*). In 2009, wood extraction for firewood and charcoal combined was reported to be one of the major contributors of degradation emissions from African landscapes, accounting for 57% of forest emissions in SSA (Griscom et al., 2009). With further growing demand for charcoal projected in coming decades (Bailis et al., 2005; Brew-Hammond & Kemausuor, 2009; Iiyama et al., 2014*a*), depletion of suitable wood species in landscapes will lead to the shifting of charcoal production frontiers with increasing distances between rural-supply and urban-demand zones thus increasing emissions further (Schure et al., 2014*b*).

In turn, if produced and used sustainably, charcoal can be a renewable fuel, contributing significantly to reducing GHG emissions in SSA while also supplying energy to urban markets and employment to tens of millions of actors across the value chain (Kammen & Lew, 2005; World Bank, 2011). Thus it has a high potential to become a climate-smart technology, especially if synergies are achieved throughout the landscape scale for economic development and sustainable energy provision.

This chapter calls for understanding the mechanisms underlying the current unsustainable charcoal production and use within the wider social, ecological and economic context of SSA landscapes, and identifying challenges and opportunities to transform the charcoal sector for healthy landscapes. Section two initially describes developmental and environmental tradeoffs in SSA rural landscapes. It then attempts to present the 'charcoal economics' to characterize the charcoal sector in SSA from the landscape perspective and to understand the drivers of degradation as well as the tradeoffs between socio-economic and environmental outcomes. Section three critically reviews the past and present approaches to addressing the woodfuel crisis from the point of view of charcoal economics, and derives recommendations for operationalizing landscape approaches (LAs) for sustainable charcoal production and use, followed by summarizing remarks in the conclusion section.

2. Charcoal production and use in landscapes

2.1 Development and environmental tradeoffs in landscapes

SSA rural landscapes consist of mosaics of bushes, grasses and farmlands interspersed with wooded areas. Wooded and shrubby landscapes in SSA support the livelihoods of farmers, agro-pastoralists and pastoralists by providing a set of ecosystem services including: biological products (e.g., food/fruits, fodder, medicines, oils, construction materials, gum, resins and fuel); supporting services (e.g., soil fertility, moisture, biodiversity); regulating services (e.g., micro/macro climate, water/air quality), and cultural/recreational services (de Leeuw et al., 2014). These ecosystem services are essential for the resilience of landscapes and for rural people to adapt to climate change. Landscapes in SSA can also play an important role in climate change mitigation, as they have a potential to store large amounts of carbon. Humid forests save much more biomass above ground per hectare than drylands, which nevertheless are important carbon stocks below ground due to their extensiveness (White & Nackoney, 2003; Skutsch & Ba, 2010).

The needs for development and cash income of a growing population in rural landscapes have driven exploitation of ecosystems, causing degradation of their services at a rate faster than their regeneration. Land clearing for agriculture has been the main driver of deforestation in SSA (Chidumayo & Gumbo, 2012). At the same time, rural landscapes have been subjected to widespread degradation due to uncontrolled livestock grazing as well as woodfuel harvest (Namaalwa et al., 2007; Skutsh & Ba, 2010). Degradation emissions from woodfuel harvest appear to represent the majority of emissions from forests in Africa (Griscom et al., 2009). Landscape-level degradation and loss of biodiversity further exposes ecosystems to climatic hazards (Naughton-Treves et al., 2007), and can lead to a reduction in their capacity to provide essential ecosystem services to support rural livelihoods.

As there are serious concerns about reconciling development and conservation tradeoffs, LAs have increasingly gained prominence in the search for solutions to achieve adaptation and mitigation simultaneously (DeFries & Rosenzweig, 2010; Sayer et al., 2013; Harvey et al., 2013). Before investigating the possibility of applying the LAs to address sustainable charcoal production and use in SSA context, the following sub-section sets the scene to understand the mechanisms underlying current unsustainable practices.

2.2 Charcoal economics: characterizing the charcoal sector in SSA

The charcoal sector in SSA generally shares two contradicting features. Firstly, charcoal is one of the most important commercialized resources and the charcoal trade in SSA contributes to incomes and employment opportunities for rural residents and benefits the national economy along the value chain (World Bank, 2011). Despite that, charcoal production is generally considered informal, even illegal, and highly associated with rural poverty (Mwampamba et al., 2013; Zulu & Richardson, 2013). Secondly, despite the depletion of resources it causes, charcoal supply in SSA has been regarded as highly efficient in meeting the ever-growing urban demand (Hosier & Milukas, 1992; Mwampamba, et al., 2013). To resolve these paradoxes calls for an understanding of the contexts in which charcoal production and use operates, namely, the regulatory environment affecting the value chain on the one hand, and the local tenure conditions governing resource access in rural areas on the other, which simultaneously provides incentives for poverty-driven charcoal production and resource degradation.

2.2.1 Multi-sectoral regulatory environment affecting the value chain

Many stakeholders are involved in different stages of the charcoal value chain which geographically stretches from rural to urban areas. They include farmers, charcoal burners, middlemen, dealers, city traders and urban consumers as well as traditional and official authorities (Schure et al., 2013). At the same time, many SSA countries have formal charcoal rules and regulations, but production and trade are rarely formally recorded, thus, in practice, remain informal (Schure et al., 2013). The charcoal value chain operates in a complex, multi-layered, multi-sectoral regulatory environment. Incoherent legislation from different government departments, such as energy, agriculture, environment, natural resource management and local government, which target the same or different sections of the value chain, result in an unclear framework for stakeholders (Sepp, 2008; Schure et al., 2013; Iiyama et al., 2014*b*). Legislation is, however, rarely effectively enforced, but ends up providing room for corruption. For example, complete bans or licensing systems are often introduced to control off-take and transport of wood (Skutsch & Ba, 2010). These measures penalize producers in the short-term, but are rarely effective in the long-term due to high costs of enforcement in controlling supply activities which are dispersed across mosaics of rural landscapes (Hosier & Milukas, 1992). Rather, these interventions result in exorbitant economic rents accruing at the transport stage of the value chain and

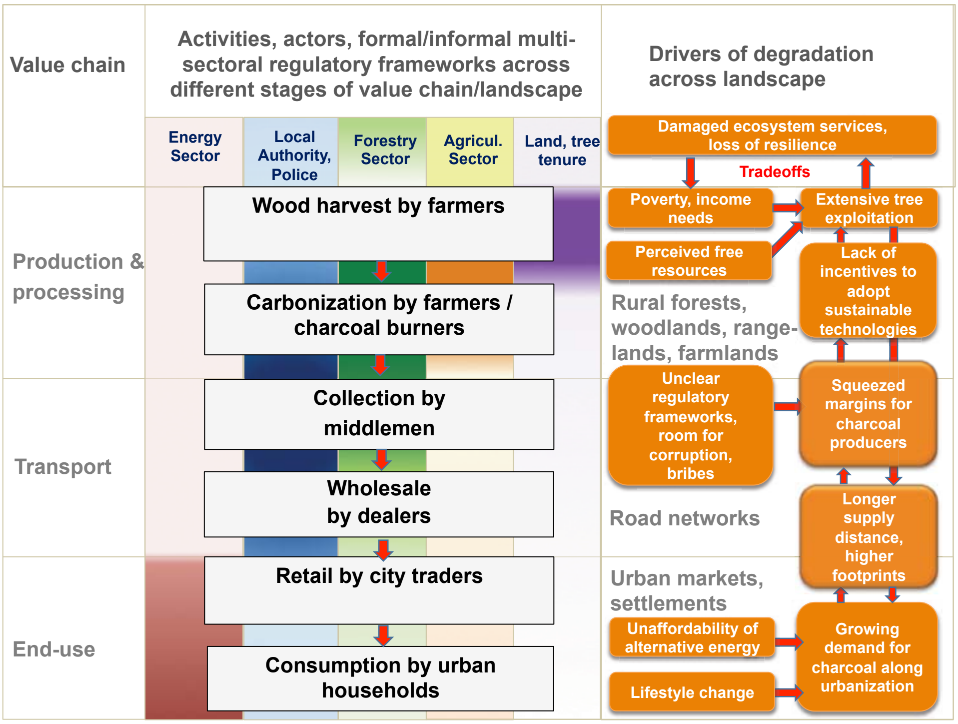

Figure 14.1 Charcoal economics. Rectangles in the centre part of the Figure indicate activities and actors across the different stages of the value chain, which include production & processing, transport, and end-use. These correspond to rural landscapes, road networks and urban markets/settlements respectively. While different government ministries and agencies often have regulations targeting one or a few different stages of the value chain (as shaded darker for each sector), the overlap of responsibilities create an unclear framework (Section 2.2.1). At the same time, in rural landscapes, customary/informal tenure systems govern resource accesses without complete exclusiveness by multiple-stakeholders creating externality problems (Section 2.2.2). The right section of the figure describes the drivers of degradation elaborated in Sections 2.2.3 and 2.3.

in bribes to those engaged in the illicit 'license' trade (Naughton-Treves et al., 2007; Schure et al., 2013). Consequently, farmers gain low returns while urban consumers pay higher prices, as bribes often add up to 20% or more of the final price (Mwampamba et al., 2013).

2.2.2 *Tenure systems governing resource accesses and uses among multiple stakeholders*

Farmers, agro-pastoralists and pastoralists in rural landscapes depend on the same resources in a seamless continuum from woodland, rangeland to farmland. They 'manage' or 'mine' multiple vegetation layers (trees, shrubs and grasses) under either customary regulations and/or formal laws that define their rights of access to the resources (Shepherd, 1991; Namaalwa et al., 2007). In some regions, the land remains communal (Hosier & Milukas, 1992). In other regions, individual or private ownership of farmland is customarily recognized even without title deeds (Siri et al., 2006). Still, access to individual plots is usually not completely exclusive to landowners with neighbours often being allowed to graze livestock as well as to exploit trees and other natural resources after harvesting of crops and during fallows (Siri et al., 2006). Under such conditions, some land use activities may complement each other, for example, farmers clearing areas previously operated by charcoal producers (Namaalwa et al., 2007). At the same time they can create competition for resources, for example, selective cutting of slow-growing hardwood species by charcoal producers depleting fodders for pastoralists, while free grazing by pastoralists hinders natural regeneration of trees (Siri et al., 2006).

2.2.3 *Mechanisms underlying unsustainable charcoal production*

Figure 14.1 summarizes the contexts in which the charcoal sector operates. Planting trees is an inherently risky venture in rural landscapes where the survival rates are low, due to not only harsh climatic conditions, but also damage caused when rural tenure arrangements allow multiple users access to the same resources. Furthermore, priority is often not given to planting trees for charcoal by risk-averse households because slow-growing species are preferred for charcoal production which, along with other results of the poor policy environment, leads to low producer margins. However, charcoal producers will keep exploiting native vegetation on their farms and beyond in extensive landscapes as long as wood can be obtained sufficiently cheaply to ensure adequate private economic returns. As an example, a case study from Tanzania indicates that the charcoal producers perceived their profits to be positive because of their very low capital outlays to fell trees and construct earth mound kilns, their own 'free' labour, 'free' wood, and lack of concern about associated external costs (Luoga et al., 2000). The perception of 'free' labour or the low opportunity cost of labour is attributed to the lack of alternative economic opportunities and low agricultural and market potentials prevalent in rural landscapes (Dewees, 1989; Iiyama et al., 2014*a*). The perception of 'free' wood is due to most costs being treated as economic externalities or the lack of exclusiveness of access to tree resources under prevailing tenure conditions (Hosier & Milukas, 1992; Luoga et al., 2000). Poverty-driven charcoal production and degradation reinforce each other in the landscape context where counter-productive, multi-sectoral regulatory frameworks and non-exclusive tenure conditions interact to provide incentives for over-exploitation of natural trees. Instead of internalizing social costs of degradation, charcoal production keeps exploiting trees by shifting its location into hinterlands.

2.3 Drivers and tradeoffs

Given the contexts outlined above, the factors that drive charcoal consumption and production as well as tradeoffs across landscapes are described below; also see Figure 14.1.

2.3.1 Urban energy demand

Urbanization and economic development are bringing about changes in consumption patterns and increases in household income in SSA, which in turn are leading to major changes in the household energy sector (Girard, 2002). The use of charcoal is preferred by many urban consumers due to its higher energy density per unit weight, cheaper transport costs and relative cleanness, producing less smoke (which causes respiratory diseases) than firewood, although emitting more carbon monoxide. It is also priced more competitively than LPG and kerosene (Ellegård, 1996; Girard, 2002; Bailis et al., 2005). Even where household income is growing and modern energy penetration is increasing, a wide range of socio-economic groups still use charcoal as a backup fuel or the main fuel for preparation of certain foods, and are expected to remain doing so in coming decades (Kammen & Lew, 2005; Brew-Hammond & Kemausuor, 2009). In turn, the use of improved cookstoves, which can significantly save the volume of charcoal used, remains low, around 6% throughout SSA due to the lack of awareness and investment costs (Schure et al., 2014*b*). Owing to low efficiencies of conversion and combustion as well as income effects, urban wood consumption for charcoal well exceeds that for rural subsistence (Kammen & Lew, 2005).

2.3.2 Production to support rural livelihoods

In many SSA countries, the rural populations are too poor to use charcoal (Schure et al., 2014*a*). Nevertheless, commercial charcoal production has pro-poor features because of the low start-up costs, low technology requiring few skills and the 'free' resources that are available. Charcoal revenues contribute substantially to producers' household income, for example, up to 75% in Democratic Republic of Congo (Schure et al., 2014*a*). They support basic needs, investments in other livelihood activities, and even act as a savings account for households to cope with shocks as charcoal can be stored strategically to provide for future spending as well as for price optimization (Schure et al., 2014*a*). On the other hand, the revenues are often neither enough to lift households out of poverty nor to provide them with incentives to adopt sustainable technologies (Zulu & Richardson, 2013; Schure et al., 2014*a*), as producers benefit least at the supply end of the long value chain where complicated regulations and vested interests squeeze profit margins.

2.3.3 Impacts of charcoal production and processing on rural ecosystems

Rapid urbanization has accelerated rural degradation due to the high levels of unsustainable tree cutting for charcoal supply by individual producers across expansive rural landscapes (Chidumayo & Gumbo, 2012; Iiyama et al., 2014*a*). In contrast to firewood for subsistence use, for which deadwood or fast-growing tree species on private land are exploited, charcoal producers generally prefer large-scale felling of slow-growing hardwood species by finding landholders who, either willingly or through coercion, allow natural trees on their lands to be cleared (Naughton-Treves et al., 2007). Furthermore, with the low conversion efficiency of between 8 and 20% of most conventionally used earth kilns, and, depending on water content of wood, the wood required for a unit of charcoal is far greater than that for firewood. This has significant implications on ecosystems (Bailis et al., 2005; Iiyama et al., 2014*a*). The unsustainable harvest results in significant carbon dioxide emissions while pyrolysis also produces incomplete combustibles, such as methane, which may have even a higher global warming impact (Kammen & Lew, 2005). At the same time, selective harvesting of trees at the extraction rate above the capacity for natural regeneration can change the composition of forests/woodlands (Namaalwa et al., 2007). Eventually, the depletion of the wood resources, which multiple stakeholders depend on and derive distinctive goods and services from, can lead to impairing ecosystem functions and resilience, and exposing local communities to climatic and other hazards (Luoga et al., 2000; Naughton-Treves et al., 2007; Skutsch & Ba, 2010; Iiyama et al., 2014*a*).

2.3.4 Implications of growing rural/supply –urban/demand distances

With growing scarcity in the supply of wood for charcoal, the distances travelled and the costs of collection increase and adversely affect rural wood users (Kammen & Lew, 2005). Eventually as the wood resources on a piece of land are exhausted, production sites shift to different supply locations leading to a constantly expanding charcoal catchment area (Hosier & Milukas, 1992), accompanied by downgrading of woodland to bush, and bush to scrub, across landscapes (Arnold & Pearson, 2003). Dwindling supply coupled with increasing distances can increase prices for urban households. Many of those households are unable to switch fuels because of costs and lack of access to alternative energy sources (Schure et al., 2014*b*).

3. Integrating landscape approaches in sustainable charcoal production and use

3.1 Lessons from the past and present

Policies and projects regarding the woodfuel sector have often addressed only parts of the value chain in relative isolation (Schure et al., 2014*b*). Many projects were implemented during the 1970s-80s specifically to address the supply side of the woodfuel crisis. Most of these approaches, however, failed due to their ignorance of incentives affecting woodfuel production in the landscape context (Dewees, 1989; Hosier, 1989; Shepherd, 1991). For example, despite expensive implementation of woodfuel afforestation/reforestation programmes, farmers did not invest in tree planting, and if they did, they opted for commercial poles/timber which fetch higher unit prices than woodfuels (Hosier, 1989). When community forest management (CFM) approaches were used, the cooperative models that were applied tended to define forests and users very narrowly, and rarely controlled the woodfuel supply coming from wider mosaics of landscapes, including fallow farmland (Shepherd, 1991).

As a result of the ‘fatigue’ of past failures, woodfuel has attracted limited interests of national and international policymakers and development agents since the 1990s (Arnold et al., 2006; Schure et al., 2014*b*). Still, counter-productive regulations have kept haunting the charcoal sector (Sepp, 2008; Iiyama et al., 2014*b*). As discussed above, the formalization under already complex multi-layered regulatory frameworks is rarely effective in controlling resources, and rather has adverse distributional effects on producers (Schure et al., 2013), without fundamentally solving incentive problems to adopt sustainable technologies.

Table 14.1 Application of Sayer et al. (2013)'s ten principles for LAs in different woodfuel interventions. A, P and N indicate application, partial application, or no application of a principle respectively, whereas – indicates little information or relevance.

Principles (Sayer et al., 2013)	Afforestation, reforestation[1]	CFM[2]	Charcoal ban, licensing[3]	FMNR[4]
1. Continual learning and adaptive management	-	-	-	-
2. Common concern entry point	P – concerns over woodfuel supply shortage, not necessarily matched by farmers' needs	P – concerns over forest protection, not necessarily matched by farmers' needs	N – aims at controlling economic resources, not promoting development	A – shares concerns over restoration of the productivity of degraded land
3. Multiple scales	P – targets forests or woodlots, ignoring other tree management forms like FMNR	N – has narrow boundary setting of forests	N – addresses only a part of the value chain thus leaving loopholes	A –considers multiple scales - farms, grazing lands, woodlands
4. Multifunctionality	N – ignores multiple utilities which farmers associate with trees	P – often ignores multiple utilities of multiple species across landscapes	N – tries to conserve resources without considering multifunctional values	A – considers multiple functions – provisioning (e.g., fuel, fodder), regulation, etc.
5. Multiple stakeholders	P – often excludes female farmers from decision-making related to tree planting	N – imposes restricted definition of forest boundaries and forest users	N – mainly penalizes producers	A – involves communities (e.g., farmers, pastoralists), government agencies, NGOs
6. Negotiated and transparent change logic	-	P – often imposes inflexible rules over access to resources	N –gives room for corruption by authorities due to asymmetric information	A - jointly identifies priority areas for protection and agrees on physical or social fencing

7. Clarification of rights and responsibilities	-	P – often ignores overlapping customary laws	N – leaves room for corruption by different regulatory authorities	A - transfers tree tenure from state ownership to local ownership
8. Participatory and user friendly monitoring	-	P – often has few incentives for unpaid work until ownership questions settled	-	-
9. Resilience	-	-	-	-
10. Strengthened stakeholder capacity	P – often involves material provision	P – often involves capacity building	-	-

[1] Dewees, 1989; Hosier, 1989 [2] Shepherd, 1991 [3] Schure et al., 2013 [4] Abdirizak et al., 2013; Harvey et al., 2013

In contrast, other approaches not primarily addressing woodfuel supply, but aiming at restoring the productivity of degraded landscapes, have proved effective in significantly improving woodfuel supply in some regions of SSA. A good example of such approaches includes farmer-managed natural regeneration (FMNR) which promotes the systematic regrowth of existing trees or from naturally occurring tree seeds in agricultural, forested and pasture lands. FMNR's basic principles include: tree stumps that are re-sprouting are selected based on the landowner's needs and resources and young trees are protected from animals and people through physical fencing or institutional arrangement to demarcate protected areas from wood cutting, livestock grazing and other agricultural activities (Abdirizak et al., 2013). FMNR is indeed a good example of climate-smart LAs to address adaptation and mitigation synergies (Harvey et al., 2013).

The success of FMNR against the failure of conventional interventions to address woodfuel/charcoal problems can provide a critical lesson. Namely, it is the importance of institutional arrangements for supportive landscape governance and resource tenure to mediate competition and conflict among multiple stakeholders who depend on the same resources. These aspects, in fact, conform to some of the ten principles of the LA outlined in Sayer et al. (2013), especially multiple scale, multifunctionality, multiple stakeholders, negotiated and transparent change logic, and clarification of rights and responsibilities, which the conventional woodfuel/charcoal interventions failed to apply adequately (Table 14.1).

3.2 Landscape approaches for sustainable charcoal production and use

Interestingly, there is a surge of integrated landscape approaches (ILAs) in SSA to address competition and conflict over scarce resources among different sectors or stakeholders through inter-sectoral /multi-stakeholder coordination of activities, policies and investment at a landscape scale (Milder et al., 2014). LAs are potentially relevant frameworks to resolve tradeoffs and to achieve synergies from sustainable charcoal production and use by facilitating the moderation of regulatory/institutional frameworks through inter-sectoral/multi-stakeholder coordination across value chains and landscapes. While many ILAs targeted improving food production, ecosystem conservation and rural livelihoods, however, very few of the existing ILAs explicitly have targeted the charcoal issues so far (Milder et al., 2014).

Box 14.1

Sustainable charcoal production and Sayer et al. (2013)'s ten principles

Designing a LA to facilitate inter-sectoral/multi-stakeholder coordination for the sustainable charcoal production and use shall apply Sayer et al. (2013)'s ten principles as follows:

Cross-cutting issues

- Adopting flexible, continual learning and adaptive management (principle 1: continual learning and adaptive management)
- Understanding the diverse interests of all stakeholders across the value chain/landscapes (principle 5: multiple stakeholders)
- Facilitating the shared recognition of socio-economic (developmental) and environmental outcomes (synergies) of sustainable charcoal and use (principle 2: common concern entry point)

Inter-sectoral coordination to get the policy environment right

- Reviewing all existing formal and informal regulations affecting the charcoal sector, and identifying their effects on access to the resources or markets by stakeholders across different stages of the value chain to determine the scope of formalization, liberalization and decentralization (principle 3: multiple scales)
- Setting up a policy forum where all the relevant ministries – energy, agriculture, forestry, livestock, environment, natural resources, local governments and others – discuss, streamline and harmonize their authority and responsibilities to regulate the charcoal sector as a prerequisite for an enabling policy environment (principle 6: negotiated and transparent change logic)
- Simplifying and harmonizing related regulations dealing with tree access and felling among the relevant authorities at the decentralized local level to ease legal compliance by stakeholders (principle 8: participatory and user friendly monitoring)

Multi-stakeholder management structure to handle externalities

- Setting up a management structure of all the stakeholders involved in and affected by charcoal production, including farmers, agro-pastoralists and pastoralists, as well as local government/extension officers from the relevant ministries, Community-Based Organisations (CBOs)/Non-Governmental Organizations (NGOs), and the most vulnerable (principle 7: clarification of rights and responsibilities)
- Helping the structure to map the resources, rules governing access and use, and conflicts arising from charcoal production and other activities (principle 4: multifunctionality)
- Empowering the structure to facilitate the identification of priority areas for protection and the modalities of social fencing and rotational fallow/harvest of wood for charcoal by the above body (principle 10: strengthened stakeholder capacity)
- Scoping for alternative income opportunities and livelihood activities to compensate for potential loss due to the resource protection, while developing mechanisms of benefit sharing from sustainable charcoal (principle 9: resilience)

Provided the diagnosis through the charcoal economics discussed in this chapter, we propose a LA to address the sustainable charcoal production and use through the application of Sayer et al. (2013)'s ten LA principles (see Box 14.1).

If successfully implemented, a LA for charcoal production and use can contribute to economic development, climate mitigation and adaptation, thus healthy landscapes, as Figure 14.2 presents. Across the transport and production/processing stages in urban-rural transects, little room for corruption and bribes by intermediaries and authorities will lead to higher producers' margins which will give incentives to produce charcoal sustainably as a profitable business enterprise. At the production/supply stage of the value chain in rural landscapes, right valuation of resources to reflect economic scarcities combined with right incentives will enable sustainable management of tree planting and regeneration. Renewable tree stocks then will keep the production frontiers from expanding thus controlling emissions from transport. Furthermore, affordability of alternative energy and efficient devices at the end use stage of the value chain in urban settlements can moderate wood demand for charcoal along with urbanization. The ultimate outcome will be enhanced ecosystem services and improved resilience to ensure sustainable development.

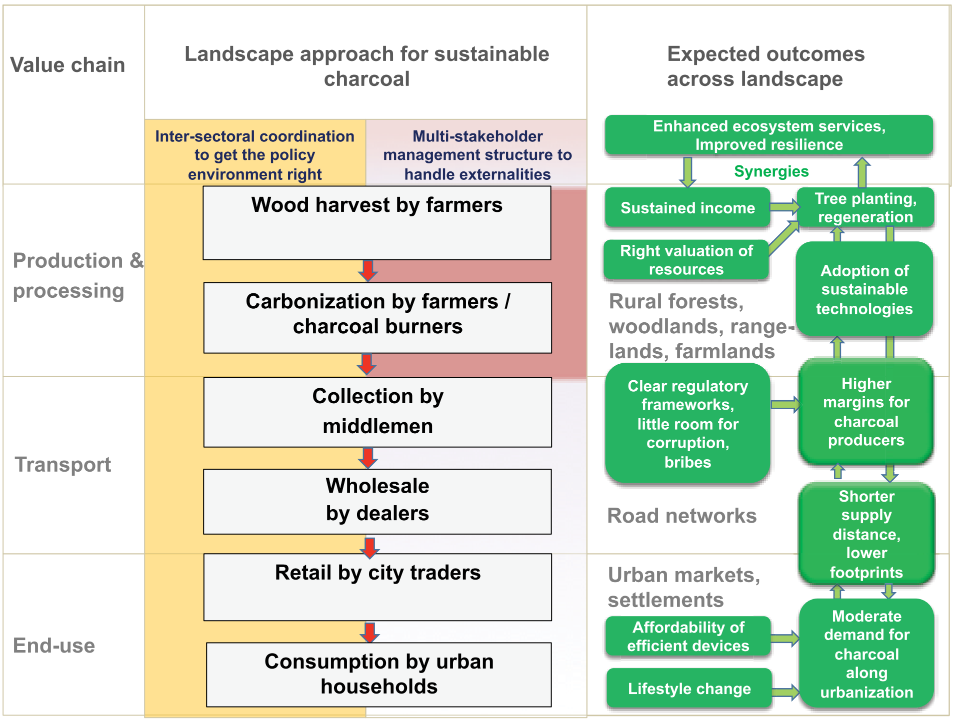

Figure 14.2 A LA for sustainable charcoal. The centre part of this figure indicates that enabling policy environment requires inter-sectoral coordination across the value chain by reviewing overlaps, harmonizing and streamlining/simplifying regulations affecting the charcoal sector. At the same time, multi-stakeholder coordination needs to set up institutional arrangements for supportive landscape governance and resource tenure to mediate competition and conflict among multiple stakeholders who depend on the same resources within rural landscapes. The right section of the figure depicts the expected outcomes of inter-sectoral/multi-stakeholder coordination for charcoal elaborated in Section 3.2.

Figure 14.3 Top: Urbanization has led to increasing demand for charcoal as a preferred, affordable fuel (Photo credit: Miyuki Iiyama). Bottom: Charcoal production targets mature hardwood species with significant degradation impacts (Photo credit: Geoffrey Ndegwa).

4. Conclusion

The absence of standard measures to capture the degrees of socio-economic and environmental consequences of charcoal in SSA, coupled with fatigues from past policy failures to address woodfuel issues in a sectoral manner has resulted in the significance of charcoal to be underplayed thus hampering serious policy debates and efforts. As a result, the majority of SSA countries have no enabling policy/institutional frameworks to guide sustainable charcoal production and use, but rather leave them deemed illegal and backward. While there is little evidence that LAs have been used to deal with unsustainable charcoal production and use in SSA, it is urgent to test and validate LAs as a learning and adaptive process. To facilitate such LAs to be best operationalized in country-specific contexts, the analytical model 'charcoal economics' will be useful to guide the designing of inter-sectoral/multi-stakeholder coordination. Charcoal economics will allow stakeholders to diagnose incentive mechanisms underlying charcoal production/ use and the socio-economic/environmental implications across landscapes. Within this process, special attention needs to be paid to political dynamics of charcoal to avoid situations where vested interests could dominate the decision-making processes and to ensure that producers and the marginalized, including the women and youth, would also be able to benefit from LA processes. Documentation of learning processes can help to develop generic platforms to operationalize LAs in different country contexts for wider application.

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References

Abdirizak, H., Gudka, M., Kibor, B., Kinuthia, M., Kimeu, P., de Leeuw, J., … Iiyama, M. (2013). *Farmer-managed natural regeneration: How to regenerate pasture and farmland on a low budget.* Technical brief prepared for DFID-KNOWFOR project. Nairobi, Kenya: World Agroforestry Centre.

Arnold, M., & Pearson, R. (2003). Comment: reassessing the fuelwood situation in developing countries. *International Forestry Review*, 5, 379- 383.

Arnold, J. E. M., Köhlin, G., & Persson, R. (2006). Woodfuels, livelihoods, and policy interventions: changing perspectives. *World Development, 34*(3), 596-611. doi:10.1016/j.worlddev.2005.08.008

Bailis, R., Ezzati, M., & Kammen, D., M. (2005). Mortality and greenhouse gas impacts of biomass and petroleum energy future in Africa. *Science*, 308, 98-103. doi: 10.1126/science.1106881

Brew-Hammond, A., & Kemausuor, F. (2009). Energy for all in Africa—to be or not to be?! *Current Opinion in Environmental Sustainability*, 1, 83–88. doi.10.1016/j.cosust.2009.07.014

Chidumayo, E. N., & Gumbo, D. J. (2012). The environmental impacts of charcoal production in tropical ecosystems of the world: a synthesis. *Energy for Sustainable Development*, 17, 86-94. doi.10.1016/j.esd.2012.07.004

DeFries, R., & Rosenzweig, C. (2010). Toward a whole-landscape approach for sustainable land use in the tropics. *Proceedings of the National Academy of Sciences, 107*(46), 19627–19632. doi: 10.1073/pnas.1011163107/-/DCSupplemental

de Leeuw, J., Njenga, M., Wagner, B., & Iiyama, M. (2014). *Treesilience, an assessment of the resilience provided by trees in the drylands of Eastern Africa*. Nairobi, Kenya: World Agroforestry Centre.

Dewees, P. A. (1989). The woodfuel crisis reconsidered: observations on the dynamics of abundance and scarcity. *World Development*, 17, 1159-1172.

Ellegård, A. (1996). Cooking fuel smoke and respiratory symptoms among women in low-income areas in Maputo. *Environmental Health Perspectives, 104*(9), 980-985.
FAO (Food and Agriculture Organization of the United Nations). (2014). *State of the World's Forests: Enhancing the socioeconomic benefits from forests.* Rome, Italy: FAO.
Girard, P. (2002). Charcoal production and use in Africa: what future? *Unasylva, 211*(53), 30-33.
Griscom, B., Ganz, D., Virgilio, N., Price, F., Hayward, J., Cortez, R., …Stanley, B. (2009). *The hidden frontier of forest degradation: A review of the science, policy and practice of reducing degradation emissions.* Arlington, VA: The Nature Conservancy.
Harvey, C. A., Chacón, M., Donatti, C. I., Garen, E., Hannah, L., Andrade, A. … Wollenberg, E. (2013). Climate-smart landscapes: Opportunities and challenges for integrating adaptation and mitigation in tropical agriculture. *Conservation Letters, 7*(2), 77–90. doi: 10.1111/conl.12066
Hosier, R. (1989). The economics of smallholder agroforestry: two case studies. *World Development,* 17,1827-1839.
Hosier, R. H., & Milukas, M. V. (1992). Two African woodfuel markets: urban demand, resource depletion and environmental degradation. *Biomass and Bioenergy, 3*(I), 9-24.
Iiyama, M., Neufeldt, H., Dobie, P., Jamnadass, R., Njenga, M., & Ndegwa, G. (2014*a*). The potential of agroforestry in the provision of sustainable woodfuel in sub-Saharan Africa. *Current Opinion in Environmental Sustainability*, 6C,138-147. doi.10.1016/j.cosust.2013.12.003
Iiyama, M., Chenevoy, A., Otieno, E., Kinyanjui, T., Ndegwa, G., Vandenabeele, J., … Johnson, O. (2014*b*). *Achieving sustainable charcoal in Kenya Harnessing the opportunities for cross-sectoral integration.* Nairobi, Kenya: ICRAF-SEI Technical Brief.
Kammen, D. M., & Lew, D. J. (2005). *Review of Technologies for the Production and Use of Charcoal.* Renewable and Appropriate Energy Laboratory Report. Berkeley, CA: Energy and Resources Group & Goldman School of Public Policy, University of California. Retrieved from http://rael.berkeley.edu/sites/default/files/old-site-files/2005/Kammen-Lew-Charcoal-2005.pdf
Luoga, E. J., Witkowski, E. T. F., & Balkwill, K. (2000). Economics of charcoal production in miombo woodlands of eastern Tanzania: some hidden costs associated with commercialization of the resources. *Ecological Economics*, 35, 243–257. PII: S0921-8009(00)00196-8.
Milder, J. C., Hart, A. K., Dobie, P., Minai, J., & Zalesky, C. (2014). Integrated landscape initiatives for African agriculture, development, and conservation: A region-wide assessment. *World Development*, 54, 68–80. doi.org/10.1016/j.worlddev.2013.07.006
Mwampamba, T. H., Ghilardi, A., Sander, K., & Chaix, K. J. (2013). Dispelling common misconceptions to improve attitudes and policy outlook on charcoal in developing countries. *Energy for Sustainable Development*, 17, 158-170. doi:10.1016/j.esd.2013.01.001
Namaalwa, J., Sankhayan, P. L., & Hofstad, O. (2007). A dynamic bio-economic model for analyzing deforestation and degradation: An application to woodlands in Uganda. *Forest Policy and Economics*, 9, 479– 495. doi: 10.1016/j.forpol.2006.01.001
Naughton-Treves, L., Kammen, D. M., & Chapman, C. (2007). Burning biodiversity: Woody biomass use by commercial and subsistence groups in western Uganda's forests. *Biological Conservation*, 134, 232-241. doi:10.1016/j.biocon.2006.08.020
Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J-L., Sheil, D., Meijaard, E., … Buck, L. E. (2013). Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses, *Proceedings of the National Academy of Sciences, 110*(21), 8349–8356. doi:10.1073/pnas.1210595110/-/DCSupplemental
Schure, J., Ingram, V., Sakho-Jimbira, M. S., Levang, P., & Wiersum, K. F. (2013). Formalisation of charcoal value chains and livelihood outcomes in Central and West Africa. *Energy for Sustainable Development, 17*(2), 95–105. doi: 10.1016/j.esd.2012.07.002
Schure, J., Levang, P., & Wiersum, K. F. (2014*a*). Producing woodfuel for urban centers in the Democratic Republic of Congo: A path out of poverty for rural households? *World Development*, In press. doi:10.1016/j.worlddev.2014.03.013
Schure, J., Dkamela G. P., van der Goes, A., & McNally, R. (2014*b*). *An approach to promote REDD+ Compatible wood-fuel value chains*. Vietnam: SNV.
Sepp, S. (2008). *Shaping Charcoal Policies: Context, Process and Instruments as Exemplified by Country Cases*. Germany: GTZ.
Shepherd, G. (1991). The communal management of forests in the semi-arid and sub-humid regions of Africa: Past practice and prospects for the future. *Development Policy Review*, 9, 151-176.

Siri, E. F., Gachathi, N., Muok, B., Ochieng, B., & Owuor, B. (2006). Synergies in biodiversity conservation and adaptation to climate change: The case of hilltop forests in Kitui, Kenya. In Mistry, J., & Berandi, A. (Eds.), *Savannas and dry forests: linking people with nature*. United Kingdom: Ashgate.

Skutsch, M. M., & Ba, L. (2010). Crediting carbon in dry forests: The potential for community forest management in West Africa. *Forest Policy and Economics*, 12, 264–270. doi:10.1016/j.forpol.2009.12.003

White, R. P., & Nackoney, J. (2003). *Drylands, People and Ecosystem Goods and Services: A Web-Based Geospatial Analysis.* Washington, DC: World Resources Institute.

World Bank. (2011). *Wood-Based Biomass Energy Development for Sub-Saharan Africa: Issues and Approaches*. Washington, DC, USA: The International Bank for Reconstruction and Development.

Zulu, L. C., & Richardson, R. B. (2013). Charcoal, livelihoods, and poverty reduction: Evidence from sub-Saharan Africa. *Energy for Sustainable Development*, 17, 127–137. doi:10.1016/j.esd.2012.07.007

Women are always part of shaping the rural landscapes. A woman is harvesting and collecting groundnuts in northern Ghana. Photo credit: Grace B. Villamor

CHAPTER 15

Gender-specific spatial perspectives and scenario building approaches for understanding gender equity and sustainability in climate-smart landscapes

Grace B. Villamor, P. Afiavi Dah-gbeto, Andrew Bell, Ujjwal Pradhan and Meine van Noordwijk

Highlights

- Men and women differ in interests, mechanisms, roles, and strategies for dealing with climate change impacts
- Men and women have different perceptions of space due to their productive and reproductive roles, power relations, and to historical and environmental contexts that shape the local 'theory of place'
- Participatory tools can be used to explore the gender-specific objectives and goals within the locally perceived socio-cultural landscapes
- We feature two methods (role-playing games and agent-based models) using case studies that demonstrate the spatial perception differences between genders
- In this chapter, we share examples of how to perceive the 'landscape' through coupling socio-cultural and ecological systems pertinent in livelihood resilience building

1. Introduction

1.1 Why connect gender and landscapes?

The nexus of gender, land use, landscapes and climate change is very complex and multi-dimensional. However, understanding these interactions may reveal important aspects for achieving food security and improving livelihood resilience to climate change impacts, especially during extreme events. After all, the concept of the landscape does not merely refer to a geographic space, but includes the social construct of a 'theory of place' based on diverse cultural and individual perceptions regarding the livelihood (or everyday life) of individuals and rights of social strata. For many communities in West African countries, the meaning of landscape is rooted in each persons' life history and experiences; and if misread and misunderstood, the landscape is misrepresented (Fairhead & Leach, 1996). Thus, the representation of landscapes should be viewed in combination with an analysis of livelihood dynamics and individual perceptions (e.g., whether the world is flat or spherical; see Vosniadou, 1994). However, peoples' perceptions vary according to their gender and everyday experiences, with the needs of women and men varying depending on their life phase, social status, income and ethnic origin (Meinzen-Dick et al., 1997). Gender, as defined by Food and Agricultural Organization of the United Nations (FAO), is likewise a social construct reflecting both perceptual and material relations between men and women, including the characteristics and qualities that each society ascribes with each sex (FAO, 1997); the empirical question of how many gender strata[1] are distinguished is answered differently in different parts of the world. There are many facets of gender differentiations in roles, responsibilities, options, and decisions that may affect the delivery of ecosystem services, landscape functionality as well as environmental sustainability. Yet, there have been few in-depth analyses linking land use and gender at the landscape level due to inherent complexities (Colfer & Minarchek, 2013; Villamor et al., 2013*a*).

A growing body of empirical evidence demonstrates that gender-specific roles and choices affect the functionality of landscapes in multifaceted ways (Kiptot & Franzel, 2012; Villamor et al., 2014*a*). For example, in terms of knowledge of the behaviour and functions of socio-ecological systems, Assé and Lassoie (2011) point out that Malian households that combine gender inclusive decision-making with relational agro-ecological knowledge and a mix of intensive and traditional extensive agriculture have greater capacity for creating adaptive soil and tree management strategies. Culturally defined gender specific roles in relation to water (e.g., collecting water for household use, washing clothes and personal hygiene) shape the ways landscapes are perceived and managed. Furthermore, women are often known as key stewards of household agricultural activities who determine agro-biodiversity and the use of location-specific crops, as well as soil restoration activities (Kiptot & Franzel, 2012; Mullaney, 2012).

Given this growing understanding of gender-specific roles and relationships in environmental stewardship, gender equality (i.e., equal access and control over resources) and equity (i.e., fair allocation of resources, participation in programmes and decision-making) have been identified as prerequisites for achieving greater sustainability (Johnsson-Latham, 2007). The realities of everyday life, however, need to be recognized and valued, such as the exclusivity of women's 'reproductive labour' (Rodenstein et al., 1996); they constrain how closely equity or equality is approached in practice. Broadly speaking, gender-differentiated roles fall into three main categories (Peter, 2006): 1) reproductive tasks undertaken to reproduce such as child bearing and rearing, feeding the family, and caring for the sick; 2) productive work that acquires goods or services for subsistence or market purposes and associated payment in cash; and 3) social/community activities performed not only for family welfare, but also for the well-being of the public and community related responsibilities. With the burden of reproductive tasks falling mainly upon women in rural areas in most cultures, women play 'triple' roles, while men typically split attention only across productive and community tasks. Consequently, as shifts in economic, social and environmental structures occur both at local and global levels, reproductive labour associated with childcare needs disproportionately constrain the responses of women to such change. Analysis that stops at the household level misses this, as well as any number of other processes that shape the agricultural landscape including interactions among women to share labour and pool risk and negotiations among men and women household members to allocate spending across food, education, assets, or leisure, among others. In particular, as patterns of seasonal and long-term labour migration shift in response to climate, development, or other stressors, the responsibilities for many decisions will pass between men and women within households or communities. With such a change in roles and responsibilities between men and women may come shifts in crop systems, production methods, and/or equitable sharing of common property resources.

The importance of gender-specific knowledge of perceptions and priorities within agricultural landscapes highlights the need for tools designed to collect and apply such information. In this chapter, we highlight two tools in particular – experimental games and agent-based models (ABMs) – whose complementarity allow us to elicit gender-specific perceptions and strategic behaviours at the field scale, and analyse implications of these behaviours at the landscape scale. To provide context for the application of such tools, first, gender dynamics in landscapes are described with specific examples. Next, descriptions of the different tools are provided supported by two specific case studies in the following section. Finally, the chapter is summarized highlighting the overall potential of applying the tools discussed to understand gender-specific perspectives within landscapes.

1.2 Gendered landscapes in practice

Typically, the available spatial information we use to research and otherwise understand landscapes is captured in 'maps' derived from a combination of local observations and satellite images. Using such images, the land composition/configurations of geographic landscapes are determined and management plans (e.g., conservation plans) are developed. However, these spaces often embed gender sensitive socio-cultural landscape characteristics that are not well discerned with conventional image processing and analysis techniques (Figure 15.1). In urban areas, particularly in western countries, the gender-orientation of space has been increasingly considered over the last 30 years in the development of settlements and infrastructure (Evers & Hofmeister, 2011). We believe that such consideration of gendered spatial perceptions in rural areas may provide new insights for enhancing adaptive capacity to climate change while improving food security. Under the joint stressors of globalization, climate change, and food insecurity, this gendered understanding of landscapes (and their perceptions) becomes increasingly important to consider in areas where the rights and opportunities differ between men and women or are otherwise limited or contested.

Similar gender-specific spatial patterns have been observed in many rural areas of West Africa such as in Northern Ghana (Figure 15.1a), Mali (Figure 15.1b), and Benin (Figure 15.1c & 15.d). There is also growing evidence of similar patterns in Asia, for example, within many rural areas in the Philippines and Vietnam (e.g., systems similar to the home gardens shown in Figure 15.1c & 15d) (Villamor et al., in prep) and across the matrilineal inheritance system of the Minangkabau tribe in the lowlands of the Jambi Province on Sumatra in Indonesia. Access to surface water (wells, streams, rivers) and gender-specific roles in water acquisition for households' needs adds complexity and leads to gender-specific change when village-level boreholes substitute for surface water sourcing (Makoni et al., 2004).

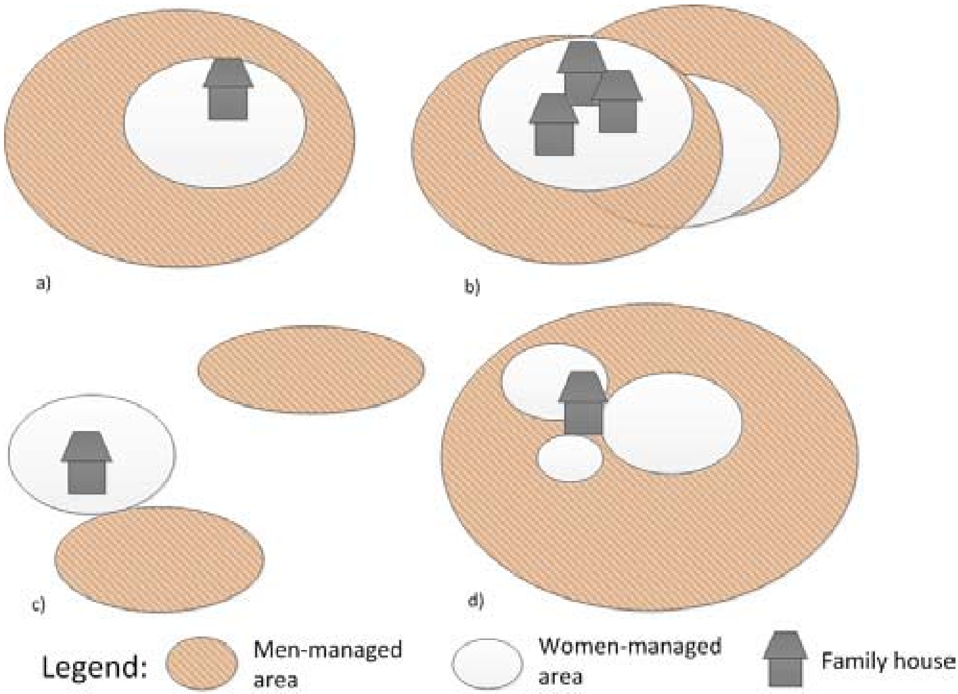


Figure 15.1 Gender specific spatial organization of households' farm management; **a** a typical household farm observed in Bolgatanga, Northern Ghana (Badmos et al., 2014), **b** the Mandé spatial organization observed in Mali (Assé & Lassoie, 2011), and **c** and **d** household farm arrangements in Tangueita, Benin (Dah-gbeto & Villamor, in prep).

These spatial patterns share similar gender specific aspects or characteristics:

1) men and women operate within specific crop production areas (see case study of Indonesia below),
2) women-managed areas are typically located near houses (spatial propinquity), whereas men tend to manage areas at greater distances from houses; and
3) within their respective areas, women tend to cultivate subsistence crops and men typically manage the production of commercially important crops, tree-based products, and/or livestock (see case study boxes 15.1 and 15.2).

Based on these observations it is evident that two factors interact with land use decisions among women: 1) reproductive labour related responsibilities, and 2) proximity to the home[2]. It can be argued that, in general, females manage relatively smaller parcels of land that are relatively closer to their household due to the limited labour availability among females for food production (as consequences of their reproductive roles) (Figure 15.1). Thus, the area used by women for subsistence farming is relatively smaller than areas used by men. For example, in northern Benin, women could only tend their shea (*Vitellaria paradoxa*) trees if they had completed their household responsibilities. Hence, the production of shea butter or oil was limited despite high demand for shea-based products (Dah-gbeto & Villamor, in prep). Distance from households to subsistence plots is also considered in managing farm plots because of time limitations and (perceived) security.

Explanations for how these gendered spatial patterns arise requires an understanding of the landscape as an integrated, socio- cultural and ecological system. Aspects of the physical and natural environment (e.g., topography, climate, volcanic activity, fauna, etc.) interact with aspects of human systems to shape the agricultural landscape, including i) power relations among men and women with inherently different demands, gender-specific values and expectations (e.g., women are required to remain near their houses for safety reasons by village elders), ii) external factors (e.g., global market-oriented policies or trends) and iii) rights and historical experiences (e.g., previous natural resource extraction experience such as timber harvest activities regulated by forestry/natural resource-based governmental bodies). Considering these factors, the spatial pattern perceived within landscapes are products of multiple interactions. Antrop (2005) defines a landscape as the *expression* of the highly dynamic interactions between socio-cultural and natural systems. Thus, it is pertinent to understand current perceptions (between genders), including how these perceptions arise and are shaped by social and cultural norms that affect the sustainability of natural resource use (i.e., success and failure of ecosystem management). Gaining such understanding may also help to provide insights into gender equity issues related to natural resources under climatic uncertainty. Most of our perceived traditional/cultural rural landscapes with distinct identity and character (see Figure 15.1) are rapidly being shaped by modernization (see Box 15.1) and globalization

Box 15.1

Outsourcing, landscapes and gender

If we accept that human roots are that of a 'social ape' living in small bands and groups that provided additional ways of securing individual needs for survival and reproduction, the starting point for most theories of change is a 'subsistence' economy at the local scale. The archaeological record shows that long-distance trade substantively predated agriculture (Diamond, 2012), but most of the products consumed where acquired locally, from various parts of the landscape. Gradual integration into local and global markets offers opportunities to 'outsource' acquisition of goods and services, benefitting from specialization. Outsourcing implies that production factors that were used to self-produce are shifted towards acquisition of externally produced goods and services. While it may be economically efficient under stable conditions, it involves exposure to new types of risks. A major step is taken when staple food is 'outsourced' and income obtained from sale of cash crops becomes the basis of 'food security'. Decisions to resist or use the opportunity to thus engage with markets have been analysed as a 'dual economy' (Dove, 2011), with many consequences for the way landscapes are used. Decisions to partially outsource food production may increase gender-differentiated land use, where men more readily engage in cash crops and women maintain the production of locally consumed goods that are not monetized and tend to be undervalued in economic studies. An example of such a pattern is found in (West) Sumatra where rice paddies are inherited, controlled and operated in a matrilineal (mother-to-daughter) pattern and tree crop lands in a mixed (both sons and daughters inherit) or male-dominated pattern (Quisumbing, 2001). Rural-to-urban migration involves major further steps in 'outsourcing' individual needs, participation in a cash-based economy, and loss of direct (economical) and indirect (emotional) links to landscapes. New gender-specificity of socially accepted roles emerge and interact with norms originally formed in rural societies (Resurreccion & Elmhirst, 2012).

(as well as population growth). What do these spatial patterns mean to gender equity and ways to adapt coping mechanisms for the impacts of climate change? We do not know the exact answers to these questions, but they are significant and need to be better understood. Part of the process of understanding why a landscape appears as it does will involve understanding the socio-cultural influences (Forman & Godron, 1986; Antrop, 2005; Wu, 2010) of which gender is certainly one. Therefore, gender analyses need to be incorporated more broadly into landscape-related research as according to Schiebinger (2014), "…unconscious sex and gender bias can be socially harmful and expensive…on the other hand, including gender analysis in research can save from life-threatening errors and can lead to new discoveries".

2. Understanding gender-specific perceptions of the landscape through participatory approaches

Accounting for gendered spatial patterns and gender relations in rural landscapes could enhance resilience-building capacity through food security policy development in response to external sources of variability (Assé & Lassoie, 2011; Mullaney, 2012; Villamor et al., 2014*a*). For instance, food production for household consumption could be endangered in densely populated rural areas, and in urban areas where most food is imported from rural areas. In terms of coping with climate variability and extreme events, increased seasonal or permanent outmigration (primarily working age men) may be a typical response to decreased food production. Employment related emigration may have negative consequences on household welfare such as child neglect or reduced ability to care for dependent household members as the family members who are left behind have to take on additional work and responsibilities (Brydon & Chant, 1989).

Participatory tools that allow insight into gender-specific decisions related to households' and communities' ability to adapt to change can be used to improve gender equity and foster climate-smart landscapes. These tools enable the identification and exploration of options that account for gender dynamics, which might not otherwise be apparent to researchers or practitioners. Some of the questions that such tools must address include (Colfer & Minarchek, 2013)[3]:

1. How is access to resources gender related? Are there broadly accepted notions that influence land tenure, inheritance, and occupation?
2. What are the behavioural gender norms that affect peoples' interactions with traditional crops, trees, and forests (e.g., masculinity ideals, seclusion of women, witchcraft beliefs)?
3. How do men's and women's daily responsibilities and economic roles differ (e.g., agriculture, forest products, livestock)?
4. What essential or valued domestic roles do men and women have that affect their respective involvement in the agricultural or forest landscapes?

Participatory appraisal techniques are not new – researchers have made use of scenario building exercises, agricultural calendars and ranking techniques for decades. Here, we highlight two techniques that have risen in prominence over the last decade as a means of eliciting behaviours and understanding their consequences – experimental games and agent-based models. These two approaches have a clear complementarity, and when applied jointly provide a powerful technique both to translate behaviours observed in the field into landscape outcomes, and to involve non-expert stakeholders in modelling and decision process (e.g., Naivinit et al., 2010). In particular, they provide a means of representing the gender-specific decisions and interactions that characterize male and female agricultural behaviour; despite this, save for a few examples (e.g., Villamor, in prep.; Saqalli et al., 2011), these techniques have, to date, been under-utilized in the study of gender in agriculture and landscape approaches.

2.1 Experimental games for eliciting behaviour

Games have a long history of application in anthropology, mainly for educational and pedagogical purposes[4]. A game is a simplified and contrived situation that contains sufficient verisimilitude or illusion of reality to elicit practical responses by those participating in the exercise (Keys & Wolfe, 1990). Games allow the plurality of views and diversity of interests (e.g., due to gender differences) to be explored. During the last decade, however, gaming (especially tabletop board games) has become a tool for examining strategic behaviour under distinct scenarios. Advancements in computer simulation games can sometimes offer more precise measurements (Keys & Wolfe, 1990). Both computer-based simulation and gaming are widely applied in natural resource management (Barreteau et al., 2007). Role-playing games (RPG) in particular are more practical and straightforward for revealing gender relations and their dynamics within landscapes. It can also promote participants' understanding of interrelated physical, spatial and social functions within the landscape.

2.2 Agent-based modelling for integrating gender specific spatial behaviour and perceptions

An ABM is a representation of a system (such as an agricultural landscape) using interacting, decision-making agents (such as farmers) (Bankes, 2002; Brown, 2006). In such a representation, landscape-scale properties such as the rates of land-cover change or population growth emerge from agent-level decisions to plant new fields or to have children, rather than from pre-defined mathematical relationships. Representing farmers as individuals is a significant data challenge, typically requiring primary data collection (Robinson et al., 2007), but offers a payoff. The one-to-one relationship that typically exists between agent behaviour and on-the-ground resource-use decisions (a discrete choice to either deforest a plot or not versus a mathematically determined rate of land-cover change) make ABMs a valuable entry point for engaging non-expert stakeholders (like farmers) in participatory training and resource management exercises.

ABMs are an ideal tool for studying contexts where interactions among individuals are strong drivers of outcomes at the landscape scale. Over the 20 years or so that ABMs have been applied to the study of natural resource management issues they have been used to understand different kinds of dynamics such as information sharing interactions among households (e.g., Ng et al., 2011), labour patterns (Naivinit et al., 2010), competing markets for resources (Schlüter et al., 2009) including focusing on system-level production and input consumption (Saqalli et al., 2011), assessing land cover changes (Bell et al., 2012; Villamor et al., 2014*b*) and determining social outcomes such as wealth distribution (Bell, 2011).

2.3 Integrating games and ABMs – landscape inferences, stakeholder engagement, and social learning

Using the results from the games to inform, structure, and calibrate the decision processes built into ABM enhances the validity of model results (i.e., convergent validity) (Ligtenberg et al., 2010; Villamor et al., 2013*b*). Integration can generate the following insights: 1) the effects of individual desires on beliefs and preferences; 2) the effects of the beliefs and preferences of other actors; and 3) the effects of joint beliefs and preferences on potential solutions to a particular planning problem (Ligtenberg et al., 2010). An ABM structured from the results of field-level behaviours provides a powerful tool for understanding how individual interactions and behaviours shape patterns observed at the landscape scale.

However, both games and ABM double as tools for inference and training. The act of playing a game can in many cases lead participants to confront novel situations and decisions. Coupled with follow-up training programmes games have been applied as means of improving collective action in different resource systems (e.g., Meinzen-Dick et al., 2014). The easily interpreted nature of decision rules in ABMs allows non-modellers to make links between their decisions and the resulting consequences for the landscape (e.g., Naivinit et al., 2010).

3. Case studies: gender-specific spatial perception

The following two case studies are examples of applying board games and ABMs to understand gender-specific land-use decisions at the landscape level.

3.1 Dassari watershed, (Tanguieta) Benin – exploring climate variability scenarios

A game called the 'grazing game' was implemented in the Dassari watershed in northern Benin. This area is a semi-arid ecosystem and its inhabitants are mainly farmers and pastoralists. Rainfall is erratic and it is predicted that drought events will become more frequent and severe with rainfall periods becoming shorter due to effects of climate change. The objective of the game exercise was to identify processes that lead to land degradation while exploring coping strategies under unpredictable rainfall patterns (van Noordwijk, 1984; Villamor & Badmos, submitted)[5]. Household farmers segregated into groups of men and women were the target players. Groups were segregated to be able to assess the gender-specific perceptions of coping strategies and the management of arid landscapes subject to unpredictable precipitation patterns.

One of the main findings resulting from the gaming exercises (Figure 15.2) was that under unpredictable rainfall pattern scenarios the strategies of men and women differed in production yield targets (Figure 15.2.1a & 15.2.2c). During the game, women began producing cattle to sell and used the proceeds to convert blocks of land to production of more profitable cash crops (e.g., cotton) and food crops (e.g., corn and sorghum). The men, who in reality are responsible for livestock production, did not respond to land degradation as long as they were able to maintain cattle throughout the course of the game. This contrasted with the strategy of the women who were careful to avoid creating degraded patches of land while also producing cattle.

Gender-specific spatial relationships became apparent during the course of the gaming exercises when players were asked what was missing from the game to better reflect

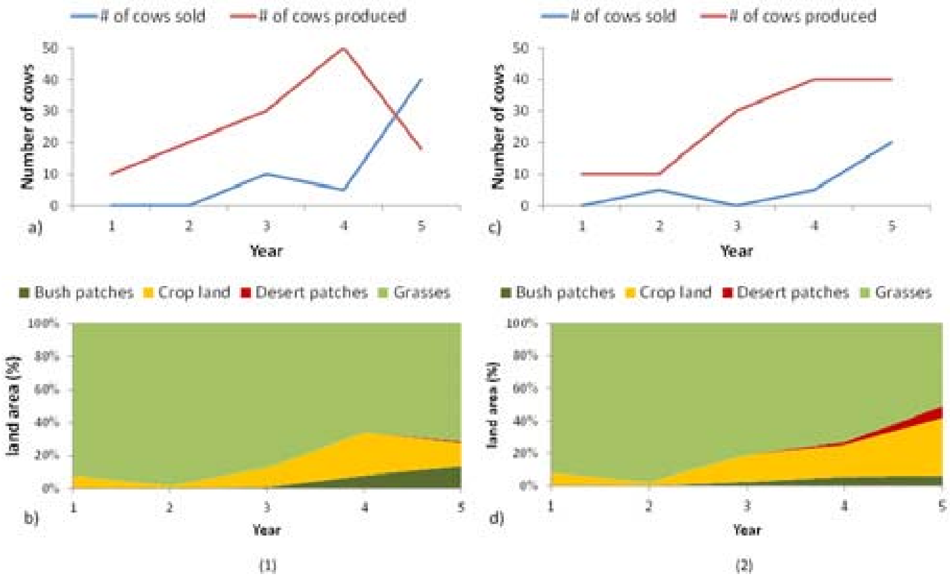


Figure 15.2 Patterns of land-use change under variable precipitation conditions created by the women-only group (1; **a** and **b**) and the men-only group (2; **c** and **d**).

reality. Men and women responded according to their perceived gender-based work experiences. Women reported pest and disease components of crop production should be included, whereas men suggested including the protected area as a limiting factor for agricultural expansion. This suggests that participating women were more concerned with the immediate issues affecting their role in crop production, while participating men were concerned with the potential for expanding production.

3.2 Indonesia (combined RPG & ABM approach) – predicting the outcome of payments for agro-biodiversity schemes

A traditional matrilineal kinship system continues to be practiced in the Bungo District of the Jambi Province on the island of Sumatra in Indonesia. Under this system women are responsible for rice fields, including both production and proprietorship bequeathed by mothers to daughters or aunts to nieces, whereas men are responsible for the agroforestry systems (e.g., rubber agroforests). The Dutch introduced rubber trees (*Hevea brasiliensis*) to Sumatra from Brazil in the 1900s. Initially rubber trees were inter-cropped with native lowland forest tree species. Rubber agroforests or 'jungle rubber' eventually became the dominant land use on Sumatra (van Noordwijk et al., 2012). However, in the early 1990s oil palm (*Elaeis guineensis*) production was introduced to Sumatra and large areas of forest and rubber agroforest have been converted to converted to oil palm production in response to increasing global demand (Villamor et al., 2014*c*). An ABM called Lubuk Beringin - Land Use DynAmic Simulator (LB-LUDAS) was applied to predict the land-use change trajectories under a payments for agro-biodiversity scheme (Villamor et al., 2014*b*). Autonomous agents (farmers) were parameterized based on gender disaggregated data (collected from samples of 95 men and 96 women). The model was coupled with RPGs to integrate other external actors that could influence gender-specific preferences and as a validation tool for the model (Villamor, 2014).

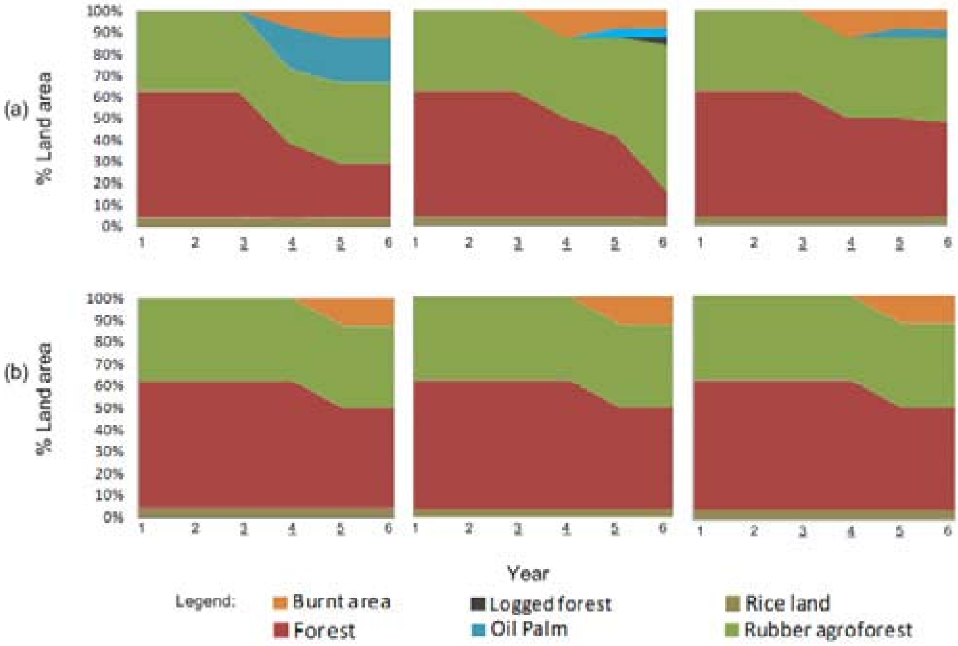


Figure 15.3 Land use change patterns based on the RPGs of women-only (a) and men-only (b) groups (Villamor et al., 2013*a*).

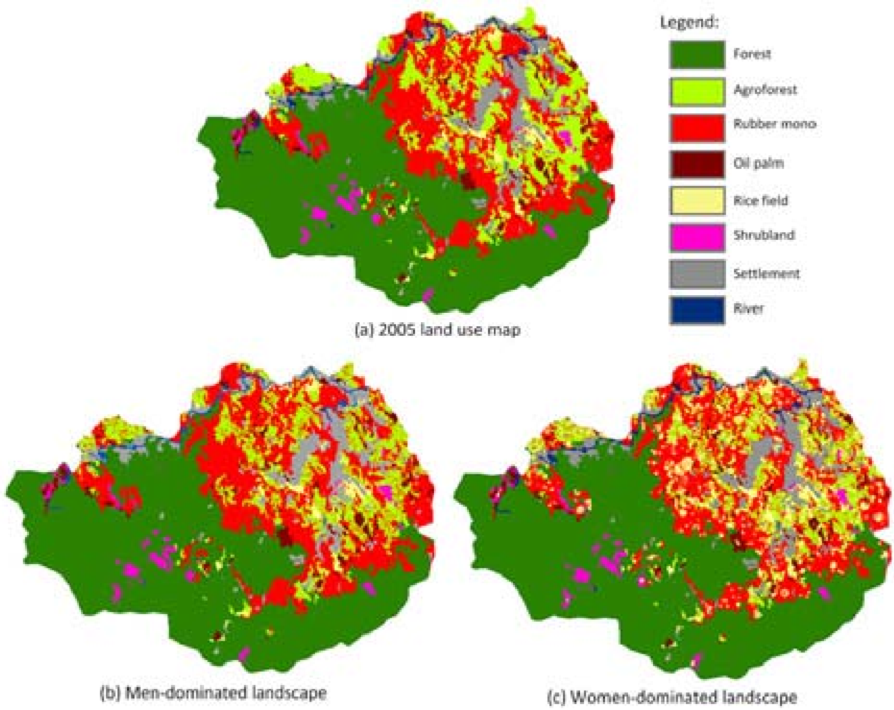


Figure 15.4 Land-use change pattern using a 2005 land use map as a baseline (a), against men-dominated (b) and women-dominated (c) landscapes simulated by the ABM.

One of the main findings from the combined ABM and RPG approach was that even though the participating women expressed a preference (Figure 15.3) for land use changes to improve profitability (e.g., monoculture oil palm and rubber plantations), their reproductive responsibilities, and their skills and labour limitations prevented them from achieving the desired outcomes. After the 20-year ABM simulation women returned to rice production (overall increasing the area under rice production Figure 15.4c). Men, on the other hand, exhibited a greater predilection for rubber agroforestry and monoculture plantations, both of which were more frequently maintained due to the ability of men to meet the labour requirements (Figure 15.4b). The simulation results also revealed that women-dominated landscapes had different spatial patterns (i.e., from clustered to fragmented pattern) than men-dominated landscapes (Figure 15.4; further analysis is presented in Villamor & van Noordwijk, in prep).

4. Gendered landscapes

The two case studies presented provide examples of the capacity for experimental games and ABMs to identify differences in gender-specific perspectives in socio-cultural-ecological landscapes. Wherever there are strong gender-specific roles embedded in agricultural landscapes, inadequate treatment of these roles may lead to major consequences for planning, intervention design, and management by misidentifying sustainability of goals and objectives and limiting their effectiveness. According to Harvey (1993) the very design of the transformed ecosystem (e.g., agricultural landscape) is redolent of prevailing social relations and reflects the social systems that give rise to them.

These are only two very early examples illustrating the potential for games and ABMs to elucidate gender-specific perspectives, behaviours and strategies and their resultant role in shaping landscape outcomes. There remains much untapped potential for this methodological pairing to advance policy and stakeholder-driven science in the area of climate-smart agriculture and climate-smart landscapes. For example, the clear pathway by which stakeholder-specific perspectives and decision processes are elucidated in the games, and expressed clearly in ABM modelling frameworks, allows non-expert stakeholders to have a point of entry into this form of technical knowledge. Beyond this, the technical strength of ABMs to project the kinds of system-level outcomes that emerge from individual decisions and interactions – here the gender-specific sharing of agricultural risks and responsibilities – can aid in designing policy interventions that are tailored to the realities of the everyday agricultural life of both men and women. Interventions designed without considering gender may exacerbate existing inequalities (e.g., increase the burden of women's roles and responsibilities) that could lead to both 'household and ecological crises'; after all, landscapes are holistic systems in which natural and socio-cultural systems co-evolve. To this end, in this chapter we illustrate the potential benefits that the experimental game and ABM toolkit can offer for gender-specific research in the context of climate-smart agriculture, and invite researchers to bring these techniques into mainstream research at the nexus of gender, land use and climate change.

Endnotes

1 While the default perception is two and there is a drive towards eliminating gender-based distinctions, a third, trans-sexual gender is distinguished in several Asian societies; recent fieldwork in south Sulawesi showed five gender strata (Martini, pers. com. 2013).

2 Economic geography traces its roots to the von Thünen model that predicted land use patterns with respect to a settlement based on transport costs; alternative interpretations include the distance-related costs of protecting resource access.

3 The sample questions presented are mainly for meso- and micro-scales. For further information see Colfer and Minarchek (2013).

4 In a way all social science research methods are based on 'role play games', where informant and interviewer roles are played within a social construct that tends to be ignored or forgotten in subsequent data analysis.

5 A full description of the modified game rules and mechanics are presented in Villamor and Badmos (submitted). The complete results of the gaming exercises in Benin are presented in Dah-gbeto and Villamor (in prep).

References

Antrop, M. (2005). Why landscapes of the past are important for the future. *Landscape and Urban Planning, 70*(1), 21-34.

Assé, R., & Lassoie, J. P. (2011). Household decision-making in agroforestry parklands of Sudano-Sahelian Mali. *Agroforestry Systems*, 82(3), 247-261.

Badmos, B. K., Agodzo, S. K., Villamor, G. B., Odai, S. N., & Guug, S. S. (2014). Using Participatory Scenario Exploration Exercise to Examine Agricultural Land-Use (ALU) Change Options in Semi-Arid Ghana. Paper presented at International Conference on Enhancing Resilience to Climate and Ecosystem Changes in Semi-arid Africa University for Development Studies, Tamale, Ghana 6 – 8 August, 2014.

Bankes, S. C. (2002). Agent-based modeling: A revolution? *Proceedings of the National Academy of Sciences, 99*(3), 7199-7200.

Barreteau, O., Le Page, C., & Perez, P. (2007). Contribution of simulation and gaming to natural resource management issues: an introduction. *Simulation & Gaming, 38*(2), 185-194.

Bell, A. R. (2011). Environmental licensing and land aggregation: an agent-based approach to understanding ranching and land use in rural Rondônia. *Ecology and Society, 16*(1), 31.

Bell, A. R., Riolo, R. L., Doremus, J. M., Brown, D. G., Lyon, T. P., Vandermeer, J., ... Agrawal, A. (2012). Fragmenting forests: the double edge of effective forest monitoring. *Environmental Science & Policy,* 16, 20-30.

Brown, D. G. (2006). Agent-based models. In Geist, H. (Eds.), *The Earth's Changing Land: An Encyclopedia of Land-Use and Land-Cover Change.* Westport, CT: Greenwood Publishing Group.

Brydon, L., & Chant, S. H. (1989). *Women in the Third World: Gender issues in rural and urban areas:* Cambridge, UK: Cambridge University Press.

Dah-gbeto, A. & Villamor, G.B. (in prep). Gender and land use under climate variability in Northern Benin.

Colfer, C. J. P., & Minarchek, R. D. (2013). Introducing 'The Gender Box': A Framework for Analysing Gender Roles in Forest Management 1. *International Forestry Review, 15*(4), 411-426.

Diamond, J. (2012). *The World Until Yesterday: What Can We Learn from Traditional Societies?* New York, USA: Penguin.

Dove, M. R. (2011). *The banana tree at the gate a history of marginal peoples and global markets in Borneo.* New Haven, USA: Yale University Press.

Resurreccion, B. P., & Elmhirst, R. (Eds.). (2008). Gender and natural resource management: Livelihoods, mobility and interventions. London, U.K.: Earthscan.

Evers, M., & Hofmeister, S. (2011). Gender mainstreaming and participative planning for sustainable land management. *Journal of Environmental Planning and Management, 54*(10), 1315-1329.

Fairhead, J., & Leach, M. (1996). *Misreading the African landscape: Society and ecology in a forest-savanna mosaic (Vol. 90)*. Cambridge, UK: Cambridge University Press.

FAO (Food and Agriculture Organization of the United Nations). (1997). Gender: the key to sustainability and food security. SD Dimensions. Retrieved from www.fao.org/sd

Forman, R., & Godron, M. (1986). *Landscape Ecology*. New York: John Wiley & Sons.

Harvey, D. (1993). The nature of environment: dialectics of social and environmental change. *Socialist Register, 29*(29).

Johnsson-Latham, G. (2007). *A study on gender equality as a prerequisite for sustainable development.* Sweden: Report to the Environment Advisory Council No. 2. Retrieved from www.sou.gov.se/mvb/
Keys, B., & Wolfe, J. (1990). The role of management games and simulations in education and research. *Journal of management, 16*(2), 307-336.
Kiptot, E., & Franzel, S. (2012). Gender and agroforestry in Africa: who benefits? the African perspective. In P. K. R. Nair & D. Garrity (Eds.), *Agroforestry - the future of global land use*, 463-497. Dordrecht: Springer.
Ligtenberg, A., van Lammeren, R. J., Bregt, A. K., & Beulens, A. J. (2010). Validation of an agent-based model for spatial planning: A role-playing approach. *Computers, Environment and Urban Systems, 34*(5), 424-434.
Makoni, F. S., Manase, G., & Ndamba, J. (2004). Patterns of domestic water use in rural areas of Zimbabwe, gender roles and realities. *Physics and Chemistry of the Earth, Parts A/B/C, 29*(15), 1291-1294.
Meinzen-Dick, R. S., Brown, L. R., Feldstein, H. S., & Quisumbing, A. R. (1997). Gender, property rights, and natural resources. *World development, 25*(8), 1303-1315.
Meinzen-Dick, R., Chaturvedi, R., Domenech, L., Ghate, R., Janssen, M. A., Rollins, N, & Sandeep, K. (2014). *Games for Groundwater Governance: Field Experiments in Andhra Pradesh, India.* CSID Working Paper Series, CSID-2014-006.
Mullaney, E. G. (2012). Countertopographies of agriculture gender, food production, and development in a globalizing world. *Consilience: The Journal of Sustainable Development, 8*(1), 101-114.
Naivinit, W., Le Page, C., Trébuil, G., & Gajaseni, N. (2010). Participatory agent-based modeling and simulation of rice production and labor migrations in Northeast Thailand. *Environmental Modelling & Software, 25*(11), 1345-1358.
Ng, T. L., Eheart, J. W., Cai, X., & Braden, J. B. (2011). An agent-based model of farmer decision-making and water quality impacts at the watershed scale under markets for carbon allowances and a second-generation biofuel crop. *Water Resources Research, 47*(9).
Peter, G. (2006). Gender roles and relationships: Implications for water management. *Physics and Chemistry of the Earth, Parts A/B/C, 31*(15–16), 723-730. doi: http://dx.doi.org/10.1016/j.pce.2006.08.035
Quisumbing, M. A. R. (Eds.). (2001). *Land, trees, and women: Evolution of land tenure institutions in Western Ghana and Sumatra.* Washington DC, USA: Intl Food Policy Res Inst.
Robinson, D. T., Brown, D. G., Parker, D. C., Schreinemachers, P., Janssen, M. A., Huigen, M., ... Barnaud, C. (2007). Comparison of empirical methods for building agent-based models in land use science. *Journal of Land Use Science, 2*(1), 31 - 55.
Rodenstein, M., Bock, S., & Heeg, S. (1996). Reproduktionsarbeitskrise und stadtstruktur zur entwicklung von agglomerationsräumen aus feministischer sicht. In A. R. u. L. (ARL) (Eds.), *Forschungs- und Sitzungsberichte,* 26-50. Hannover: Agglomerationsräume in Deutschland.
Saqalli, M., Gérard, B., Bielders, C., & Defourny, P. (2011). Targeting rural development interventions: Empirical agent-based modeling in Nigerien villages. *Agricultural Systems, 104*(4), 354-364.
Schiebinger, L. (2014). Scientific research must take gender into account. *Nature, 507*, 9.
Schlüter, M., Leslie, H., & Levin, S. (2009). Managing water-use trade-offs in a semi-arid river delta to sustain multiple ecosystem services: a modeling approach. *Ecological research, 24*(3), 491-503.
van Noordwijk, M. (1984). Ecology textbook for the Sudan. Khartoum: Khartoum University Press.
van Noordwijk, M., Tata, H. L., Xu, J., Dewi, S., & Minang, P. A. (2012). *Segregate or Integrate for Multifunctionality and Sustained Change Through Rubber-Based Agroforestry in Indonesia and China: Agroforestry - The Future of Global Land Use.* In Nair, P. K. R, & Garrity, D. (Eds.), (Vol. 9), 69-104. Netherlands: Springer.
Villamor, G. B. (2014). Gender, land use and role-play games. In Catacutan, D., McGraw, E., & Llanza, M. (Eds.), *A User Guide to Gender Analysis in Agroforestry.* Los Banos: World Agroforestry Centre.

Villamor, G. B., & Badmos, B. K. (submitted). Grazing game a social learning tool for adaptive management in response to climate variability in semi-arid areas of Ghana. *Ecological Modelling.*

Villamor, G. B., Desrianti, F., Akiefnawati, R., Amaruzaman, S., & van Noordwijk, M. (2013*a*). Gender influences decisions to change land use practices in the tropical forest margins of Jambi, Indonesia. *Mitigation and Adaptation Strategies for Global Change,* 1-23. doi: 10.1007/s11027-013-9478-7

Villamor, G. B., Troitzsch, K. G., & van Noordwijk, M. (2013*b*). Validating human decision making in an agent-based land-use model. Paper presented at the 20th International Congress on Modelling and Simulation, Adelaide, Australia.

Villamor, G. B., van Noordwijk, M., Djanibekov, U., Chiong-Javier, M., & Catacutan, D. (2014*a*). Gender differences in land-use decisions: shaping multifunctional landscapes? *Current Opinion in Environmental Sustainability,* 6, 128-133.

Villamor, G. B., Le, Q. B., Djanibekov, U., van Noordwijk, M., & Vlek, P. L. G. (2014*b*). Biodiversity in rubber agroforests, carbon emissions and rural livelihoods: Multi-agent, multi-dimensional simulation tool to preview policy scenarios in lowland Sumatra. *Environmental Modelling & Software,* 61, 151-165.

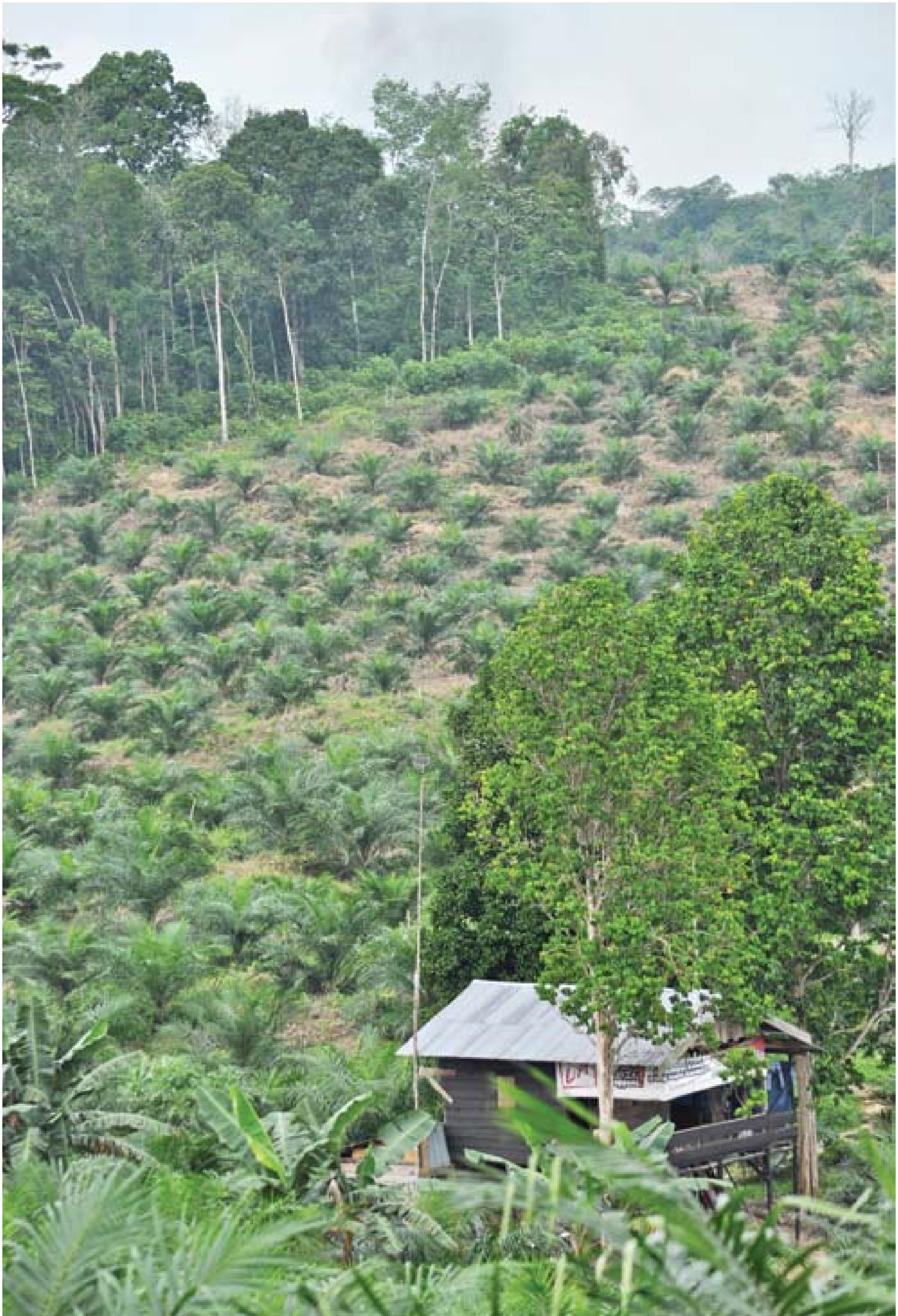
Villamor, G. B., Pontius, R. G. Jr., & van Noordwijk, M. (2014*c*). Agroforest's growing role in reducing carbon losses from Jambi (Sumatra), Indonesia. *Regional Environmental Change, 14*(2), 825-834. doi: 10.1007/s10113-013-0525-4

Villamor, G. B., & van Noordwijk, M. (in prep) Gender, land use and decision making in Sumatra: an agent-based modeling approach.

Villamor, G. B., Catacutan, D., van Noordwijk, M. (in prep) Linking land use and gender: a case in Vietnam.

Vosniadou, S. (1994). 16 Universal and culture-specific properties of children's mental models of the earth. *Mapping the mind: Domain specificity in cognition and culture,* 412.

Wu, J. (2010). Landscape of culture and culture of landscape: does landscape ecology need culture? *Landscape ecology, 25*(8), 1147-1150.



Land use conversion at the edge of forest in Tanjung Jabung Barat, Jambi, Indonesia. Photo credit: Putra Agung, World Agroforestry Centre

CHAPTER

16

The opportunity costs of emission reduction: a methodology and application to support land use planning for low emission development

S Suyanto, Andree Ekadinata, Rachmat Mulia, Feri Johana and Atiek Widayati

Highlights

- Opportunity cost, a basic concept from economic theory, informs decisions made by private land users and highlights social tradeoffs
- Quantifying social and private opportunity costs across landscapes is a powerful tool to assess the feasibility of reconciling conservation and development policy
- Opportunity cost analysis can help identify a fair compensation level for those who forego opportunities to change land use
- The REDD Abacus SP and FALLOW are complementary models that provide an effective means to identify possible conservation and development scenarios and to estimate associated opportunity costs
- Analytical models beyond opportunity costs should be developed to increase understanding of the total costs and benefits of land-based emission reduction activities

1. Introduction

Compensating landowners and countries for foregone benefits from development is at the heart of currently discussed mechanisms for Reducing Emissions from Deforestation and forest Degradation, preserving carbon stock, enhancing forest carbon stock and sustaining the management of forests (REDD+). For REDD+ efforts to achieve free, prior and informed consent, the level of compensation should be commensurate with the magnitude of negative economic consequences of not deforesting, not degrading, or actively protecting and enhancing carbon stocks. All land use choices have consequences for the expected future stream of costs and benefits to different stakeholders, which economists summarize in the concept of Net Present Value (NPV; see below). A choice for anything other than the most profitable land use implies an 'opportunity cost'. As it may also lead to a reduction of net emissions, we can express the ratio of difference in profitability and the gains in carbon as the minimum carbon price that would allow land users to break even when engaging in alternative emission reduction land use practices.

Defined as this ratio, the value of opportunity costs vary within and across landscapes, informing the design of efficient emission reduction programmes that want to maximize emissions reduction within a limited budget.

Opportunity cost is defined as the "…benefit forgone by using a resource for one purpose instead of another" (Maher et al., 2012). Opportunity cost is the value of the second best alternative, once all its implementation costs are accounted for. The opportunity costs from a private accounting perspective may differ from that of a societal (or social) perspective, as both costs and benefits are perceived differently. A difference between social and private opportunity costs can be the basis of a 'compensation' programme from which all involved can derive net benefits.

Pursuing emission reduction efforts under a landscape approach involves incorporating perspectives of multifunctionality as well as multiple actors and their stakes (van Noordwijk et al., 2011*a*). Use and utilization of lands provide a major entry point to a landscape approach when calculating emissions and in developing emission reduction strategies. Opportunity cost analysis can be an integral part of this process as it provides information of which land use(s) and which actor(s) are causing emissions, where the lost opportunities are if there is a change from a 'business as usual' scenario, as well as the associated gain for the next-best emission reduction option. These considerations of costs and benefits are translated into 'land use options' in the analyses, and reflect how the landscape will perform under different economic scenarios.

This chapter aims to contribute to the integration of opportunity cost analyses into emission reduction efforts to support land use planning for low emission development by discussing two methods and their applications. The chapter starts with a review of current theories and studies on opportunity costs and their contribution to emission reduction efforts. This is followed by descriptions of the two methods: REDD-Abacus SP and the FALLOW model. Application of these two methods is presented based on a case study in the Tanjung Jabung Barat (Tanjabar) District in Sumatra, Indonesia, in which the feasibility, scenario development and tradeoff analyses are incorporated and discussed. Finally, complementarities and limitations of the two methods are discussed.

2. Integrating opportunity costs into emission reduction actions

Associated REDD+ costs have been grouped into three categories: 1) opportunity costs, 2) implementation cost, and 3) transaction costs (White & Minang, 2011). Among these three types of costs, the application of opportunity costs has been widely adopted for REDD+ feasibility studies (Potvin et al., 2008; UNREDD, 2011). According to Pagiola and Bosquet (2009), opportunity costs are usually the single-most important category of costs a country would incur if it reduced its rate of forest loss to secure REDD+ payments. Moreover, White and Minang (2011) argued that opportunity costs hold significant importance because they will 1) be the largest portion of costs associated with REDD+, 2) provide insight into the drivers of deforestation, 3) help to understand impact, and 4) help to identify fair compensation for those who change their land use to contribute towards emission reductions. Although, as we will discuss below, transaction and implementation costs for REDD+ may be higher than were originally envisaged, it will be the high opportunity costs that will directly indicate that REDD+ based on financial incentives is unlikely to succeed in a given landscape, and it can thus act as a preliminary reality check and filter (van Noordwijk et al., 2011*b*).

The opportunity cost for avoiding deforestation can be calculated from the difference between the net benefit (NPV) provided by a land use that maintains forest and alternative land uses, such as agriculture. Data required for analysis of opportunity costs include a life cycle analysis of predominant land uses and their time-averaged carbon stocks, and quantified patterns of land use change (Hairiah et al., 2011). Based on review of 29 regional empirical studies, Bottcher et al. (2009) found the average opportunity cost was USD 2.51 per ton carbon dioxide equivalent (tCO_2e). Opportunity costs to reduce global deforestation by 46% based upon another study were estimated to range from USD 2.76 to USD 8.28/tCO_2e (Stern, 2007).

At the country and site level, Swallow et al. (2007) identified that a major opportunity for emission reductions, with modest opportunity costs, existed especially if forest conversion to three types of land-use could be avoided: 1) logging and subsequent conversion to extensive production of annual crops in sparsely-populated areas of Indonesia (East Kalimantan), Peru (Ucayali) and Cameroon (Awae); 2) conversion of forests to simple coffee systems in Lampung (Indonesia); and 3) all conversion of peat forests in Jambi province (Indonesia).While, in Sub-Saharan Africa, the main causes of forest conversion is still considered to be subsistence agricultural expansion and fuel extraction (Fisher et al., 2011), patterns in Latin America and Asia are dominated by production opportunities for domestic and export markets. The latter implies a likelihood of 'market-based leakage', as emissions avoided at one location are simply shifted elsewhere, as market demand remains unsatisfied (Kuik, 2014).

The Alternatives to Slash-and-Burn (ASB) Partnership has extended the scope of analysis to consider the inclusion of all sources of land-use based carbon pools and proposed the REALU (Reducing Emissions from All Land Uses) framework in this context. This framework consists of four pillars that reflect 1) the inclusion of emission reductions from deforestation and degradation (as in REDD), 2) emission reductions from peat lands, 3) enhancement of carbon sequestration and 4) emission reductions from agricultural activities (van Noordwijk et al., 2009).

Under the REALU framework, World Agroforestry Centre (ICRAF) has developed three opportunity cost methods (van Noordwijk et al., 2011*b*): 1) a direct comparison of NPV and time-averaged carbon stock at the level of land use systems as an easily applied first-level filter, 2) landscape-level opportunity cost curves using the REDD Abacus SP software, and 3) the FALLOW (Forest, Agroforest, Low-value Lands or Waste) model for further scenario analysis. We will here focus on the latter two methods.

3. Opportunity cost methods

3.1 The opportunity cost curve using the REDD-Abacus SP software

The opportunity cost curve provides a comprehensive view on the relationship between opportunity costs and the volume of emissions that can be avoided in comparison to a business as usual scenario of land use change. The opportunity cost curve as such does not specify who will have to be paid how much to avoid (abate) emissions, but it does provide estimates of the average and marginal opportunity costs of emission reductions (Swallow et al., 2007). Figure 16.1 shows the schematic diagram of the calculation of opportunity costs.

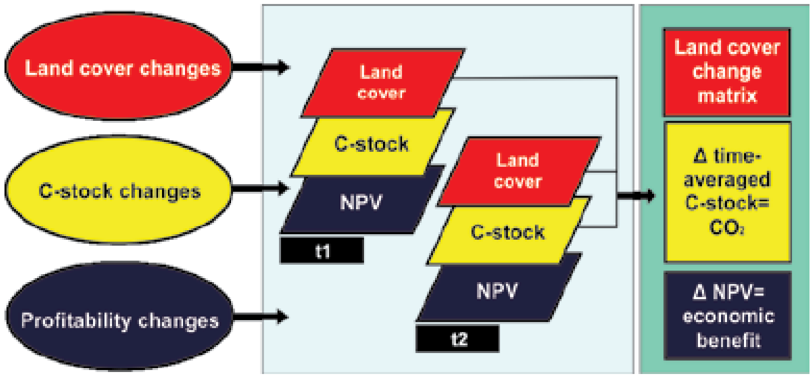


Figure 16.1 Schematic diagram of opportunity cost estimation (Swallow et al., 2007). C-stock = carbon stock.

The World Bank Institute adopted this opportunity cost curve method for estimating the opportunity cost of REDD+ (White & Minang, 2011). As part of this methodology, the REDD-Abacus SP software, developed by the World Agroforestry Centre (ICRAF; Harja et al., 2012), facilitates the calculations and construction of graphs. There are five steps in the analysis:

a. Land use classification and characterization

Selection of an operational land use classification for the focal area, that relates local land use typologies to remote sensing image analysis, characterized using life-cycle analysis to determine time-averaged carbon stock and profitability (White & Minang, 2011).

b. Analysis of land use, land use change and trajectories;

Analysis of land use and cover trajectory (ALUCT; Dewi & Ekadinata, 2010) requires a time series of land cover maps derived from satellite images. Knowing land use change patterns can identify drivers and agents of emitting-related activities in a particular period in the past. Two final forms of output resulting from ALUCT are: 1) area-based change analysis and 2) trajectory analysis. An area-based change analysis is a simple analysis conducted by comparing total area of land cover types in each time period. The results provide a clear indication of overall trends of land use/cover changes in the area. Maps can provide further information on the location and trajectories of changes. Trajectory analysis, when maps for more than two time-steps are available, summarizes sequences of historical changes in land use/cover of each pixel in the map within the study period.

c. Estimation of time-averaged carbon stock for the major land use systems

Aboveground carbon stock estimation is conducted through plot level measurement (Hairiah et al., 2009). Within a plot, the individual tree measurement is conducted measuring many variables for individual trees, including diameter at breast height and the species (or genus at the very least if species cannot be identified). Wood density is an important variable in estimating biomass, and therefore carbon stock (Chave, 2005), and a database developed by ICRAF can be used to access published literature at species or genus level to determine specific wood density. Additional field measurements include dead wood (necromass) measurement, litter data collection, and soil sample collection. Soil samples need to be analysed for the soil carbon content and the bulk density.

d. Calculation of the private profitability of the land use systems in terms of discounted net present value

A key summary metric of profitability of a land use system is the NPV (present discounted value) of revenues (volumes times price) less the costs of tradable inputs (e.g., fertilizer, fuel, etc.) and domestic factors of production (e.g., land, labour, management) over the specific time period considered in the analysis. The rental cost of land is typically not included because for a farmer or landowner the analysis considers the return to land. Because it can account for input and factor costs as well as outputs, and discounts future values over time, this measure of total factor productivity is superior to partial measures of productivity (e.g., yield or output per unit labour). Referring to Gittinger (1982), the NPV, i.e., the present worth of benefit (revenues) less the present worth of the cost of tradable inputs and domestic factors of productions, mathematically it is can be demonstrated by this equation:

$$NPV = \sum_{t=0}^{t=n} \frac{B_t - C_t}{(1+i)^t}$$

Where B_t is benefit at year t, C_t is cost at year t, t is time denoting year and *i* is the discount rate.

The private profitability reflects a micro-economic perspective for farmer's decisions, comparing investment in alternative land use systems. The same costs and benefits calculated with the prices at the societal level (thus without the aggregated effects of taxes and subsidies), and with a discount rate reflecting choices in society, leads to the social opportunity cost, that should be applied to estimate net benefits for a national or regional economy as a whole (Kragten, 2001).

An investment in a land use activity unit over the period of analysis is appraised as profitable if NPV, adjusted for the opportunity costs of foregone options, is greater than 0. In reverse, an activity with NPV minus opportunity costs less than zero is 'unprofitable' by definition. Though this does not necessarily mean that there are no positive cash flows for such a system. Tomich et al. (1998) argued that in areas where land is scarce, the NPV calculation over a 25-year period can be interpreted as the 'returns to land' for the selected land use activity unit under study, because the returns are the 'surplus' remaining after accounting for costs of labour (including imputed value of family labour), capital (through discounting), and purchased inputs. Where the value of land changes in response to the land use practice, further adjustments will be needed.

It should be noted that the net stream of costs and benefits for a land use system that conserves or restores forest may well be negative if all local 'implementation costs' are included.

e. Developing the opportunity cost curve using the REDD-Abacus software

The opportunity cost of foregoing change of land use is the difference in NPV per tCO_2e emitted (Swallow et al., 2007). For each pair of changes in land use and land cover categories per unit area per year, changes of time-averaged carbon stock differences can be calculated. Correspondingly, the differences in NPV per unit area (can either be

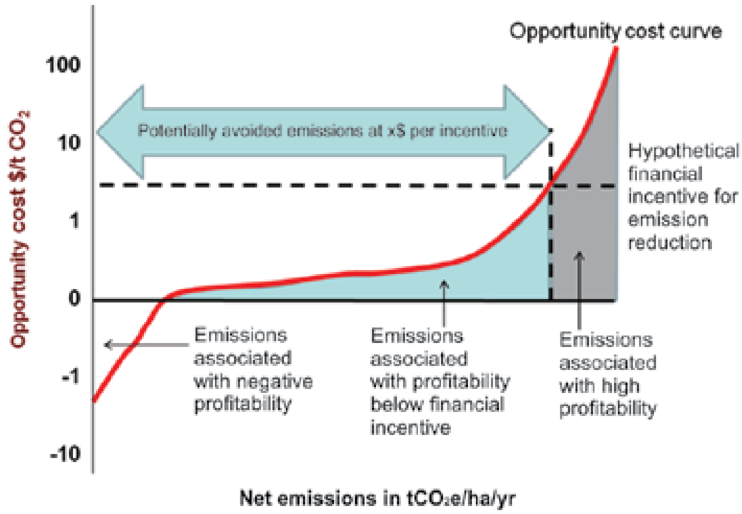


Figure 16.2 Conceptual figure of the opportunity cost curve (Swallow et al., 2007).

private or social profitability) can be calculated. Therefore changes in NPV per tCO_2e emitted can be calculated by dividing up changes in NPV with changes in carbon stock; the opportunity cost of the avoiding the particular changes in land use and land cover. Thus the formula to calculate the opportunity cost in USD/ tCO_2e is:

$$\frac{NPV_{Time\ 2} - NPV_{Time1}}{3.67*(Cstock_{Time1} - Cstock_{Time\ 2})}$$

Figure 16.2 shows a conceptual figure of an opportunity cost curve and its interpretation. Changes of time averaged carbon stock as a result of land use change is presented in the x-axis while change in profitability associated with the land use change is presented in the y-axis.

3.2 FALLOW (Forest, Agroforest, Low-value Lands Or Waste) model

FALLOW is a model that simulates the process of land use change. Instead of being based on a historical land use probability matrix to make projections of future land use like in REDD-Abacus, it regards farmers as the main agent of land use change. Their decisions, based on labour and capital allocation considerations for managing different land use types, determines the dynamic of the land use mosaic in a rural landscape. The model takes into account different factors that influence farmers' decisions including biophysical, economic, as well as social factors such as influence from relatives or openness to extension (van Noordwijk, 2002; Suyamto et al., 2009; Mulia et al., 2013*a*). The results of the simulation show the impact of land use changes on both economic and ecologic levels in the landscape.

Generally, a rural landscape consists of forest and non-forest lands (both of which can include smallholders) and large scale plantations. In large plantations, the type of vegetation is more fixed across the year. The main difference between the REDD-Abacus and the FALLOW model is thus the way they predict land use types in the smallholders' plantations.

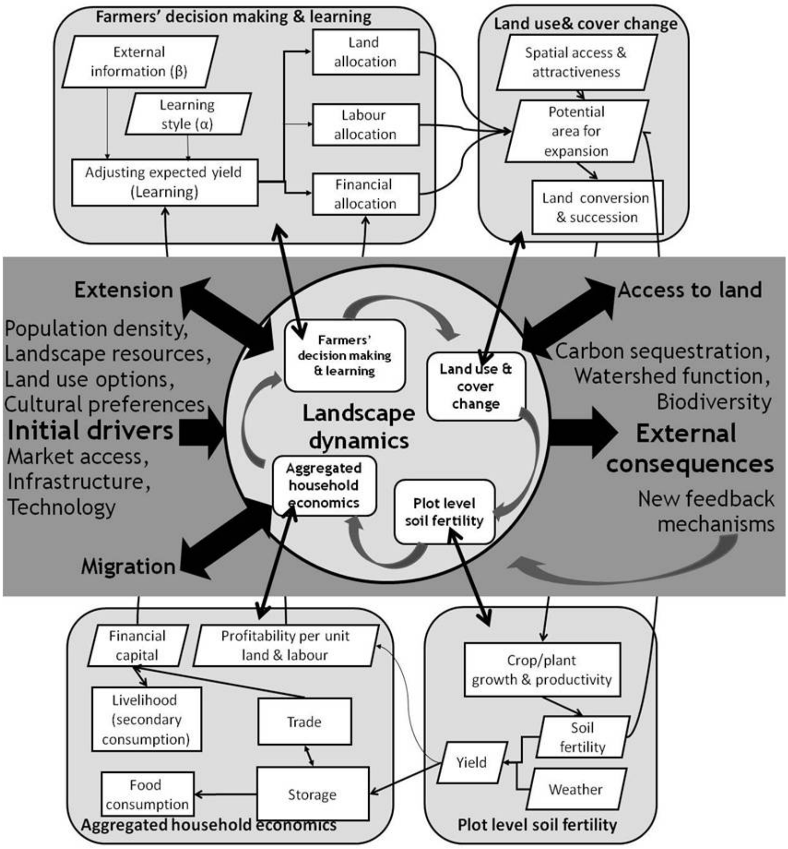


Figure 16.3 The four core modules of the FALLOW model described in Lusiana et al. (2012).

The FALLOW model is designed within the PC-Raster programming language. It operates in annual time steps and needs map-based inputs and parameter values. The input maps can be obtained from satellite images. Input maps and parameter values that represent biophysical, economical, demographic and social aspects in the landscape allow for the development of different land use strategies and scenario simulations within the model. In the current model version, economic and ecological dimensions in the landscape are represented by farmers' income per capita and by total standing carbon stock, respectively.

There are four core modules in the FALLOW model (Figure 16.3). They describe land use change as a result of the farmers' decisions and learning process about other land use options. The farmers consider current profit to labour and to land, cultural deliberation and external information (e.g., from relatives or extension) to determine land use types in the subsequent year. Available labour and land capital are allocated to selected land uses which later determine both spatial and temporal dynamics of the landscape mosaic. Land productivity depends on soil fertility and potential yield, where as income per capita is calculated based on income from the yields and/or off-farm activities. The calculated carbon stock in the landscape includes smallholders' plots and other land use types such as large plantations or forests.

4. Case study: the application of opportunity cost and FALLOW methodologies

An opportunity cost curve was estimated using the REDD Abacus SP software method to assess the economic feasibility of REDD+ in the Tanjabar District in Indonesia (Suyanto et al., 2014). In the same site the FALLOW model was used to calculate the potential cost needed to maintain local agroforestry and forest lands from the invasion of smallholder oil palm activities within the same district (Mulia et al., 2013*b*). The scale of analysis of the REDD ABACUS SP method can range from district to national level while FALLOW normally operates with input maps not more than 1 million pixels in size.

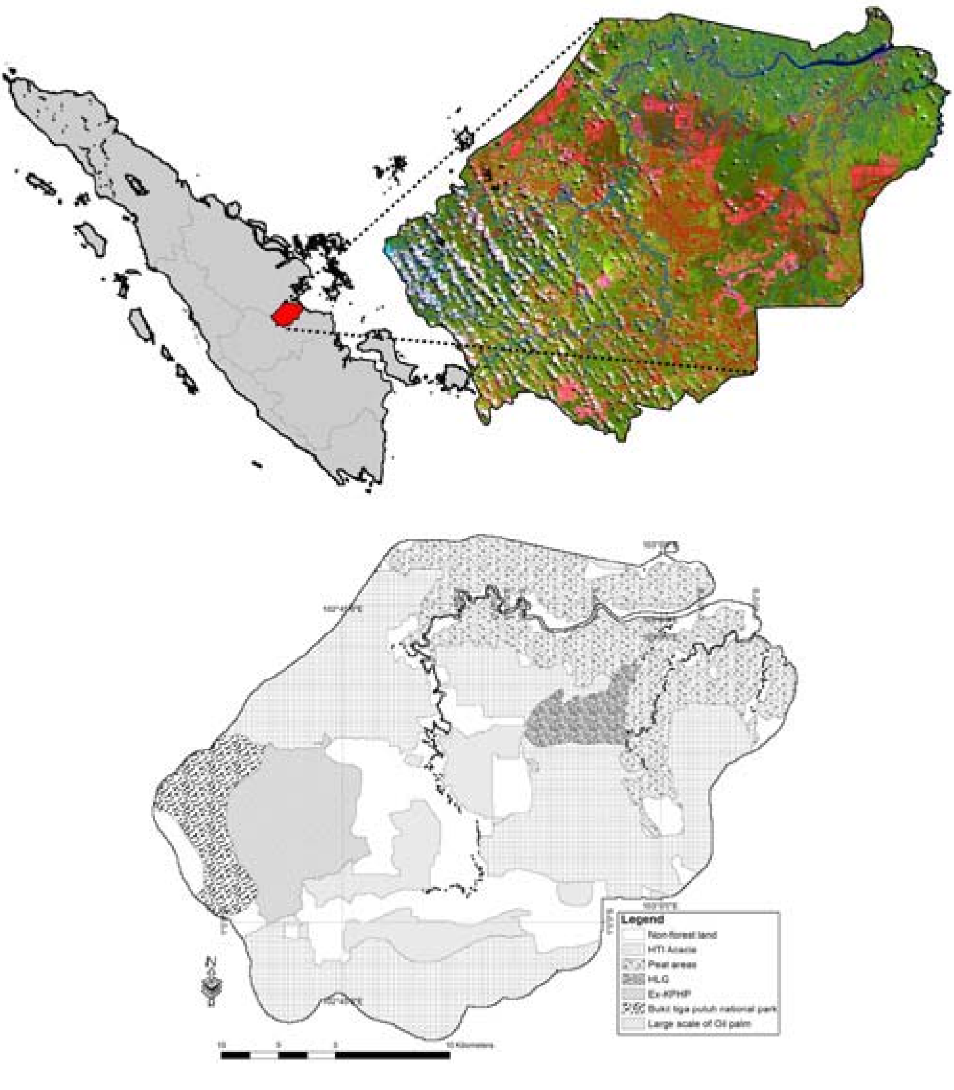


Figure 16.4 Location of Tanjabar District in Jambi Province, Sumatra, Indonesia and the different land uses within the landscape area.

The landscape of study in the district was made up a complex mosaic including a large portion of peat lands in the northern part of the district (Figure 16.4). The peat lands were mostly converted into smallholder plantations except an area called Hutan Lahan Gambut (HLG) that is now designated as protection forest for ecological and hydrological reasons. The remaining forests were situated mainly in the southern part of the district. An industrial timber plantation of acacia trees known as Hutan Tanaman Industri (HTI) covered about 35% of the district. Oil palm existed in both large plantations and smallholder plots. Important tree-based systems included rubber, coffee and coconut agroforestry systems with monoculture oil palm starting to gain more prominence within the district. The aim of the model's application was to calculate the potential cost needed to compensate farmers' income to incentivize them to maintain local agroforestry systems and remaining forests instead of converting their land into oil palm plantations, a highly profitable land use option in the region.

4.1 The feasibility for low-emission development in Tanjabar

Through intensive fieldwork in the landscape, time-averaged carbon stock and profitability for various land use systems were developed as shown in Table 16.1.

Table 16.1 Time-averaged carbon stock and profitability of land use systems in Tanjabar.

Land use system	Time average carbon stock (ton/ha)	NPV (USD/ha)
Rubber agroforest	58	1580
Rubber agroforest on peat	58	1481
Coffee-based agroforest	28	5722
Acacia plantation	58	1040
Rubber monoculture	41	2417
Rubber monoculture on peat	41	1747
Oil palm	40	7615
Oil palm on peat	39	5866
Coconut-betelnut agroforest	32	2002

Figure 16.5 shows the opportunity cost curve for Tanjabar in 2005-2009. The opportunity cost curve calculates potential avoided emissions through promotion of different land uses including the corresponding price of carbon needed as an incentive.

Figure 16.6 shows potential emission reductions in the district by 2020, assuming that all potential emissions with an opportunity cost below 5 and 10 USD can be avoided. The cumulative potential emissions in the district in 2020 is estimated at 61.91 tCO_2e/ha/yr, while the reduced emissions by excluding all land use conversion below a 5 USD threshold is estimated at 51.71 tCO_2e/ha/yr. The opportunity cost curved also showed that there is a potential for 16% emissions reduction using a 5 USD/tCO_2e incentive. However, if the threshold is increased to 10 USD, the amount of reduced emissions does not change much. For a large proportion of emissions in the landscape there are large opportunity costs making carbon payment incentive mechanisms prohibitive. This is a good example of many areas in Indonesia where development activities, although producing a large amount of emissions, also are significantly profitability and important for local development. Therefore within the district a small amount of potential future emissions can be avoided through an incentive payment mechanism, but this should be complemented with policy interventions that focus on low-emission development strategies by conserving high carbon stock areas and focusing high carbon high profitability activity land development through participatory approaches such as land use planning.

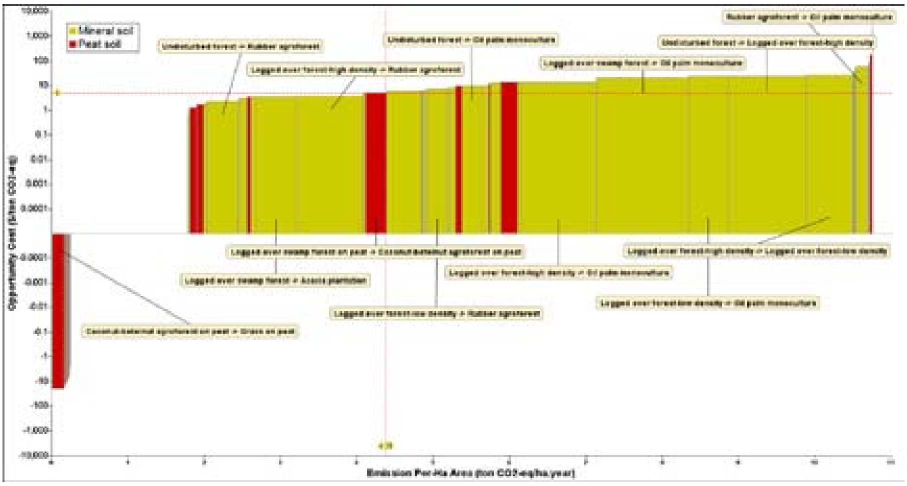


Figure 16.5 Opportunity cost curve of emission reductions from land use change in Tanjabar.

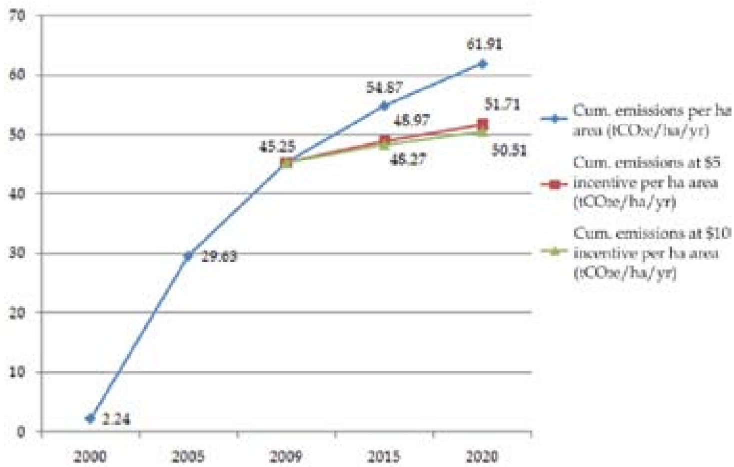


Figure 16.6 Potential emission reductions at 5 USD/tCO_2e and 10 USD/tCO_2e thresholds.

4.2 Scenarios to reduce emissions

Four land use scenarios were used in the FALLOW model (Table 16.2). They reflect possible emission reduction interventions as defined and described by different stakeholders in the Tanjabar District including the local forest and agricultural departments (Mulia et al., 2013*b*). 1) The current trend is reflected in the 'Business as Usual' (BAU) scenario where there is no protection of the remaining peat forest (HLG) for conversion into smallholder plots. The only protected forest is the Bukit Tiga Puluh National Park (BTNP) situated in the southern part of the district. No legal protection was granted for the rest of the forest on non-peat soils in the southern part. 2) In the second scenario, 'Protected Peat Forest', the HLG is protected from conversion to other land use types. 3) The 'REALU' scenario reduces emissions from all land uses through protection of existing forests and local agroforestry systems such as rubber and coffee from conversion to other land use types. This scenario also aims to support product diversification, but excludes coconut agroforestry due to its much lower profit return relative to other agricultural options. 4) The 'Green REALU' scenario is the REALU scenario plus restriction of new oil palm plantation establishment in non-productive, non-peat soils such as grass or shrub lands only.

In all scenarios, farmers are assumed to allocate land and labour capital proportionally to the profits gained in the simulated livelihood types. Due to lack of data about labour requirements, no labour was allocated to industrial acacia plantations (HTI) and large-scale oil palm plantations. Therefore, the calculated income per capita only includes income from smallholders' plantations outside the HTI, other large-scale plantations and protected forests. The calculated carbon stock, however, includes all land cover types in the landscape. The model ran for 30 simulation-years to cover a complete cycle of simulated tree-based systems. No change in road and settlement distribution was assumed in all scenarios. A simulation of dynamic road and settlement distribution in the landscape is possible when maps of future road and settlement distribution are provided as inputs to the model.

4.3 Tradeoffs between farmer income and emission reductions

Protecting the remaining 15 thousand hectares of HLG in the Protected Peat Forest scenario would require a tradeoff resulting in the potential loss of 10.7 million USD of farmers' income per year (compared to the BAU scenario; Table 16.2). On the other hand, the strategy can avoid the loss of 1.65 million tCO_2e/yr standing carbon stock resulting in a tradeoff value of about 1.76 USD/tCO_2e. A much greater potential loss of income resulted in the Green REALU scenario involving the preservation of forests and local agroforestry systems while restricting new oil palm plantations in areas other than unproductive non-peat soils as these restricted/protected activities encompassed a greater area. For the REALU scenario, only a slight difference in carbon stock was produced when preserving rubber and coffee agroforestry systems instead of allowing the plots to be converted into oil palm plantations due to the carbon stock of rubber and coffee systems not being higher than oil palm plantations with the exception of old rubber systems.

Table 16.2 Potential loss of annual income per tCO_2e of each scenario compared to the BAU in the Tanjabar District, calculated by the FALLOW model.

No	Intervention	Area (10^3 ha)	Δ total income (10^6 USD/yr)	Δ C stock in the landscape (10^6 tCO_2e/yr)	Tradeoff (USD/ tCO_2e)
1	Protected Peat Forest	15	-10.17	1.65	-1.76
2	REALU	123	-41.35	0.42	-26.82
3	Green REALU	38	-18.21	1.16	-4.27
4	Total (1+2+3)	176	-69.73	3.23	-5.88

5. Complementarities and limitation of the methods

Although both the models discussed here, the REDD Abacus SP and FALLOW models, calculate opportunity costs, each have a slightly different focus. REDD Abacus SP focuses on the calculation of opportunity costs on all changed activities at the landscape scale and future scenario projections, while the FALLOW model is more focused on the benefits gained by the local community, for example, a farmer.

Like in all other models, the outputs of the two models are sensitive to the value of input parameters. Therefore, model parameterization should be done carefully not regarding the output values as exact values. Model outputs should be used as a basis to design a more sensible land use strategy to implement in the field.

The REDD Abacus SP is easier for implementation than the FALLOW model because it has less input parameters. However, this also means the model is less detailed in describing the process of land use change and its consequences. Still, the REDD-Abacus SP will have more groups of users because of its simplicity and quick preparation. On the other hand, due to much more input parameters to better understand the detailed process of land use change, the FALLOW model is suitable for those that aim to study the relationship between the process of land use change and the consequence to the people and the landscape. Still, albeit more complex, the FALLOW model only represents the ecological aspect in the landscape by standing carbon stock. In the current version, other aspects of ecological prosperity like biodiversity (included in the version used by van Noordwijk (2002)) or water quality are not taken into account.

REDD+ transaction and implementation costs need to be included in the overall decisions whether or not to engage in REDD+. The farm and landscape level implementation costs of forest protection or restoration should be included as NPV in a specific land use option. In current applications, however, the costs of active protection may be underestimated. Further implementation costs will be incurred when actual emission reductions have to be measured, reported and verified (MRV). Depending on the design of MRV systems, the temporal frequency and scale at which precision is needed (Lusiana et al., 2013) and the level of local involvement (Brofeldt et al., 2014), these MRV costs can exceed the opportunity costs. So far the transaction costs have been high in the early stages of the REDD Readiness learning curve (Agung et al., 2014), but are expected to sink into the background once REDD+ is implemented at the scale needed to achieve meaningful emission reductions.

6. Conclusion

Assessing the opportunity costs through the two methods presented in this chapter has provided relevant information of forgone benefits given certain options of emission reductions pursued. The application of the two methods contributes equally at the broader landscape and administrative scale as well as at the net individual farmer level.

It is recognized that for emission reduction efforts, there are yet more relevant costs to be calculated. However, even with the absence of transaction costs, implementation costs and social costs, the analysis of opportunity costs can still be powerful in providing information for decisions-makers for assessing the economic feasibility of emission reductions from land use change or land-based activities.

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Endnotes

1 http://www.worldagroforestry.org/regions/southeast_asia/resources/redd-abacus-sp
2 http://pcraster.geo.uu.nl

References

Agung, P., Galudra, G., van Noordwijk, M., & Maryani, R. (2014). Reform or reversal: the impact of REDD+ readiness on forest governance in Indonesia. *Climate Policy*. Retrieved from http://dx.doi.org/10.1080/14693062.2014.941317

Bottcher, H., Eisbrenner, K., Fritz, S., Kindermann, G., Kraxner, F., McCallum, I., & Obersteiner, M. (2009). An assessment of monitoring requirements and costs of "Reduced Emissions from Deforestation and Degradation". *Carbon Balance and Management*, 4, 7.

Brofeldt, S., Theilade, I., Burgess, N. D., Danielsen, F., Poulsen, M. K., Adrian, T, … Widayati, A. (2014). Community Monitoring of Carbon Stocks for REDD+: Does Accuracy and Cost Change over Time? *Forests*, 5, 1834-1854.

Chave, J., Andalo, C., Brown, S., Cairns, M. A., Chambers, J. Q., Eamus, D., … Yamakura, T. (2005).Tree Allometry and Improved Estimation of Carbon Stocks and Balance in Tropical Forests. *Oecologia*, 145, 87–9.

Dewi, S., & Ekadinata, A. (2010). *Analysis of Land Use and Cover Trajectory (ALUCT)*. Bogor, Indonesia: World Agroforestry Centre - ICRAF, SEA Regional Office.

Fisher, B., Lewis, S. L., Burgess, N. D., Malimbwi, R. E., Munishi, P. K., Swetnam, R. D., … Balmford, A., (2011). Implementation and opportunity cost of reducing deforestation and forest degradation in Tanzania. *Nature Climate Change*, 1, 161-164.

Gittinger, J. P. (1982). *Economic Analysis of Agricultural Project* (2nd ed.). Baltimore, USA: John Hopkins University Press.

Harja, D., Dewi, S., van Noordwijk, M., Ekadinata, A., Rahmanulloh, A., & Johana, F. (2012). *REDD Abacus SP-User Manual and Software*. Bogor, Indonesia:World Agroforestry Centre-ICRAF, SEA Regional Office.

Hairiah, K., Dewi, S., Agus, F., Velarde, S. J., Ekadinata, A., Rahayu, S., & van Noordwijk, M. (2011). *Measuring Carbon Stocks across Land Use Systems: A Manual*. Bogor, Indonesia: World Agroforestry Centre - ICRAF, SEA Regional Office.

Kragten, M., Tomich, T. P., Vosti, S., & Goekowsi, J. (2001). *Evaluating land use systems from a socio-economic perspective*. Lecture note 8. Nairobi, Kenya: International Centre for Research in Agroforestry.

Kuik, O. (2014). REDD+ and international leakage via food and timber markets: a CGE analysis. *Mitigation and Adaptation Strategies for Global Change,* 19, 641-655.

Lusiana, B., van Noordwijk, M., & Cadisch, G. (2012). Land Sparing or Sharing? Exploring Livestock Fodder Options in Combination with Land Use Zoning and Consequences for Livelihoods and Net Carbon Stocks Using the FALLOW Model. *Agriculture, Ecosystem and Environment*, 159, 145–160.

Lusiana, B., van Noordwijk, M., Johana, F., Galudra, G., Suyanto, S., & Cadisch, G. (2013). Implication of uncertainty and scale in carbon emission estimates on locally appropriate designs to reduce emissions from deforestation and degradation (REDD+). *Mitigation and Adaptation Strategies for Global Change, 19*(6), 757-772.

Maher, M., Stickney, C., & Weil, R. (2011). *Managerial Accounting: An Introduction to Concept, Methods and Uses*. Mason, USA: South-Western, Cengage.

Mulia, R., Lusiana, B., & Suyamto, D. A. (2013*a*). *Manual of FALLOW Model Version 2.1*. Bogor, Indonesia: World Agroforestry Centre.

Mulia, R., Widayati, A., Suyanto, Agung, P., & Zulkarnain, M. T. (2013*b*). Low Carbon Emission Development Strategies for Jambi, Indonesia: Simulation and Trade-off Analysis Using the FALLOW Model. *Mitigation and Adaptation Strategies for Global Change,* 19,773-778. doi 10.1007/s11027-013-9485-8

Pagiola, S., & Bosquet, B. (2009). *Estimating the costs of REDD+ at country level.* Version 2.2. Arlington, VA: Forest Carbon Partnership Facility, World Bank.

Potvin, C., Guay, B., & Pedroni, L. (2008). Is reducing emissions from deforestation financially feasible?. A Panamanian case study. *Climate Policy*, 8, 23-40.

Suyamto, D. A., Mulia, R., van Noordwijk, M., & Lusiana, B. (2009). FALLOW 2.0. *Manual and Software*. Bogor, Indonesia: World Agroforestry Centre.

Suyanto, S., Ekadinata, A., Sofiyuddin, M., & Rahmanullah, A. (2014). Opportunity Costs of Emissions Caused by Land-Use Changes. *Open Journal of Forestry, 4*(1), 85-90.

Stern, N. (2007). *The Economics of Climate Change: The Stern Review*, Cambridge, U.K.: Cambridge University Press.

Swallow, B., van Noordwijk, M., Dewi, S., Murdiyarso, D., White, D., Gockowski, J., …. Weise, S. (2007). *Opportunities for Avoided Deforestation with Sustainable Benefits. An Interim Report by the ASB Partnership for the Tropical Forest Margins.* Nairobi, Kenya: ASB Partnership for the Tropical Forest Margins.

Tomich, T. P., van Noordwijk, M., Budidarsono, S., Gillison, A., Kusumanto, T., Murdiyarso, D., Stolle, F., & Fagi, A. M. (Eds). (1998). *Alternatives to Slash-and-Burn in Indonesia: Summary Report and Synthesis of Phase II*. Bogor, Indonesia: ICRAF.

UNREDD (UN-REDD Programme Vietnam). (2011). *Final report: analysis of opportunity cost for REDD+*. Retrieved from http://vietnam-redd.org/Upload/Download/File/UN-REDD_OCA_Final_Report_3211_4432.pdf

van Noordwijk, M. (2002). Scaling Trade-offs Between Crop Productivity, Carbon Stocks and Biodiversity in Shifting Cultivation Landscape Mosaics: The FALLOW Model. *Ecological Modelling*, 149, 113–126.

van Noordwijk, M., Minang, P. A., Dewi, S., Hall, J., & Rantala, S. (2009). *Reducing Emissions from All Land Uses (REALU): The Case for a whole landscape approach.* ASB Policy Brief 13. Nairobi, Kenya: ASB Partnership for the Tropical Forest Margins.

van Noordwijk, M., Hoang, M. H., Neufeldt, H., Öborn, I., & Yatich, T. (Eds.) (2011*a*). How trees and people can co-adapt to climate change: reducing vulnerability through multifunctional agroforestry landscapes. Nairobi, Kenya: World Agroforestry Centre (ICRAF).

van Noordwijk, M., Dewi, S., Suyanto, Minang, P., White, D., Robiglio, V., … Harja, D. (2011*b*). *Abatement cost curves relating past greenhouse gas emissions to the economic gains they allowed.* Project Report. Bogor, Indonesia: World Agroforestry Centre - ICRAF, SEA Regional Office.

White, D., & Minang, P. (Eds.) (2011). *Estimating the opportunity costs of REDD+*. A training manual. Washington, DC: World Bank Institute.

Heterogeneous humid tropical landscape of Sumatra needs inclusive, integrated and informed land use planning. Photo credit: Degi Harja Asmara

CHAPTER 17

Negotiation support tools to enhance multifunctioning landscapes

Sonya Dewi, Andree Ekadinata, Dony Indiarto, Alfa Nugraha and Meine van Noordwijk

Highlights

- The multifunctionality of landscapes is currently constrained by gaps between the theory of land use plans and the practice of the political ecology of development
- Reconciled planning units recognize and address gaps between regulations and realities, perspectives of policymakers and local land managers, economic driving factors and land capability
- The diversity of stakeholders of provisioning and other ecosystem services can support multifunctionality in a landscape if pixels and people can be clearly linked to institutions and regulations
- Wide ranging scenario simulations that predict likely consequences ahead of implementation with a model that is acceptable as such can inform the negotiation process

1. Introduction

Land, people and institutions together shape landscapes. People manage land within the limits set by institutions that they respect, but they may break the rules of others that are not effectively enforced. Land use influences ecosystem processes that in turn determine ecosystem functions for the primary land user (taking decisions to use land in a certain way), but also for others. Negative consequences on other stakeholders are the basis of conflicts, but these can be contained if land use rules emerge that are effectively respected and enforced. The rules may include compensation or economic incentives, but these need to have a common point of reference in a joint understanding of how the landscape functions. Where previously 'decision support' systems were focused on informing a single decision-maker, the term 'negotiation support' emerged to describe a process of achieving a shared understanding of how the landscape system functions, the various interests of the main stakeholders, and the various ways these are affected by current status and trends, and by alternative development scenarios (van Noordwijk et al., 2001).

The landscape is a logical focal scale to leverage change at the interface of development and environment, since it is where the implementation will take place and where interventions can still be concretely defined through policy and networks of stakeholders (Sayer et al., 2013). However, the links with scaling-up and scaling-down need to be explicitly represented, as household decisions at a lower-system level drive the action, and broader jurisdictional issues at higher scales provide dynamic policy contexts. Land use planning, as currently known, started in countries where claims to authority by the state were not directly challenged. Even so, land use planning failed where it was seen to be driven as a 'top down' process. In reality, rural land use planning in the developing world can be seen as an 'organized anarchy', but nevertheless, it has the potential to derive strategic ways to optimize land resources to address climate change-biodiversity-food security crises (Rudel & Meyfroidt, 2014).

The most effective part of the land use planning processes was the 'zoning', linking land use restrictions to places. Where the process was largely driven by technocrats relying on 'objective' biophysical characteristics, such as land suitability, it needed to be reconciled with the social and political contexts of decision-making and the perceptions and expectations of various actors.

In Indonesia, and similar developing countries, three additional reasons of the failures of land use planning apply. Firstly, institutional settings do not allow the land use planning process to be truly integrative since decision-making on forest land is mostly taken at the national level. Not much power is devolved to lower levels and as a consequence interactions among processes and actors that manage forest land and non-forest land remain weak. Forest land allocation is not part of local development planning, but certain responsibilities on guarding 'watershed protection' forests are vested at the local level. This discrepancy brings about inefficiency in the whole landscape planning and at the same time in forest planning and management. Secondly, lack of clarity of land tenure is a challenge for land use planning based on functions as it intersects with existing conflicts over land rights among individuals or groups; such conflicts need to be resolved in the domain of land administration, yet changes in the land use rules, as part of land use planning, can both aggravate and help resolve problems. Thirdly, technical capacity at the local government administration level is not sufficiently developed to lead the technical part of the land use planning process. Both competency and institutional capacity should be addressed. Efforts to bypass government and achieve self-regulation in oil palm as a major commodity value chain have not been successful, however (Ruysschaert & Salles, 2014).

In the remainder of this chapter we will discuss general experience with integrated land use planning as a convening and negotiation process, before introducing a specific 'tool' for integrative, inclusive and informed land use planning. We will describe our experience with using this tool in a process of reconciliation of multiple perspectives, before comparing it with wider experience in the concluding remarks.

2. Integrated land use planning as a convening and negotiation process

Land use planning is not only important in producing an implementable plan as an output; the increased probability of success brought about by the process of planning, convening and negotiating (Clark et al., 2011) is perhaps of even more importance. Three key principles in land use planning within landscape approaches are: i) integrative, (i) inclusive, and iii) informed.

The *integrative* principle acknowledges the ineffectiveness of current land-based government regulations and donor-supported, non-governmental programmes at different levels, due to lack of leadership, synergy and coordination at the planning stage. Integrative planning underlines the importance of having synergized processes and aligned objectives across conservation, development, and spatial land-use planning.

Inclusiveness is a buzz word that everybody agrees to ,but the level of operationalization in land-based-related planning really varies. For example, free and prior informed consent (FPIC) enforces inclusiveness of local and indigenous people at the stage where a land-based action is about to be taken, but not necessarily at an earlier stage of diagnosis and option exploration. We argue that inclusiveness should be endorsed as early as at the planning stage.

The *informed* principle ensures that land-based-related planning decisions are made based on knowledge that comes from data, information, and the understanding of processes and functions that are contextual. Scientific and local ecological knowledge within the policy context should be captured and modelled to simulate intervention scenarios, and therefore *ex-ante* (i.e., ahead of implementation) consequences can inform the tradeoff analysis in selecting scenarios (Bateman et al., 2013; van Noordwijk et al., 2013).

3. LUMENS in integrative, inclusive and informed land use planning

In developing countries, the application of such detailed planning within landscape approaches is rare. Three major challenges are: i) a lack of common and agreed spatial allocation within planning units (PU) and inadequate interaction among PUs across various planning processes, ii) the lack of negotiation during land use planning, and iii) the lack of a simple technical tool to allow *ex-ante* tradeoff analysis against scenarios in land use planning.

Building on the experience in reducing conflict over watershed functions in a highly contested watershed in Lampung (Sumatra, Indonesia), where the negotiation support system, consisting of a tool plus a process, was first formulated (van Noordwijk et al., 2001; Clark et al., 2011), the LUWES (Land use planning for low emission development strategy) tool emerged as a next step for district or provincial level subnational governments beyond the analysis of opportunity costs of emission reductions (Dewi et al., 2011). It was set up as a framework with a user-friendly, parsimonious and publicly available software that allows inclusivity, integration and informed negotiation of land use within a landscape. LUWES found its way to broad application in Indonesia as part of a technical step in developing province and district level mitigation action planning (Johana & Agung, 2011). On the process side of LUWES, strong positive feedback was obtained, but the lack of explicit attention to water, biodiversity and multiplier effects in a local economy was seen as an obstacle for full local 'buy-in'.

As a next step forward a tool called Land Use planning for Multiple Environmental Services (LUMENS) is currently taking shape, supported by a working group of potential users and technical experts. Again, it is to be a tool and a process. Application of LUMENS so far has had a district (in Indonesia: Kabupaten) as a focal area, but application at other scales is feasible.

As a process, LUMENS starts with stakeholder mapping, followed by bringing stakeholders into working groups. The district planning office has so far been a logical starting point. These working groups are facilitated in a joint outcome mapping (OM) process, and a series of capacity building trainings in informed negotiation on spatial allocation and land use plans and implementing strategies. OM (Earl et al., 2001) has been widely applied in behavioural change projects in developing countries; it is a vehicle to build consensus on visions, missions and outcome challenges with explicit formulation of the roles and objectives of each group of actors within the overall system and the interaction among them.

In preparation of the tool, a parallel process is the inventory, collection and compilation of data of various types that relate to the focal area. The data are converted to formats that match software packages that jointly form the LUMENS tool. This is a spatially explicit, semi-agent-based model that can accommodate a broad range of scenarios. While it is based on a scientifically sound model, we restrict local data input to be minimal, recognizing the scarcity of reliable on-the-ground data in developing countries, in contrast to increasingly reliable remote sensing data layers in public databases.

The LUMENS tool builds on the modular design of LUWES and allows the developer or future contributors to add more facilities, indicators, modelled processes to suit users' needs, as well as allow users to run only relevant parts of the software, based on their objectives. LUMENS was not developed fully from scratch; development made use of freeware and open source tools such as Quantum-GIS, FragStat, and available routines in the R environment. Figure 17.1 shows the process flow and components of the LUMENS tool. Box 17.1 lists key concepts used for the various modules.

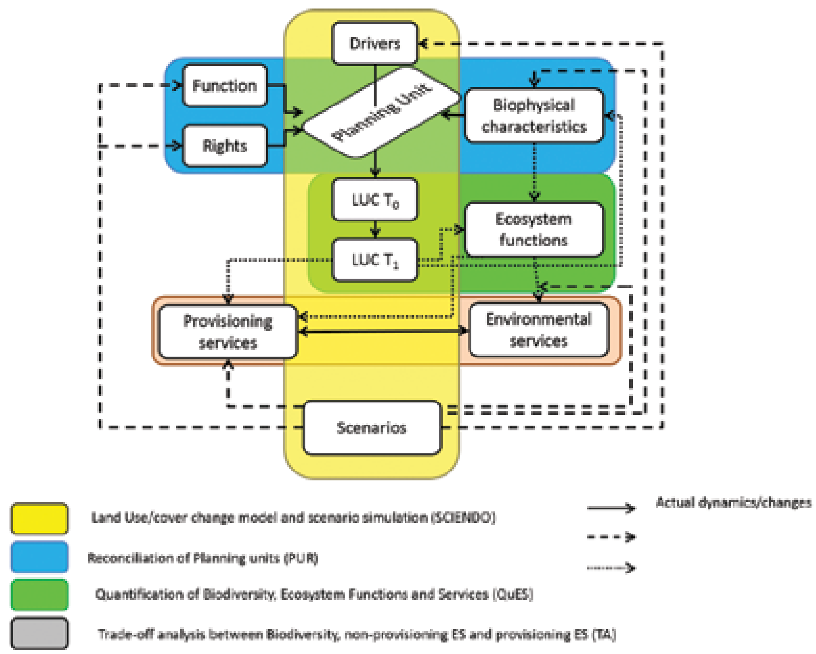

Figure 17.1 Land Use Planning for Multiple Environmental Services (LUMENS): process and components. LUC = Land Use Change; ES = Environmental Services.

Box 17.1

Steps in the LUMENS tool

(also see Figure 17.1)

1. **Delineation of Planning Units (PU's).** The units for subsequent analysis are derived in an iterative process of splitting and lumping a set of spatially explicit and non-overlapping planning units. These units serve to reconcile current socio-economic conditions with existing development and spatial plans and tenure status. Plausible intervention is specific to functions, tenure arrangements, management and other factors, and therefore planning-unit specific.

2. **Driver analysis and spatially explicit modelling of historical land use and land cover changes with respect to each PU**. Two options are provided: for large landscapes with a relatively few PU's or where the dynamics of land use and land cover change and proximate drivers that determine the dynamics are distinctive among PU, modelling is conducted for each PU, recognizing the social interactions between PU's. Otherwise, if the landscape is small, the number of PUs is high, or dynamics within the PU are relatively homogenous, a single model for the entire landscape will be sufficient. We adapt the algorithm of a Land Transformation Model (LTM) from Pijanowski et al. (2002).

3. **Quantification of biodiversity and ecosystem service consequences land use or land cover change (LULCC),** needs to estimate the contribution of each planning unit and emergent properties at the landscape level. The historical biodiversity, watershed functions and carbon stocks are accounted for from past LULCC and as current degree of ecosystem degradation relative to a pre-human reference point. LUMENS adopts the algorithm of the ABACUS tool for carbon storage dynamics (Harja et al., 2013), SWAT (Soil and Water Assessment Tool) (SWAT, 2014) and GenRiver for a water budget model and the Flow Persistence metric (van Noordwijk et al., 2011) at multiple positions in the landscape and Degree of Integration of Focal Area (DIFA) for a biodiversity measure that takes into account the configuration and composition of land uses and cover in quantifying habitat fragmentation by integrating plot-level measurement of species diversity (Dewi et al., 2013).

4. **Baseline scenario for a 'Business As Usual' (BAU) pattern of LULCC and projection of ecosystem service consequences (as in Step 3).** The likely locations of changes are projected from the driver modelling results from Step 2, allowing interactive input on, for example, location of new road development. For the baseline we assume stationary spatial processes. The quantity of change can be drawn from: i) exogenous processes, i.e., as output from other regional or global models, ii) rate of LULCC in the past, assuming a decreased rate of change in forest areas when remaining stocks are being depleted, and iii) forward looking scenario, i.e., foreseen demands from socio-economic development perspectives. Especially for ii) and iii), scenarios should be PU-specific to allow multiple stakeholders to analyze tradeoffs at multiple scale and to increase the accuracy of location projection.

5. **Development of scenarios that are intended to change the BAU trajectory towards either greener development, more aggressive and expansive development, or others.** Scenarios of land use change can range from changes to locally specific drivers that can be translated either into activity data, both non-spatially explicit input such as zone-specific areas of changes, rate of changes, or spatially explicit input such as a new concession. Scenarios can include changes in emission factors from any intervention in agricultural or

silvicultural practices or changes in practices that are associated with better management within stable land use/cover which can reduce biodiversity loss or maintain hydrological functions. A scenario that changes PUs, and therefore restrictions on the management types, is also allowed.

6. **The projection of future LULCC is conducted similarly to Step 4.** Quantification of biodiversity and ecosystem services is conducted on the projected LULCC based on development and/or conservation scenarios as in Step 3. Tradeoff analyses between biodiversity and provisioning and non-provisioning ecosystem services from the multiple scenarios produced from Steps 4 and 5 are included. At the moment, two indicators are considered: land use profitability and the multiplier effect of the land-based sector. Subsequently, a social accounting matrix is utilized for provisioning ecosystem services to compare the opportunity cost of each scenario. The tradeoff analysis, together with other considering factors, serves as a basis for the negotiation process of multiple stakeholders to select a scenario to implement.
7. **Formulation of action plans,** including necessary instruments to implement the most preferred scenario, and to clarify transaction and implementation costs that are not yet captured in the opportunity cost analysis.

Despite the absolute necessity of common perspectives on land capability, land restrictions and land managers across the landscape for inclusive planning, it is rare that zoning is discussed and conducted beyond land capability zoning. We will elaborate the way the process and the tool interact within Planning Unit Reconciliation module (PUR) of the software in conjunction with data compilation and verification, discussions with stakeholder groups and key informants, to flush out the negotiation part of the overall tool.

4. LUMENS as a process: reconciliation of multiple perspectives into PUs

Legal pluralism implies that multiple perspectives on land rights coexist. Negotiation processes often have an 'agree to disagree' stage, where differences are clarified and differentiated from common ground. Within the landscape such a stage can arise between stakeholders which include local and national government, those who self-identify as indigenous people, local communities, migrants and the private sector with land use concessions (Galudra et al., 2014). Recognition of multiple and partially divergent perspectives is needed to move forward in a reconciliation process. Inclusion of the spatial representation of a claim does not imply legal or formal recognition, but it may help in analysis of consequences of current negotiating positions. Planning land uses only based on formal land allocation and ignoring existing uses would result in unrealistic and non-implementable plans. Aligning the functions and the group of stakeholders' desirable uses with the realities and future demands needs to go beyond the typical land capability zoning. Planning unit reconciliation should aim for representation of the perspectives of both the rural poor and urban settlers.

The reconciliation process is technically supported by the PUR module in LUMENS. The module clarifies tenure conflicts or overlapping permits as a first step towards resolving conflicts. PUR provides a technical tool to combine multiple layers of relevant information into planning units that capture multiple views on how to define zones. These planning units then can be discussed and negotiated to produce reconciled planning units.

The process consists of two sequential parts:

1. A zoning process to identify areas of high similarity in a diverse landscape is conducted based on biophysical characteristics, existing spatial plans, local development strategies and socio-economic conditions. Two main activities are: 1) inventories and compilations of land-based development plans, biophysical characteristics (including topography, climate, land use/cover, etc.), maps of permits and concessionaires, and social economic layers (obtained from various government agencies, local community groups, non-governmental organization (NGO)'s, university researchers and other stakeholders at local and national levels); 2) spatial analysis using a Geographical Information System (GIS) to create and combine spatial layers of all available data. The outputs are maps of land parcels making up the landscape, with combined attribute tables of functions, permits and land use/cover. The table reveals conflicting functions and overlapping permits, inconsistencies between functions and existing land use/cover and other peculiarities that need to be resolved. This map enables multiple stakeholders to understand the landscape as a whole, including the potential conflicting agenda and perspectives among them. Multiple stakeholders can use this map as a basis for expressing their perspectives and negotiating them, within the existing regulatory framework for immediate actions, or beyond for further formal process.
2. A reconciliation process to divide the landscape into planning units with minimum inconsistency of, and conflicts in functions, uses and perspectives. The first option in the technical steps is to have the forum of multiple stakeholders to go into the details of each of the problematic areas and resolve them manually case-by-case through discussions. This option can be very time consuming if the quality of data layers is low and complexities of land-related issues are high. The second option is to have the forum discuss the hierarchy or level of priorities among the data layers occupied to produce the planning units, for example, land allocation as the highest level of priority, community-based management as the second, and permits as the third. This hierarchy can be developed by discussions or through an Analytic Hierarchy Process (AHP). Each inconsistency and conflicting allocation can then be resolved, automatically setting such rules in the software. There are cases where reconciliation is not possible without some further legal process and in this case such land parcels are grouped into a class with a particular note on potential conflict.

Figure 17.2 Merangin working group conducting planning unit reconciliation (left); mosaic of cropland and agroforests in river valley of Merangin (right).

The reconciled planning units, as the way to divide up the landscape, become the basis of stakeholder mapping (i.e., who makes decisions, who are the actors, who benefits), deriving understandings on drivers of land use changes in the past, quantifying the contributions of areas, actors, institutions on the past changes and impacts, identifying hotspots of threats, deciding on leverage points and interventions, planning for development and conservation, and advising on benefit-sharing and distribution of a rewards for a ecosystem services provision scheme. This step can be one of the tools within a safeguard information system of the Reducing Emissions from Deforestation and forest Degradation (REDD+) mechanism. All the subsequent steps within land use planning will rely on the PUs for the historical analysis of land use/cover changes and ecosystem functions, for the baseline scenario development and intervention scenario developments. PUs can also be altered as part of intervention scenarios. Conventional land use planning does not acknowledge the multiple perspectives and mostly refers to either the legal perspective or the purely biophysical land capability.

Others steps within LUMENS (Box 17.1) are more technical in nature and are not elaborated further here, but examples of results are provided in Box 17.2.

Box 17.2

LUMENS Application in Merangin, Jambi, Indonesia

Merangin is a district located in the southwest of Jambi Province, Sumatra. The total area spans 7,679 km^2, from lowlands in the east extending up to Bukit Barisan mountain range foothills in the west (Figure 17.3). Starting in 2011, researchers from the World Agroforestry Centre (ICRAF) have been collaborating with a working group in Merangin District, to develop land use plans within low emission development strategies using the LUWES tool. Since 2013, the working group has broadened the scope of analysis beyond carbon through the application of LUMENS, by considering biodiversity and watershed functions as well.

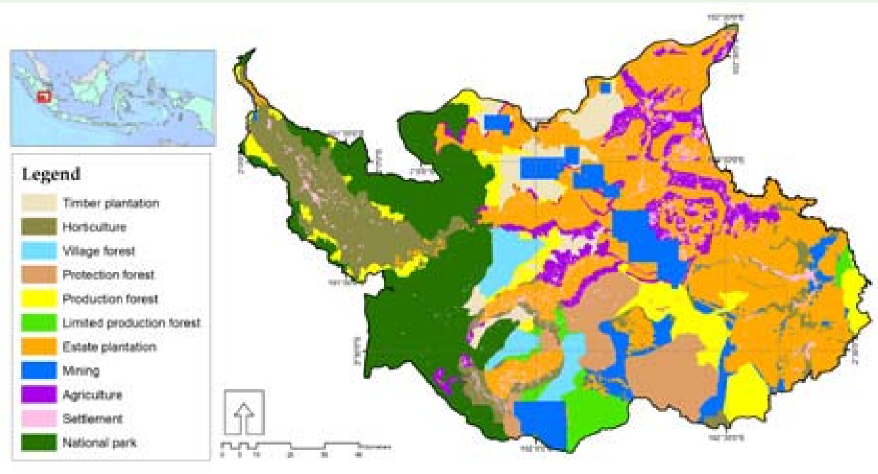

Figure 17.3 Planning Unit map resulting from the reconciliation process.

Based on historical time series of land cover maps of Merangin in 1990-2000-2005-2010, the land cover change in Merangin consists of deforestation and forest degradation to mixed rubber forest systems followed by the vast increases of oil palm monoculture and rubber monoculture plantations. As the result of the reconciliation of PUs (Step 1 of LUMENS), a PU map was produced (Figure 17.3).

Several scenarios of future land uses and land use changes have been built based on historical dynamics and trends: 1) Business as usual scenario (BAU): historical change is retained, assuming stationary processes and drivers; 2) Expansive agricultural development scenario (Expand): speeds up the conversion of forest to oil palm, acacia plantation, and agroforests; 3) Green development scenario (Green): undisturbed forests will remain intact, most logged over forest is retained, degraded areas in protected forest areas rehabilitated. Figure 17.4 showed the simulated land cover map of Merangin in 2015-2020-2025 under the three different scenarios.

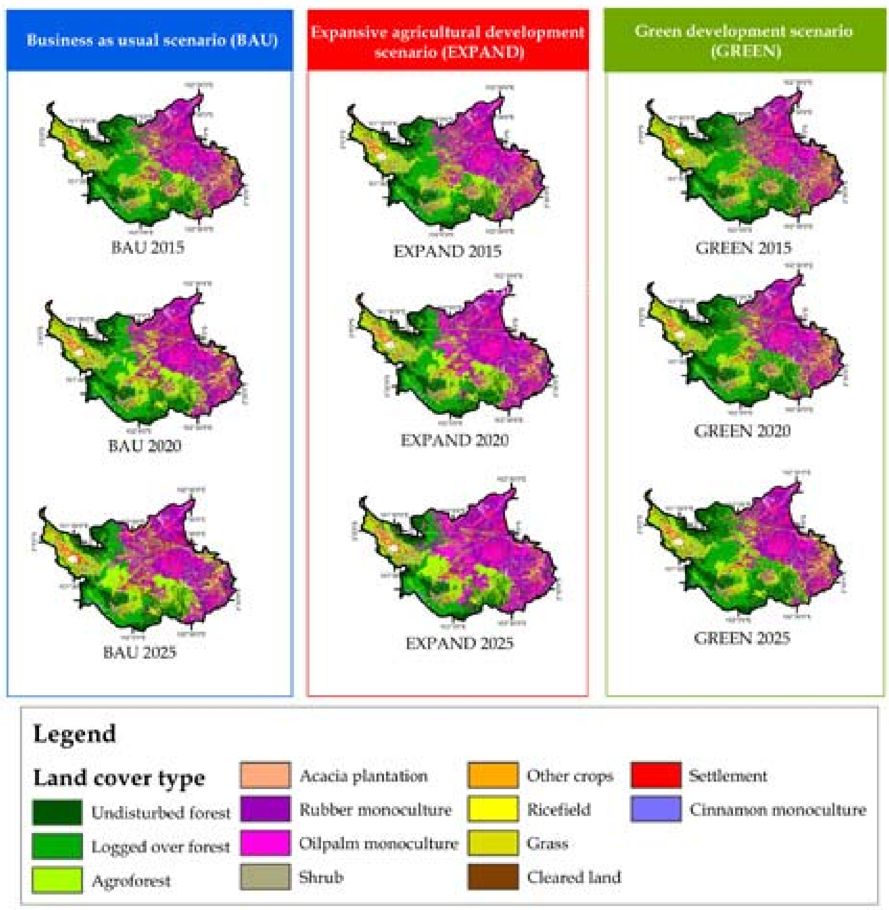

Figure 17.4 Projections of land use/cover maps to 2025 under the three different scenarios.

Figure 17.5 shows the Degree of Integration for Focal Area (DIFA), one of biodiversity indicators within LUMENS, continuing to decline under the Expand (13.11%) and BAU (14.29%) scenarios, but remaining stable relative under the Green scenario (17.95%). Cumulative net emission increase under Expand and BAU. Spatially explicit projections of the above scenarios up to 2025 are used to further estimate the *ex-ante* economic benefit and ecosystem services from the LULCC. The BAU scenario projection up to 2025 shows on average a 3.1% growth in total land use profitability, while that from Green shows a -0.2% growth and Expand, 6.9%. Opportunity costs (i.e., the economic benefit generated from land use changes that result in carbon dioxide (CO_2) emissions) are relatively high. From the BAU scenario, only 7.6% of total emissions (Figure 17.4) are associated with less than 5 USD. In total, the Green scenario reduces 23% (199.3 ton CO_2 equivalent (e)/hectare (h) a) of emissions from the BAU scenario (258.5 tCO_2e/ha), while Expand increases emissions by 6% (275.1 tCO_2e/ha). Considering the difference between total land use profitability between the Green and BAU scenarios, the opportunity cost of implementing the Green scenario amounts to 26.1 USD per t of reduced CO_2e emissions, which is towards the high side of carbon's market price. Relying on full compensation benefits from external sources will neither be feasible nor sustainable. Co-investment between internal actors and external players is deemed necessary for maintaining ecosystem services in the long run. Beyond carbon, biodiversity and watershed functioning are perhaps the two most relevant factors to local actors and communities.

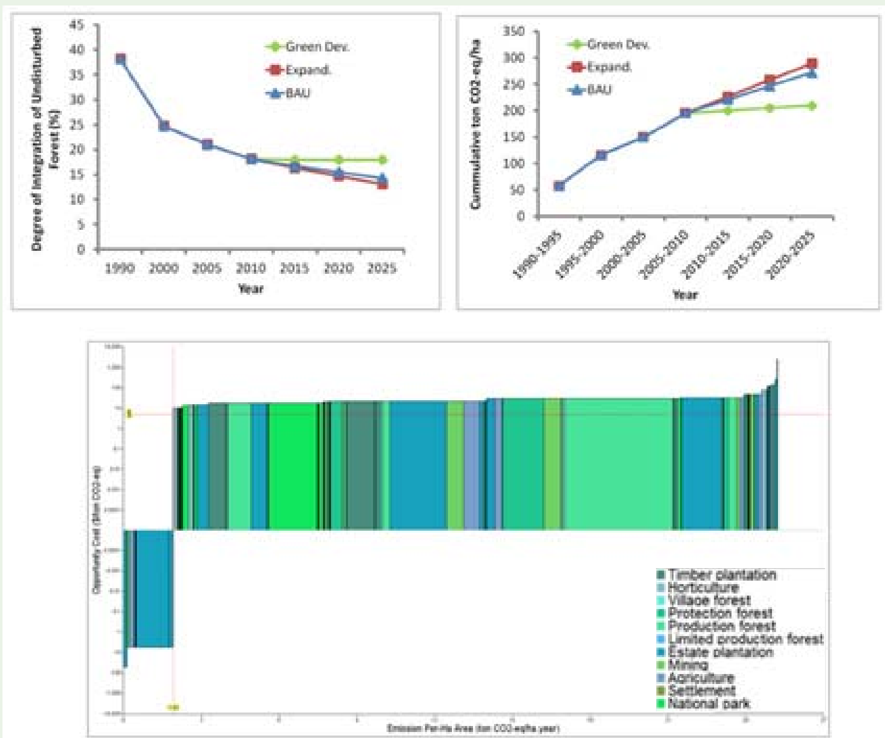

Figure 17.5 Changes over time (due to actual land use/cover changes until 2010, and scenario-based projection of land use/cover changes from 2015-2025) for the DIFA biodiversity measure (top left), land-based emissions (top right) and Opportunity Cost Curve of the BAU scenario from 2010-2015 (bottom).

5. Concluding remarks

Beyond well-explored principles, there are major gaps in operationalizing a productive landscape approach in tropical landscapes. In LUMENS, a landscape is interpreted as a contiguous area, large enough to contain heterogeneity in biophysical characteristics and human-social-political-cultural dimensions, with intra-dependencies that dictate some shared agenda among the constituents. The intended outcome of the tool is the identification of common objectives and the establishment of agreed rules, with the final goal of achieving sustainability. The application recognizes the jurisdictional level at which the process of development of policies and regulation, and development and conservation planning and strategies take place. It is compatible with 'jurisdictional approaches' as discussed in the REDD+ arena.

The experience from working in Merangin District in Jambi Province, Indonesia, has been insightful and encouraging. Facilitation and capacity strengthening of the multiple stakeholder negotiations in planning have been fruitful on many accounts resulting in: raised awareness, developed skills, an improved database, active interaction among members and with external actors, and feedback with regards to tool development. We trust that the outcome of the process will take us closer toward an operational landscape approach to achieve a sustainable landscape. Technical backstopping and relatively low resource support have brought the working group to a different level of interaction and informed decision-making processes. The working group is to collaborate further in refining and finding better options and scenarios, formalizing the results and mainstreaming them into policies and implementation. Some members have also been invited to share their experiences with other districts and at the province and national levels. Currently the district is a strong candidate for REDD+ piloting, with funding available through the national programme that allows some action plans to be implemented.

LUMENS software is to be developed further before the alpha version is launched. However the proof of concept has been very encouraging. Further development will be to link the scenario models at the district scale with optimization models at a broader scale to cater for global and national drivers better, and therefore to accommodate wider ranges of policy scenarios. Proof of application in several other districts in other provinces in Indonesia is planned, with possibilities of further applications elsewhere. In the current discussions on appropriate scales and institutions to reduce emissions that derive from forest conversion, a combination is needed between changes in the way forest institutions operate and changes in the way local governments interact with forests. Whether this is called a 'landscape approach' or a 'jurisdictional approach', it requires both technical tools to effectively use the wealth of spatial data that can currently be generated, and a process of negotiations between stakeholders who initially may be far apart in perspectives. The tools need to be flexible for use under various circumstances, but yet be sufficiently defined to speed up learning and transfer to other users. In very few, if any landscapes, will emission reductions be a dominant rationale for actions – it is thus important that the tools focus on multiple environmental services, with emission reductions as an easily quantified co-benefit.

Acknowledgements

The works on LUMENS development, testing and applications will not have happened without its predecessor, LUWES (Land Use Planning for Low Emission Development Strategy). Therefore the authors would especially thank Degi Harja Asmara, Feri Johana, Putra Agung, Gamma Galudra, M. Thoha Zulkarnain and Lisa Tanika for the fruitful collaborations on LUWES development and application. We are also indebted to the Merangin working group, in particular, Dony Fadila and Nana, for their strong commitment and enthusiasm throughout the process, and moreover the invaluable input on the tool. This work has been supported by the European Commission, Danish International Development Agency, CGIAR and the Margaret A. Cargill Foundation.

References

Bateman, I. J., Harwood, A. R., Mace, G. M., Watson, R. T., Abson, D. J., Andrews, B., … Termansen, M. (2013). Bringing Ecosystem Services into Economic Decision-Making: Land Use in the United Kingdom. *Science*, 341, 45-50.

Clark, W. C., Tomich, T. P., van Noordwijk, M., Guston, D., Catacutan, D., Dickson, N. M., & McNie, E. (2011). Boundary work for sustainable development: natural resource management at the Consultative Group on International Agricultural Research (CGIAR). *Proceedings of the National Academy of Sciences*. doi:10.1073/pnas.0900231108

Dewi, S., Ekadinata, A., Galudra, G., Agung, P., & Johana, F. (2011). *LUWES: Land use planning for Low Emission Development Strategy*. Bogor, Indonesia: World Agroforestry Centre - ICRAF, SEA Regional Office.

Dewi, S., van Noordwijk, M. Ekadinata, A., & Pfund, J. L. (2013). Protected areas in relation to landscape multifunctionality: squeezing out intermediate land use intensities in the tropics? *Land Use Policy,* 30, 38–56.

Earl, S., Carden, F., & Smutylo, T. (2001). *Outcome Mapping*. Ottawa, Canada: International Development Research Centre.

Galudra, G., van Noordwijk, M., Agung, P., Suyanto S., & Pradhan, U. (2014). Migrants, land markets and carbon emissions in Jambi, Indonesia: land tenure change and the prospect of emission reduction. *Mitigation and Adaptation Strategies for Global Change, 19*(6), 715-732.

Harja, D., Dewi, S., van Noordwijk, M., Ekadinata, A., Rahmanulloh, A., & Johana, F. (2013). REDD abacus SP. In van Noordwijk, M., Lusiana, B., Leimona, B., Dewi, S., & Wulandari, D. (Eds.) *Negotiation-support toolkit for learning landscapes*, 197-200. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Johana, F., & Agung, P. (2011). *Planning for low-emissions development in Merangin district, Jambi province, Indonesia.* Brief No 19. Bogor, Indonesia: World Agroforestry Centre - ICRAF, SEA Regional Office.

Pijanowski, B. C., Brown, D. G., Shellito, B. A., & Manik, G. A. (2002). Using neural networks and GIS to forecast land use changes: a land transformation model. *Computers, Environment and Urban Systems, 26*(6), 553–575.

Rudel, T. K., & Meyfroidt, P. (2014). Organizing anarchy: The food security–biodiversity–climate crisis and the genesis of rural land use planning in the developing world. *Land Use Policy*, 36, 239-247.

Ruysschaert, D., & Salles, D. (2014). Towards global voluntary standards: Questioning the effectiveness in attaining conservation goals. The case of the Roundtable on Sustainable Palm Oil (RSPO). *Ecological Economics*, 107, 438–446.

Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J-L., Sheil, D., Meijaard, E., … Buck, L. E. (2013). Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. *Proceedings of the National Academy of Sciences, 110*(21), 8349–8356. doi: 10.1073/pnas.1210595110

SWAT (Soil & Water Assessment Tool). (2014). SWAT: *Soil & Water Assessment Tool.* Texas: Texas A&M University. Retrieved from http://swat.tamu.edu/

van Noordwijk, M., Tomich, T. P., & Verbist, B. J. (2001). Negotiation support models for integrated natural resource management in tropical forest margins. *Conservation Ecology, 5*(2), 21. Retrieved from http://www.consecol.org/vol5/iss2/art21 van Noordwijk, M., Widodo, R. H., Farida, A., Suyamto, D., Lusiana, B., Tanika, L., & Khasanah, N. (2011). *GenRiver and FlowPer: Generic River and Flow Persistence Models. User Manual Version 2.0.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. Retrieved from http://www.worldagroforestry.org/sea/publication?do=view_pub_detail&pub_no=MN0048-11

van Noordwijk, M., Lusiana, B., Leimona, B., Dewi, S., & Wulandari, D. (Eds.) (2013). *Negotiation-support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Community meeting in Lanzi Village, Uluguru Tanzania. Photo credit: Miika Makela

CHAPTER
18

Institutional arrangements for climate-smart landscapes

Susan W. Wambugu, Susan W. Chomba and Joanes Atela

Highlights

- This chapter highlights seven institutional benchmarks for achieving climate-smart landscapes
- Case study analysis shows that the benchmarks are highly contextual in practice
- Achieving the benchmarks in practice involves synergies and tradeoffs
- Optimal choices involves strategic choices such as targeting investments with knock on effects on other benchmarks

1. Introduction

"Institutions are the multitude of means for holding society together, for giving it a sense of purpose, and for enabling it to adapt" (O'Riordan & Jordan, 1999).

Landscapes are gaining policy and scientific attention as a means to addressing the multiple aspects of climate change. Climate-smart landscapes operate on the principle of integrated landscape management encompassing ecological, social and economic actions that synergize adaptation and mitigation within the target landscape (Scherr et al., 2012). In climate-smart landscapes, institutions play a central role in structuring risks and sensitivity to climate hazards. They are critical as mechanisms for enabling or constraining individual and collective responses to climate risks and hazards (Agrawal, 2010). This chapter broadly defines institutions as a system of laws, rules, norms and regulations that define, constrain, and shape actors' interactions (North, 1990; Ostrom, 1990). Ideally, institutions comprise interactions of multiple actors at various levels to formulate and implement rules and regulations or norms that shape resource use and access at the landscape level. This chapter focuses on these actors, their roles, and how they organize themselves to respond to climate change challenges in landscapes.

The analysis undertaken is mainly concerned with the performance of multi-level actor interactions in practice based on key institutional benchmarks drawn from institutional literature. It specifically aims to evaluate how present institutional arrangements of climate-smart interventions apply these benchmarks, and then suggests possible improvements that could enhance the initiatives' work in achieving climate-smart landscapes. The specific objectives of the chapter are to: 1) highlight institutional arrangements in climate-smart agriculture and forestry landscapes and 2) to apply benchmarks on institutional arrangements, drawn from the literature, to determine the extent to which they are realizable in practice.

The chapter constitutes six sections. This brief introduction is followed by an overview of the various actors usually present in a climate-smart landscape and their roles. The third section briefly discusses the seven institutional benchmarks for climate-smart landscapes. These benchmarks are then applied in section four to evaluate the performance of ongoing climate-smart interventions within agriculture and forestry landscapes. Discussion and concluding thoughts for achieving climate-smart landscapes in practice are outlined in the last two parts.

2. Overview of institutional arrangements in climate-smart landscapes

Several actors with different roles and relationships interact within landscapes. They have different mandates and interests, capabilities and weaknesses, necessitating interactions within and across levels which are governed by laws, rules and regulations as illustrated below.

Actors and policies operating at various levels, global to local, shape climate-smart landscapes that explicitly address mitigation and adaptation. For instance, global level actors generate and disseminate climate-related knowledge applicable at global, regional and local levels. Such actors include the Intergovernmental Panel on Climate Change (IPCC) and the United Nations Framework Convention on Climate Change (UNFCCC) and its subsidiary bodies. Both provide platforms within which states and non-state actors design, negotiate and commit to global emission reductions. Decisions reached

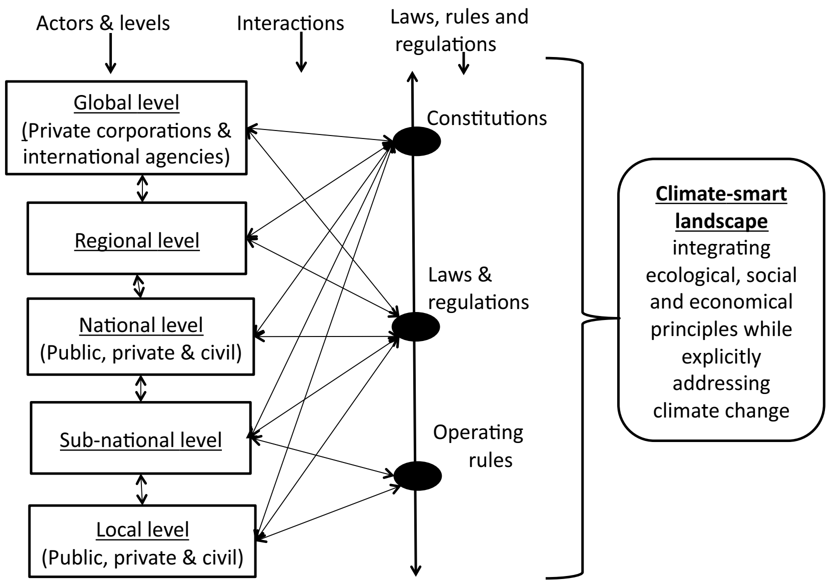

Figure 18.1 Institutional arrangements, i.e., actors and their interactions at various levels, governed by laws, rules and regulations in shaping landscapes (developed from multi-level governance perspectives and social dimensions of climate change) (Adger, 2001; Cash et al., 2006; Mwangi & Wardell, 2012; Meinzen-Dick et al., 2013).

at this level have an impact on the nature of decisions and activities at the landscape level. Furthermore, the knowledge generated forms the basis for setting up funding mechanisms by multilateral agencies such as the World Bank and UN bodies for landscape-level actions. Other global level actors include scientific bodies such as the CGIAR Consortium which generates scientific knowledge, for example, on agroforestry systems and climate-smart agriculture, often piloted at the landscape level. A host of international nongovernmental organizations have also emerged to advocate for equity and rights in climate change initiatives such as Reducing Emissions from Deforestation and forest Degradation (REDD+). In their actions, these actors provide feedback to the national and international levels through policy recommendations.

At the regional level, a number of bodies with collective policies and goals act as intermediaries between states and the international agencies. Regional bodies comprising of Non-Governmental Organizations (NGOs) such as the Tropical Rainforest Alliance and intergovernmental agencies such as the Central African Forest Commission (COMIFAC) advocate for the interests of their member states at international negotiations, but also formulate ways of addressing regional-level climate change and sustainability challenges. Such regional actors are important for addressing environmental challenges in trans-boundary landscapes such as forests, mountains and lake basins. For example, COMIFAC in the Congo Basin constitutes 10 member states, and advocates for sustainable management of forests, including issuing joint submissions to the UNFCCC on behalf of its member states. Essentially, regional networks are significant in creating synergies, building human, political and financial capital for climate actions that transcend geographical boundaries.

At the national level, government ministries, parastatals and related agencies formulate, guide and facilitate the implementation of climate and related policies at the national, subnational and local levels. Linked to the global level, these actors are critical for successfully embedding mitigation and adaptation actions to the broader national level policies, defining resources rights, e.g., tenure, trees and carbon, at the local level. There are major critiques of the institutions at this level so far including lack of coordination and weak linkages within government organizations and across different sectors, inadequate capacity for climate monitoring, funding dependency and consequent global subordination by funding agencies (Brown et al., 2010; Atela, 2013).

At the local level, institutions are critical in shaping how local communities are affected by, and respond to, climate-related challenges. They mediate individual and collective action in four critical ways: by shaping the impact of climate change and vulnerabilities of communities to climate change; by shaping the manner in which communities respond to climate change; by acting as intermediaries for external support between the local communities and the intervening agents (Agrawal et al., 2008); and by providing the medium for local representation and access to external resources. Informal institutions (denoting non-codified rules and norms, e.g., customary rules) are more prevalent at this level, and include communal regulations and norms that define access and use of key resources such as land and forests. Despite the critical role of local level institutions, they are mainly treated as recipients of climate-related knowledge in many interventions. A number of obstacles such as social resistance to change, weak governance, lack of information on climate-related disasters as well as lack of assets and insurance that can enable them to withstand shocks are presented as their main weaknesses (Agrawal et al., 2008; Alemagi et al., 2014). Despite these setbacks, local networks (organizations as well as individuals) are increasingly becoming connected to regional and global networks, introducing new opportunities, and risks (Mwangi & Wardell, 2012).

In summary, institutional networks and collaborations at the landscape scale often involve a complex mix of the above, presenting challenges in choices (who to work with), display of power relations, bureaucratic challenges and sometimes social and cultural resistance. Despite the complexity and challenges of working across many scales and levels, such interactions have great potential for synergies. At this juncture, it is critical to note that although climate change as an explicit subject has only started being addressed by institutions in various landscapes, multiple institutions pre-existed as evidenced by different actors, rules and roles in many agriculture and forestry landscapes. The experiences from such previous interactions may help build lessons and progress towards climate-smart landscapes. In the next section, we review these lessons in the form of benchmarks, with which we assess real landscapes based on practical experiences.

3. Key benchmarks for institutions in climate-smart landscapes

Here we present seven benchmarks which are outlined in the literature as crucial in defining climate-smart landscapes. While the benchmarks cut across various landscapes (such as forestry, agricultural, urban, coastal and drylands), the variations between landscapes will determine what criteria are prioritized. Our presentation however does not imply any order of importance or that this list is exhaustive in itself. Rather, they serve as reference points which we can use to analyze institutional arrangements for climate-smart landscapes.

The benchmarks are drawn from and expanded using a variety of sources, including Eco-Agriculture Partners four 'institutional mechanisms' (Scherr et al., 2012); the six "INS" of climate-smart agriculture (Meinzen-Dick et al., 2013) and other selected literature. Subsequently, we identify indicators for each benchmark to better illustrate how they are operationalized as presented below.

3.1 Participatory and collaborative processes

Various actors ranging from government, international agencies, non-governmental organizations, local communities, and the private sector get involved in initiatives at the landscape level (Scherr et al., 2012). Bringing together actors provides the opportunity to "… negotiate priorities, [and] recognize legitimate local, regional, national and business interests" (Scherr et al., 2012). The process can also facilitate the building of partnerships, sharing of knowledge, and pooling of resources. A collaborative approach aids in building the requisite social capital necessary for ensuring the long-term sustainability of climate-smart practices in the landscape (FAO, 2013). To operationalize this benchmark in our cases, we focus on the inclusivity of the planning and implementation processes of the climate-smart practices through: a) the variety and levels of actors in the landscape, b) what levels and sectors they represent (if applicable), d) the presence and nature of local representation, i.e., descriptive versus substantive, and e) how resources, knowledge and decision-making powers are shared among the actors.

3.2 Secure tenure

The landscape as a unit of production, economic endowment and an environmental regulation unit is closely linked to property rights which define ownership and access to key resources such as land and forests (Lyster, 2011). Access to land, including clear and secure tenure, as well as historical patterns of distribution determines the ability of households to make investments on lands, contribute to their own food production and access to credit (Cotula & Mayers, 2009). For instance, access to benefits associated with carbon is largely determined by land, forests and tree tenure, as demonstrated through the case studies (see Box 18.1). In the case studies, we focus on a) clarity and security of land tenure, forests and tree tenure and b) use and access rights of these resources.

3.3 Equitable benefit-sharing mechanisms

Benefit-sharing mechanisms are important for articulating equity in benefits between actors occurring across the various levels (international, national, landscape and local) and within levels (e.g., within communities) (Luttrell et al., 2013). As value chains are created within forestry and agriculture landscapes, the associated costs and benefits of actions to actors helps to indicate climate-smart potential. This requires paying attention to equity issues crucial for checking against elite capture of benefits from marginalized groups in the society such as migrants, low castes, native forest dwellers, women and youth (Westholm et al, 2011; McDermott et al., 2013). Under this benchmark, we focus on the actual benefits-sharing mechanisms in the landscapes. Gender equity in benefit-sharing is however tackled separately (see next section, 3.4). We specifically consider the following criteria in our analysis: a) clarity and transparency in benefit-sharing mechanisms, b) equity in benefits, c) actor accountability in benefit sharing, and d) a pro-poor benefit-sharing approach.

3.4 Gender consideration

Social stratifications, and particularly those surrounding gender are key considerations in forestry and agriculture climate-smart landscapes (Leach et al., 1999). This stems from the fact that there are differentiated gender roles, rights and values that have been shown to be associated with such landscapes. For instance, land and tree tenure in societies where ownership of such recourses is along patrilineal lines compromises the ability of women to make decisions and benefit from such resources. On the other hand, significant gender differences exist in values such as collaboration, solidarity and conflict resolution among men and women (Westermann et al., 2005). In the cases analyzed, we focus on the following gender indicators: a) representation of women and youth in decision-making, b) active participation in the project activities, c) gender equity in benefit-sharing mechanisms, and d) gender-biased cultural practices.

3.5 Strategic targeting of investments

Successful achievement of a climate-smart landscape requires that waste of resources is minimized both through pooling of resources intended to meet similar objectives and putting the same resources to multiple uses along the chain of project formulation and implementation (Scherr et al., 2012). This is important for ensuring that funds are put to the most effective and efficient uses possible. Harmonized interventions create opportunities to target the same funds at initiatives with multiple, interrelated, and sustainable objectives (Visseren-Hamakers et al., 2012). This may involve channelling various funding streams (whether public or private) through a common mechanism. Our analysis examines whether such mechanisms exist in the case study landscapes and specifically: a) whether they are pro-poor in their targeting, and b) whether funds from diverse sources are directed towards common objectives.

3.6 Monitoring and evaluation of impacts

Because there are so many objectives to be met within a climate-smart landscape, the ability to track and monitor them becomes important (Scherr et. al 2012). While the purpose of this chapter does not include developing indicators for monitoring success, we seek to gain an understanding of whether there are systems in place for tracking change over time to determine if the goals (ecological, social, economic, climate-related) are being met. We focus on a) whether there are credible verification standards present for tracking carbon fluxes, b) whether local communities participate in the monitoring of carbon fluxes, c) changes in livelihoods, d) monitoring of other goals such as wildlife conservation, and e) whether there is opportunity for continuous research and learning in the landscape. Some of these goals compete and complement each other and therefore we look at mechanisms for addressing tradeoffs and synergies at the landscape level.

3.7 Explicitly addressing mitigation and adaptation needs

At the heart of 'climate-smart' landscapes is the inclusion of mitigation and adaptation goals in the broader context of the landscape (Duguma et al., 2014). The roles of actors present in the landscape in meeting these goals need to be clearly understood. For our analysis, we focus on a) carbon sequestration, b) emissions reductions, and c) adaptation of livelihoods and the ecosystem to climate change impacts.

The following section consequently applies these benchmarks to three agriculture and forestry case study landscapes in Kenya to assess the extent to which they are considered. But first we provide an overview of the methods, and a case study box with summaries of the historical background of the individual case studies.

4. Empirical cases on institutions in climate-smart landscapes

The cases presented are based on empirical data collected using mixed methods designed under two PhD and one MPA studies conducted in Kenya between 2011 and 2014, (see Wambugu, 2012; Atela, 2012, 2013; Atela et al., 2014; Chomba, in press; Chomba et al., in press). Each individual study entailed different, but related objectives, embedding institutional research, with common findings on multiple and complex institutional arrangements in each of the cases. The authors draw from their primary and secondary data, as well as field experiences to evaluate the cases against the benchmarks.

The three case study landscapes include: the Kasigau Corridor Carbon project in southeastern Kenya, the Kenya Agricultural Carbon project (KACP) in western Kenya and the Kamae-Kipipiri project in central Kenya. Box 18.1 provides an overview of the varied ecological and social characteristics of the three projects.

Box 18.1

Brief histories and backgrounds of the three case study landscapes

Kasigau Corridor Carbon Project

The Kasigau landscape is a mosaic of dryland forests interspersed with pastoral areas and farmlands. Located in the southeastern part of Kenya, the area has historically supported agropastoralism by local communities and wildlife conservation activities (it lies between two national parks). A REDD+ carbon project was introduced in the late 2000s by a private land holding company, Wildlife Works, on its Rukinga Ranch. The project was intended to supplement ongoing conservation efforts by supporting alternative livelihoods of local communities aimed at reducing pressure on the forest, protecting biodiversity, and contributing to climate change mitigation. The project has since spread to other communal and privately held ranches in the area with the sale of carbon credits and distribution of benefits amongst various actors already ongoing. Community members have formed Location Carbon Committees (LCCs) to represent their views in the project's decision-making processes. The certified project applies the Verified Carbon Standard (VCS) and Climate, Community and Biodiversity Alliance (CCBA) standards for the credits which are mainly sold to international corporations. Private landholders get direct cash benefits (in some form of easements) as they have a contractual agreement with the project implementer, Wildlife Works, to that effect. Project costs are then deducted and the reminder is allocated between the various LCCs and Community Based Organizations (CBOs) for spending on prioritized community projects. Although the project is well known and widely cited, the State has no direct involvement in it.

Kenya Agricultural Carbon Project

The project is being implemented over a large area in a landscape in western Kenya around Lake Victoria. The area has traditionally supported smallholder farming and fishing communities and human settlements. The main crops grown are maize, beans and potatoes. There is also a protected humid tropical rainforest in the wider landscape (not covered by the project). A number of past interventions to improve farmer outcomes and productivity by state and non-state actors (such as the Kenya Agricultural Research Institute and the World Agroforestry Centre) have been implemented. The ongoing Kenya Agricultural Carbon Project (KACP) is run by Vi Agroforestry, an international NGO and supported by the World Bank. Other stakeholders include approximately 60,000 farmers, the local administration, and local CBOs. The project aims to achieve a 'triple-win' scenario, i.e., achieve mitigation, adaptation, and food security while addressing land degradation and farmer livelihoods. Certified carbon credits generated from sustainable agricultural land management practices such as agroforestry are verified using the VCS certification and partly sold to the World Bank's BioCarbon Fund. Although farmers are meant to receive direct cash benefits from these sales, these are yet to be significant as carbon prices remain low and project and technical costs are prioritized.

Kamae-Kipipiri

The Kamae-Kipipiri landscape is found in the Central Region of Kenya in the Aberdare Ranges. The mountain ranges are heavily forested and serve as wildlife habitat and water catchment areas for many of the country's larger watersheds. Much of the forest is protected but has suffered deforestation and degradation as large and small-scale farming and associated human settlements have been established. The Green Belt Movement (GBM) has worked with local communities, and women in particular, to restore indigenous forest and plant more trees on farms since the late 1970s to protect the watersheds and improve livelihoods. It initiated a carbon project in the landscape in 2007 in partnership with the Kenya Forest Service (KFS), local community forest associations (CFAs) and with support from the World Bank. The project aims to reforest depleted areas and reduce degradation from human activities such as overgrazing thus addressing mitigation, adaptation and other landscape goals. Carbon credits generated from project activities are sold to the World Bank's BioCarbon Fund with benefits accruing to the communities in the form of prioritized development projects after deduction of project costs.

All the three projects state their focus is on achieving climate-smart practices, but the outcomes vary in different ways. To understand the ways in which the projects attend to the institutional benchmarks, we assess and present the benchmarks and corresponding indicators under each of the projects in the matrix presented in Table 18.1.

5. Discussion

The cases presented exhibit a diversity of actors from private, to state and civic, operating at different levels, i.e., from international to regional, national and local levels. The nature of activities in the landscapes also varies from wildlife and forest conservation to assisted regeneration and on-farm tree planting but with a focus on building climate-smart landscapes. In this section, we discuss the similarities as well as the differences across the three projects in addressing the seven benchmarks.

One of the key striking similarities is that all the projects are mainly planned and implemented by international and civil society organizations, while including national and local-level actors as partners. Thus we can argue that these do not represent 'home grown solutions to home grown problems' in the landscapes. This is not surprising, considering that the projects, which started either under REDD+ or the Clean Development Mechanism, are technical in nature or are designed based on technical guidelines which are beyond the capabilities of local communities. As a result, the projects exclude local communities, and sometimes even national-level actors such as in the case of Kasigau, and only engage them in the projects as participants in implementation.

Similarly, monitoring and verification of carbon, livelihood and biodiversity impacts was implemented through technical guidelines under CCBA and VCS, mainly by the project proponents, with little or no input by the communities. As such, the process remained largely technocratic and a privilege of the project proponents. An exception however was noted in the KACP, which attempted to engage farmers in carbon monitoring through the Activity Baseline Monitoring System (ABMS). However, the process, due to its technical linkage to credible verification requirements under the VCS, remained science-driven, oblique and factually subjective to the farmers. The technicalities around scientific standards of farmer sampling did not account for farmers' consent, language for understanding, raising further concerns on the credibility of information provided by farmers in the farmer evaluation forms.

All three projects had had positive indicators for pro-poor targeting either through their geographical scope, distribution of benefits, or incorporation of various other non-

Table 18.1 Comparative matrix for the three case projects aiming to achieve climate-smart outcomes in various landscapes.

Climate-smart benchmarks and indicators	Kasigau Corridor Project	Kenya Agricultural Carbon Project (KACP)	Kamae-Kipipiri Project
Participatory and collaborative processes			
a) inclusivity of actors in the planning and implementation processes of climate-smart practices	Project design was done mainly by Wildlife Works, an international private corporation based in the US. The local community was involved in planning and implementing the already designed activities.	Project design was done mainly by Vi Agroforestry, an international NGO, in collaboration with consultants from the World Bank. The local community has been involved in implementation.	Planning mainly by the NGO, Green Belt Movement (GBM). The local community has been mainly involved in implementation.
b) variety and levels of actors in the landscape	Private actors at the international level purchase credits. International agencies, regional and state actors absent.	The project includes the World Bank and Vi Agroforestry (international organizations) and local farmers. The private sector is missing.	The project includes the World Bank (international organization), the GBM (national level), and the local communities.
c) economic sectors represented (if applicable)	Wildlife; Forestry	Agriculture	Forestry
d) presence of local representation	Local communities are represented through LCCs and CBOs.	Local farmers participate in the project through farmer groups.	Local communities are represented through CFAs.
e) how resources and knowledge are shared among actors	Project information on benefit-sharing and activities communicated to the community even though community members still do not understand the accounting processes involved. The project managers have also presented the project's work to national and international stakeholders through workshops and conferences.	Project information, especially on benefit-sharing and carbon accounting procedures, not fully communicated to the local communities. The project however shares information on its work in various national and international platforms.	Project information not fully communicated to the local communities.

Secure tenure			
a) explicitly articulated ownership of land, forests, agricultural produce and carbon as resources	Ownership of land is mainly through private and communal group ranches some of which have been leased to the project. Rights to carbon are clarified and were transferred to the project through an informed consent agreement between the project and the executive board of the group ranches.	Ownership of land is mainly by individual smallholder farmers. Rights to carbon are unclear.	Forest under assisted regeneration is state-owned, while the participating communities are private small-holders.
b) use and access rights of these resources	Communities' access to forest resources is limited; particularly activities such as charcoal burning are prohibited.	Access to tree resources on private lands is uncontrolled. There is generally communal use of individual lands especially for activities such as grazing.	Communities are granted access to forest products through state CFA agreements.
Equitable benefit-sharing mechanisms			
a) are benefit-sharing mechanisms in the landscape clear and transparent in their framing?	Benefit distribution is clearly articulated in the project documents with one third distribution of revenue to project costs, individual landholders and communities respectively, but the implementation reflects complexities of factoring in costs and uncertainties of carbon markets leading to skewed benefit allocation in favour of land owners and the project at the expense of non-group ranch members.	Carbon revenue calculations are included in the project documents but not clarified to farmers. The carbon benefits are simply highlighted as a bonus because the project managers do not want to raise expectations.	Benefit-sharing mechanisms are articulated in the project Memorandum of Understandings between CFAs, GBM and KFS which are guided by negotiations and the Forest Act (GoK, 2005).
b) are they equitable?	Landholders derive the greatest benefits as they receive a contractually agreed cash payment. Communities receive the least benefits.	Farmers who are the carbon producers end up with 30% of total carbon revenue.	Communities are supported with communal projects, but it is not clear what share of carbon money is invested in these communal projects.

c) do they foster accountability among actors?	In some cases, especially with LCCs and CBOs, but the project proponent is not accountable to the local communities or the Kenyan government. Project costs are not transparent.	The World Bank undertakes review and validation exercises to ensure delivery of carbon. However the carbon accounting is done at higher management levels with no accountability checks, i.e., accountability measures mainly applied to farmer activities.	The engagement of legally functioning CFAs reasonably provide for accountability especially through state laws, but there are no mechanisms to hold CFAs to be downwardly accountable to the rest of the community.
d) are they pro-poor?	The communal approach to benefit-sharing enables inclusion of the poor, landless and immigrants to benefit from the one third of carbon revenue directed to community projects. Ranch shareholders however receive much more than non-ranch shareholders.	It is not pro-poor as there is no specific support for pro-poor assets such as water access thus making it difficult for the poor themselves to engage in project activities such as tree planting and management.	The communal project enables inclusivity of the poor in benefit sharing.
Strategic targeting of investments			
a) whether they are pro-poor in their spatial targeting	The project is being implemented in a semi-dry area that ranks among the poorest in the country	Implemented in an area that is ranked as 'moderate' in the poverty index even though some livelihood assets relevant to the project, e.g., water access are really constrained.	The project is being implemented in a highland area, endowed with humid forest resources and is relatively less poor compared to most areas in Kenya.
b) whether funds from diverse sources are directed towards common objectives	Carbon proceeds are the main source of income even though the project has established a trust fund through which other funds could be directed to adaptation.	Funds mainly drawn from carbon revenue purchased through the World Bank. No clear mechanism for attracting other funds.	Not clear.

Monitoring and evaluation of impacts			
a) credible verification standards present for tracking carbon fluxes present	The project applies VCS and CCBA standards for verification.	The VCS standard is applied in verifying the project's activities.	The VCS standard is applied in verifying the project's activities.
b) participation of local communities in the monitoring of carbon fluxes	Communities not involved in the monitoring of carbon pools.	Farmers are involved in recording activities on their farms but are not involved in the carbon accounting, arguably due to technicalities involved.	Communities provide records on the number of seedlings planted and surviving trees, but do not take part in the actual carbon accounting.
c) positive changes in livelihoods	There's an improvement relative to past interventions.	None observable at the time of the research, but some positive changes could occur with time.	Improvement in livelihoods monitored even though project faces competition from other relatively more rewarding land uses.
d) monitoring of other goals such as wildlife conservation	These are systematically monitored through aerial and ground surveys. The project standard, CCBA, requires evaluation of biodiversity and community benefits.	Changes in crop yields are monitored alongside carbon.	Socioeconomic impacts such as community projects are evaluated and reported even though the project standard is purely targeting carbon.
e) opportunity for continuous research and learning in the landscape	A number of studies have been conducted in the landscape and the project offers internship opportunities to research students.	Relatively cautious of potential negative reporting that could impede the project given the complex system within which it operates.	Relatively cautious about research activities due to past experiences with 'negative' research reports.

Explicitly addressing mitigation and adaptation needs			
a) carbon sequestration	In-situ conservation and natural regeneration of degraded areas core activities.	Carbon is generated through on-farm activities including agroforestry and soil carbon replenishment.	Carbon is generated through avoided deforestation as well as reforestation and afforestation activities.
b) adaptation of livelihoods and the ecosystem to climate change impacts	Addressed, although the focus has been on community rather than household/ individual adaptation capabilities.	Households’ food security addressed as part of carbon. No funds allocated for livelihood support.	Community projects supported as part of adaptation. It is not clear how this support translates to household-level wellbeing.
Gender			
a) representation of women and youth in decision-making fora	Implicit in project documents, but representation remains low in practice.	No mechanism for gender equality in representation.	Not clear.
b) active participation in the project activities	Women and youth are involved in project activities, but no affirmative action/requirements for consideration of the same.	Mainly women are involved through groups. Participation of men and youth is very minimal.	Women and men involved. Youth involvement is minimal.
c) gender equity in benefit-sharing mechanisms	Existing tenure system (on which benefit-sharing mechanisms are based) reinforces gender bias as it is mainly patriarchal.	No mechanism in place.	No mechanism in place.
d) gender-biased cultural practices	Not observed, but high rates of illiteracy in women compared to men were noted. Also high rates of drinking illicit brews by men, leaving household burdens entirely to women were noted. Further gender research would be required.	Men have traditional rights to land inheritance while women don’t, even though most farmers are women.	Not observed.

economic benefits to communities. However the level and nature of pro-poor targeting activities differed across landscapes. For instance, whereas the Kasigau Carbon project is located generally in a poor semi-arid area compared to the Kamae-Kipipiri project which is located in high-potential highlands. The later targets mainly women, who are a less economically enfranchised group, while the former targets thousands of smallholder farmers who are excluded from land ownership through complex group ranch land allocations. The KACP on the other hand targets thousands of smallholder farmers through sustainable land management practices, mainly agroforestry, as well as payments to grow trees.

Key differences among the projects were noted on benchmarks such as tenure, mode of participation, monitoring and evaluation and equity in benefits sharing. The projects worked under various land holdings, spanning from individual land holdings, to communally held lands and state-owned forests. The Kasigau Corridor Carbon project, for instance, recognized private ranches, communal land and private land. It also recognized different social groups' claims to communal lands, and incorporated poor and landless households into the project. This enabled them to draw benefits that they would otherwise foregone if the project targeted land owners in the project area only. The KACP project worked with lands that were customarily held by individual families, yet communal use of these lands was a common practice. This compromised the mitigation agenda of the project as individual commitments (such as incorporating after-harvest crop residues back into the soil) competed with communal interests (such as allowing free grazing of land).

The mode of participation and community representation also varied across the three projects, with organized forms such as LCCs, CBOs and CFAs in the Kasigau and Kamae-Kipipiri projects respectively. Under the KACP, individual households participated directly in the project. While organized forms of representation had the advantage of creating synergy and collective bargaining among the local communities, they were not guaranteed broad-based or democratic representation. For instance, in Kasigau, the initial organizations that the project chose to work with included state-sanctioned representation under chiefs and elected local authorities. However, these were soon abandoned in favour of single purpose carbon committees, the LCCs, formulated specifically to address carbon issues. The reasons for the drastic change included corruption and bureaucratic dogmas. Whereas LCCs achieved the desired project goals of prioritizing and distributing carbon revenue efficiently, the fact that they are not anchored within institutionalized structures of governance implies that they will likely not be relevant beyond the project lifetime (Chomba et al. in press.) The Kamae-Kipipiri project, on the other hand, has engaged with the community through CFAs which are legally recognized management units by the state, but powerless in negotiating benefits with the state. In the case of the KACP, however, farmers have no idea that the new project is being implemented under a 'triple win', climate-smart agriculture banner, and they assume simple continuity with past interventions.

Finally, the three projects varied in their considerations for gender equity. The Kamae-Kipipiri landscape has traditionally explicitly aimed at empowering women by providing them with additional revenue streams through afforestation and enhancing their participation in decision-making. The Kasigau and KACP projects, however, target the general community with no explicitly recognized gender considerations.

In summary, this section reveals the complexity of institutional arrangements in each of the case studies. While our benchmarks and indicators served as a comparative basis for comparing the cases, our analysis also depicts tradeoffs in achieving the benchmarks. Ideally, achieving one benchmark (e.g., globally designed credible monitoring standards) may potentially compromise other benchmarks (e.g., participatory monitoring). In our conclusions, we discuss key approaches for optimizing institutional arrangements for climate-smart landscapes.

6. Conclusions

The first approach to optimizing institutional arrangements towards climate-smart landscapes involves identifying and engaging key actors in the landscape at various levels, their interests and the competencies they avail. Even in private sector led interventions, the role of government agencies is still critical to facilitate political goodwill. Uncertainties remain where government policy contradicts project goals or where no such policy exists. Limited community input, non-inclusive project designs and mitigation-oriented standards may compromise the ability of the case projects to achieve climate-smart landscapes.

The second approach regards designing effective participatory processes. The involvement of local communities needs to go beyond mere participation as other landscape management objectives may suffer. It is important to note that individual farmers and forest-dependent communities have the right to know and be actively involved in developing such interventions, and, as such, local institutional changes and development that support these ideals must be identified and supported. Broad-based representation, with specific emphasis on gender and other marginalized groups such as migrants, forest dwellers, etc., must be anchored in institutionalized structures such as devolved local government to provide continuity beyond project interventions.

The third approach regards simplification and flexibility in project designs. According to Minang and van Noordwijk (2013), design flexibility and legitimacy are key to synergizing mitigation and adaptation and greater efficiency, effectiveness and equity in implementation and outcomes. This also applies to the design of monitoring systems, which must be simple, flexible and include other social and livelihood outcomes, and not just carbon.

Additionally, the roles of buyers and consumers of landscape products and services should ensure sustainability of their production and ensuring minimal negative consequences. Landscape products and services, varying from agricultural products such as food (from livestock and crops) and various forms of ecosystem services (e.g., water, carbon sequestration, soil erosion control, etc.), have both local and international consumers. Local buyers and consumers have a more intimate relationship with the actual landscapes, as the sustainable supply of most of the products and services, for instance food and water, directly affect them. The Kamae-Kipipiri and KACP landscapes both incorporated local consumers of landscape products in exchange for forest management (Kamae-Kipipiri) and adoption of sustainable farming practices. The Kasigau project, however, largely excluded the local communities from accessing these products and services. Whereas we have witnessed consumer strategies such as fair trade for timber, coffee, cocoa, etc. to safeguard against human exploitation and illegal activities, this is not well established in carbon schemes. Consumers should insist more on social justice for the providers of the ecosystem products and services, to minimize undesired effects such as displacement of people to create carbon sequestration and conservation areas.

While this chapter proposes seven benchmarks which inform appropriate institutional pathways for climate-smart landscapes, we acknowledge that there is a great deal of interrelatedness among them, that these benchmarks are by far non-exhaustive, and that in achieving various projects goals, there will be tradeoffs and synergies to be taken into consideration. While priorities may be very landscape-specific, we advocate for the pursuit of benchmarks that have positive knock-on effects on others and can build upon the gains made so far.

References

Adger, W. N. (2001). Scales of governance and environmental justice for adaptation and mitigation of climate change. *Journal of International Development, 13*(7), 921-931.

Agrawal, A. (2010). *Local institutions and adaptation to climate change. Social Dimensions of Climate Change: Equity and Vulnerability in a Warming World.* Washington DC: World Bank, 173-198.

Agrawal, A., McSweeney, C., & Perrin, N. (2008). Local Institutions and Climate Change Adaptation. Washington, DC: World Bank.

Alemagi, D., Minang, P. A., Feudjio, M., & Duguma, L. (2014). REDD+ readiness process in Cameroon: an analysis of multi-stakeholder perspectives. *Climate Policy* (ahead-of-print).

Atela, J. (2012). *The politics of Agricultural carbon finance: The case of the Kenya Agricultural Carbon Project*. Brighton, UK: Steps Centre.

Atela, J. (2013). Governing REDD+: *global framings versus practical evidence from the Kasigau Corridor REDD+ Project, Kenya*. STEPS Working Paper 55. Brighton, UK: STEPS.

Atela, J. O., Quinn, C. H., & Minang, P. A. (2014). Are REDD projects pro-poor in their spatial targeting? Evidence from Kenya. *Applied Geography*, 52, 14-24.

Brown, H., Peach, C., Nkem, J. N., Sonwa, D. J., & Bele, Y. (2010). Institutional adaptive capacity and climate change response in the Congo Basin forests of Cameroon. *Mitigation and adaptation strategies for global change, 15*(3), 263-282.

Cash, D. W., Adger, W. N., Berkes, F., Po, G., Louis, L., Olsson, P., ... Young, O. (2006). Scale and cross-scale dynamics: governance and information in a multilevel world. *Ecology & Society, 11*(2).

Chomba, S. (In press). Institutional Choices under REDD+ and their implications for local democracy: Lessons from Kasigau project in Kenya.

Chomba, S., Kariuki, J., & Lund, J. F. (In press). Roots of Inequity: Tenure Arrangements and Carbon Benefits in the Kasigau Corridor, Kenya.

Cotula, L., & Mayers, J. 2009. *Tenure in REDD – Start-point or afterthought?* Natural Resource Issues No. 15. London, UK: International Institute for Environment and Development.

Duguma, L., Minang, P., & van Noordwijk, M. (2014). Climate Change Mitigation and Adaptation in the Land Use Sector: From Complementarity to Synergy. *Environmental Management*, *54*(3), 420-432.

GoK (Government of Kenya). (2005). Forests Act. GoK: Nairobi, Kenya.

FAO (Food and Agriculture Organization of the United Nations). (2013). *Climate Smart Agriculture Source Book*. Rome, Italy: Food and Agriculture Organization of the United Nations.

Leach, M., Mearns, R., & Scoones, I. (1999). Environmental Entitlements: Dynamics and Institutions in Community-Based Natural Resource Management. *World Development, 27*(2), 225-247. doi: http://dx.doi.org/10.1016/S0305-750X(98)00141-7

Luttrell, C., Loft, L., Gebara, M. F., Kweka, D., Brockhaus, M., Angelsen, A., & Sunderlin, W. D. (2013). Who Should Benefit from REDD+? Rationales and Realities. *Ecology and Society, 18*(4). doi: 10.5751/ES-05834-180452

Lyster, R. (2011). REDD+, transparency, participation and resource rights: the role of law. *Environmental Science & Policy, 14*(2), 118-126. doi: http://dx.doi.org/10.1016/j.envsci.2010.11.008

McDermott, M., Mahanty, S., & Schreckenberg, K. (2013). Examining equity: a multidimensional framework for assessing equity in payments for ecosystem services. *Environmental Science & Policy,* 33, 416-427.

Meinzen-Dick, R., Q. Bernier, & E. Haglund. 2013. *The six "ins" of climate-smart agriculture: Inclusive institutions for information, innovation, investment, and insurance.* CAPRi Working Paper No. 114. Washington, D.C.: International Food Policy Research Institute. doi: 10.2499/ CAPRiWP114

Minang, P. A., & van Noordwijk, M. (2013). Design challenges for achieving reduced emissions from deforestation and forest degradation through conservation: Leveraging multiple paradigms at the tropical forest margins. *Land Use Policy,* 31, 61-70.

Mwangi, E., & Wardell, A. (2012). Multi-level governance of forest resources (Editorial to the special feature). *International journal of the Commons, 6*(2), 79-103.

North, D. C. (1990). *Institutions, institutional change and economic performance.* Cambridge, U.K.: Cambridge University Press.

O'Riordan, T., & Jordan, A. (1999). Institutions, climate change and cultural theory: towards a common analytical framework. *Global Environmental Change, 9*(2), 81-93.

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action.* Cambridge, U.K.: Cambridge University Press.

Scherr, S. J., Shames, S., & Friedman, R. (2012). From climate-smart agriculture to climate-smart landscapes. *Agriculture and Food Security*, 1, 12.

Visseren-Hamakers, I. J., Gupta, A., Herold, M., Peña-Claros, M., & Vijge, M. J. (2012). Will REDD+ work? The need for interdisciplinary research to address key challenges. *Current Opinion in Environmental Sustainability, 4*(6), 590-596.

Wambugu, S. (2012). Securing Tenure for Reducing Emissions from Deforestation and Forest Degradation (REDD+) in Kenya. Paper presented at the 'Beyond Carbon: Ensuring justice and equity in REDD+ across levels of governance', St. Anne's College, Oxford, UK.

Westermann, O., Ashby, J., & Pretty, J. (2005). Gender and social capital: the importance of gender differences for the maturity and effectiveness of natural resource management groups. *World Development, 33*(11), 1783-1799.

Westholm, L., Biddulph, R., Hellmark, I., & Ekbom, A. (2011). REDD+ and Tenure: A review of the latest developments in research, implementation and debate. *Focali report,* 2.

PART

4

Involving the Private Sector

Brewery operated by SABMiller's Colombian subsidiary, Bavaria, in the Chingaza watershed outside Bogotá. Photo credit: Foto Rudolf, Bogotá

CHAPTER

19

Private sector investment in landscape approaches: the role of production standards and certification

Gabrielle Kissinger, Mark Moroge and Martin Noponen

Highlights

- Production standards and certification can serve as stepping stones to an integrated landscape management (ILM) approach, by enabling companies to evaluate environmental or social interventions beyond the farm or production unit scale
- Certification has limitations for ILM implementation, however, as most systems limit their scope to the property boundaries and criteria, assessment of management beyond the production unit can be difficult to document and comply with
- Private sector investment in landscape initiatives can be leveraged if they are designed for compatibility with public sector ones
- New innovations are exploring how certification can serve public-private partnerships, low-carbon development plans and jurisdictional certification schemes

1. Introduction

The private sector is increasingly interested in integrated landscape management (ILM) as a means to mitigate risks, and address opportunities beyond the production unit. Scherr et al. (2013) define the key elements of ILM as: 1) shared or agreed management objectives that encompass multiple benefits from the landscape, 2) design of land management practices to contribute to multiple objectives, including human well-being, food and fibre production, climate resilience and conservation of biodiversity and ecosystem services, 3) interactions between ecological, social and economic interests are managed to realize positive synergies and to mitigate negative tradeoffs, 4) collaborative, community-engaged processes for dialogue, planning, negotiating and monitoring decisions, and 5) markets and public policies are shaped to achieve the diverse set of landscape objectives and institutional requirements. Water, climate, biodiversity and community risks are those that cannot be addressed solely at the farm- or concession-scale, and therefore agribusinesses are increasingly applying landscape initiatives as a means to address these risks (Kissinger et al., 2013). Based on seven case studies, this chapter explores the motivations of companies pursuing landscape initiatives at the production level, and shares insights into the role of production standards and certification as a tool to implement ILM. This chapter further explores the interplay between certification standards and landscape approaches, methods and barriers to increase uptake and adoption, and whether these initiatives are a means to mainstream ILM in business operations. Although we recognise the importance of identifying ILM examples in the mining and extractive industries, we found limited evidence of those and therefore focus on agribusinesses and forestry.

1.1 Risks

Natural resource-dependent companies increasingly recognize that their future operating environment will differ from that of the past. Farms must increase productivity to produce more food, with nearly all of the additional food requirements occurring in developing countries. Furthermore, due to an estimated global population rising to at least 9 billion people by 2050 (FAO, 2009; Foresight, 2011), it is commonly accepted that the resources businesses depend on will be increasingly scarce in the future, and that this scarcity will increasingly reflect on company balance sheets. For example, by 2030, the global demand for freshwater will exceed supply by 40% (UNEP, 2011). There are also limits to future agricultural expansion, as the global supply of arable land becomes increasingly scarce. To avoid crop expansion, and just meet projected crop needs by increasing production, crop yields would need to increase by an estimated 32% more from 2006 to 2050 than they did from 1962 to 2006 (Searchinger et al., 2013). In the face of these constraints, agricultural production must increasingly shift to marginal and unconventional production conditions, which will decrease yields and increase susceptibility to production shortfalls (Lee et al., 2012), while perpetuating a cycle of environmental service degradation. The availability and price of agricultural commodities are also of increasing concern, and are highly impacted by climate change, resource depletion, and demographics (MSCI, 2012).

As such, companies seeking solutions to these challenges at the production level and throughout the supply chain cannot rely on markets alone to assess and respond to sustainability challenges (TEEB Foundations, 2010). Companies are increasingly identifying high-risk agricultural raw materials in their supply chains, setting time-bound targets for their sourcing and supply arrangements, and seeking certified products for assurance of production standards. For example, Unilever aims for 50% of its agricultural raw materials to be sustainably sourced by 2015 and 100% sustainably sourced by 2020 (Unilever, 2010). Similarly, Nestlé, Mars, Tesco, McDonald's, Walmart and other brand manufacturers and retailers have made sustainability purchasing commitments for agricultural products (Kissinger, 2012). Traceability is increasingly a valued attribute of certification, as a means to identify high-risk inputs (MSCI, 2012).[1] Other sectors similarly value certification as a means of demonstrating performance. For example, the Forest Stewardship Council (FSC) is investigating how its certification can reach beyond forests through "Forest Certification for Ecosystem Services". Similarly, the Initiative for Responsible Mining Assurance released a draft standard for responsible mining in 2014, which identifies social and environmental criteria, guidance on mine closure and reclamation and management systems.

1.2 Opportunities

Third-party production standards and certification regimes provide a means for companies to demonstrate to brand manufacturers and consumers that food and beverage commodities have been produced with sustainable practices. Examples of commonly used production standards include the Roundtables on Sustainable Palm Oil, Soy, Biofuels, and Bonsucro (sugar), the Sustainable Agriculture Network (SAN)/ Rainforest Alliance Certification[2], Fairtrade, UTZ, and others. Standards tend to focus on best practices related to social issues, land use, and agricultural production practices within the production unit (e.g., farm, concession and/or mill). However, some standards incorporate principles or criteria that stretch beyond the production unit in order to include biodiversity, livelihood, and/or ecosystem service considerations (these are explored further in the cases study section). In these contexts, standards can serve as stepping stones to a more ILM approach, by enabling companies to evaluate environmental or social interventions beyond the farm-scale, create partnerships for shared problem-solving, and pilot ILM concepts.

There is growing pressure from brand manufacturers and consumers on producers of raw materials to demonstrate sustainability through standards compliance, adherence to national regulations, and reduced greenhouse gas (GHG) emissions. One such example is the Consumer Goods Forum (CGF) which comprises of more than 400 retail and brand manufacturers globally with total combined sales of €2.5 trillion. The CGF Board pledged in 2010 to mobilize resources within member businesses to achieve zero net deforestation by 2020. The CGF seeks to achieve this goal through individual company initiatives and by working collectively in partnership with governments and NGOs, in order to address challenges in the sourcing of commodities such as palm oil, soy, beef, and paper and board (Consumer Goods Forum, 2014). Catalysed by the CGF, the Tropical Forest Alliance (TFA) 2020 formed as a public-private partnership with the Governments of the United States, United Kingdom, Norway and the Netherlands and numerous NGOs seeking to work with private sector actors to address deforestation pressures in four key commodity value chains of palm oil, soy, pulp and paper, and beef. Working at landscape scales will be essential in order to affect the TFA's goals related to tropical forest and ecosystem conservation and commodity production, including working with smallholder farmers and other producers on sustainable agricultural intensification, while promoting the rehabilitation of degraded lands and reforestation.

New approaches are being piloted in Brazil and elsewhere to develop jurisdictional approaches for measuring the environmental and social performance of land use practices. This can involve all major commodities in a region being produced under an umbrella standard (a regional or place-based standard).

2. Production standards and ILM case studies

Companies pursue integrated landscape initiatives due to operational and reputational risks, regulatory risks, and compliance with voluntary production standards, to attain greater supply chain efficiency, and as a means to capture market shares (Kissinger et al., 2013). This section explores seven examples of companies piloting ILM through production standards, which often seek identification of high conservation value (HCV) forests or identification of labour and livelihood concerns affecting the broader community.

2.1 The Rainforest Alliance and Olam in Ghana's Juabeso-Bia Region

The Rainforest Alliance worked with Olam in Ghana's Juabeso-Bia Region to apply an ILM approach with the aim of increasing economic opportunities for poor, marginalized farmers through application of sustainable agriculture and forest best management practices, for GHG emissions reductions and climate change adaptation. Olam International's involvement helped achieve the scale necessary, increase productivity and income for farmers, enhance resilience of their production systems, conserve biodiversity, and reduce supply chain risks. Thousands of cocoa farmers and community members were trained on climate-smart land-use practices for SAN certification and SAN Climate Module verification. A project design document was developed to demonstrate positive benefits according to the Climate, Community and Biodiversity Alliance (CCBA) standards. Reduced conversion of remaining forest to farmland is anticipated. It should be noted that Olam's investment in the landscape was complemented by funding from the Norwegian Agency for Development Cooperation (NORAD) and United States Agency for International Development (USAID), allowing for other activities that enhance the landscape approach, for example, reforestation of degraded areas, conservation of High Conservation Value (HCV) forest areas, alternative livelihood opportunities, capacity building for REDD+ readiness, improved governance, and the CCBA project design document.

2.2 The Wilmar pilot in West Kalimantan and Sumatra, Indonesia

The Wilmar pilot in West Kalimantan and Sumatra, Indonesia seeks to design and test guidelines and best management practices for implementing Roundtable on Sustainable Palm Oil (RSPO) principles and criteria related to biodiversity. The stated aim of the project is to provide better access to critical information, methods for integrating this information in plantation management, and technical guidelines. A second part of the project seeks to reduce or remove policy-related barriers to implementation of the RSPO biodiversity related principles and criteria. The solutions therefore bring multiple key actors and information sets together—plantation management, biodiversity interests, government and the RSPO—to enable conservation of HCV habitats.

2.3 Gebana and Solidaridad

Gebana is working with Solidaridad and partners such as the cooperative Central Association of Family Farmers (COOPAFI) and the Municipality of Capanema in Brazil, to enable the production and commercialization of Round Table for Responsible Soy (RTRS) certified soy produced by smallholders in the region. Certification was achieved in 2013. There are three areas of intervention: 1) a self-assessment toolkit to enable continuous improvement based on meeting existing Brazilian federal laws and the RTRS standard, 2) training and demonstration on better management practices for biodiversity friendly smallholder produced soy, and 3) methods to link biodiversity friendly RTRS certified soy production with frontrunner companies seeking certified products.

Trainings in best management practices and the Gebana zero-till system helped the Capanema municipality have the lowest use of agrochemicals in the region. While large companies such as Grupo Maggi, Los Grobo, and Ceagro have achieved RTRS certification, the 163 smallholders in Paraná state became the first family farmers to achieve this in Latin America. Solidaridad aims to have 400 smallholder soy family farmers from the municipality of Capanema entering a preferential market for RTRS certified soy on 6,000 hectares with an extra added value (i.e., price premiums; IFC, 2014). The Body Shop has purchased soy oil from Gebana since 2006 for its skin care products.

2.4 Ethical Tea Partnership

The Ethical Tea Partnership (ETP) was formed as a means for tea purchasers to address tea supply chain challenges and operates in Kenya, India, Indonesia, Sri Lanka and China. The 36 member companies created the ETP Global Standard, which contains a set of principles and action steps to guide tea estates to adopt consistent practices around social issues, such as gender, harassment, wage levels, child labour as well as environmental management. Some environmental principles reach beyond the estate- or farm-scale to guide managers to include assessment or interventions in the areas of soil management, reduction in agrochemical use, waste management, ecosystem management, and provisions around the establishment of new production areas, which is only allowed if land use capacity studies demonstrate long-term production capacity is available (ETP Standard, 2013). The ETP standard helps producers attain international certifications such as Fairtrade, Rainforest Alliance and UTZ Certified. In Kenya, ETP is working with its members to address producer support and sustainability of the tea sector due to climate change impacts. ETP has also identified how to reduce deforestation pressures, as forests adjacent to tea plantations are often felled for fuelwood to heat kilns. By establishing eucalyptus plantations to supply fuel for kilns, fuelwood can be obtained without causing more deforestation (and this could link to Kenya's Reducing Emission from Deforestation and forest Degradation (REDD+) plans).

2.5 Solidaridad and the John Bitar Company

Solidaridad is working with the John Bitar Company and cocoa farmers in the southwest of Ghana towards the creation of biological corridors to link fragmented biodiversity hotspots in the cocoa growing frontiers and to enhance sustainable cocoa livelihoods and biodiversity conservation in and around the Suhuma and Krokosua Forest Reserves. By improving human capacity to tackle forested land degradation in the Western region of Ghana, there will be a direct contribution to the global objectives of the United Nations Convention to Combat Desertification (UNCCD), and other global environmental conventions that recognize the importance of addressing land degradation (Solidaridad, 2013).

2.6 Mondi's approach to ILM

Mondi's interest in ILM stemmed from its need to proactively address environmental and social challenges affecting its packaging and paper business and the urgency of global challenges such as climate change, water management and material consumption. Mondi sought to increase the eco-efficiency of products and reduce GHG emissions. As wood is a key raw material for Mondi's operations in 31 countries, the company sought to secure access to sustainable fibre in the short- to long-term to meet the needs of the business, recognizing increasingly constrained resources. Mondi also pursued a series of measures through its sustainable development plan to address the wellbeing of employees, secure key talent and skills, and maintaining its licence to trade by building strong community relationships. Mondi sought 100% FSC certification on 316,000 hectares of plantation forest it owns or leases in South Africa and on 2.1 million hectares of its leased or managed boreal forests in Russia. Mondi's awareness of ecosystem stewardship may have been solidified through their operation-wide HCV assessments, which resulted in 638,810 hectares (26% of their operating base) being set-aside for conservation in Russia and South Africa (Mondi, 2013).

2.7 The Carbon-Coffee Project

Agroindustrias Unidas de México (AMSA), an Ecom Agroindustrial Corp (ECOM) Trading subsidiary, forms part of the Carbon-Coffee Project, an alliance between the coffee buyer, Negocios Sostenibles, a Mexican NGO who provides training and technical assistance on best practices in agricultural activities, the Rainforest Alliance, and UNECAFE, a smallholder coffee cooperative. These four partners joined forces for landscape restoration to enhance microclimatic stability of coffee production and enhance coffee productivity in four UNECAFE coffee producing communities in the coastal region of Oaxaca, Mexico. The project is an afforestation/reforestation (A/R) project under the Verified Carbon Standard (VCS) and will restore degraded lands, abandoned pastureland and enrich low-intensity coffee production areas through planting native tree species and citrus trees. To date, the project has planted over 25,000 trees with more planned over the next four years. Moreover, the projected revenues from the project will be invested in training, technical assistance and technologies necessary to enhance coffee productivity and quality, improving the profitability of coffee production. Financial support for the project has been provided at various stages from different donors, with exploratory/start-up funding provided by the International Finance Corporation Innovation Fund and other funding provided via the Z ZURICH Foundation, Fundacion ADO, and Fundacion Comunitaria Oaxaca. Current support is provided via Banamex-Fomento Ecologico, AMSA and in-kind resources from other project partners.

3. Methods for including landscape elements in certification standards

Standards commonly use process- and practice-based measures (best management practices), as opposed to the more costly and time-consuming outcome and impact assessment methods. A few newer standards require measurement of and compliance with various environmental outcomes. Some examples of this are Bonsucro's upper limits on GHG emissions per unit, or the Roundtable on Sustainable Biofuels assessment of soil organic matter and habitat connectivity (Milder et al., 2012). Based on the cases reviewed, the impacts of activities at landscape levels can be incorporated in certification principles and criteria through two ways: 1) principles or criteria clearly state exactly which elements are included and how performance is evaluated, or 2) through procedures and information sharing, which may be context specific, but lacks the consistency of the former.

The ETP standard provides a few principles that include landscape elements, such as determining land use capacity and production capacity before establishing new productions areas, avoiding collateral damage to ecosystems outside tea estate boundaries, and strong social provisions. Other standards, such as the Roundtable on Sustainable Palm Oil, rely on identification of HCV areas and seek plans for reduction of GHG emissions (RSPO, 2013). Identification of HCV areas can bridge to broader incorporation of ecological values in business operations, as in the example of FSC certification and

Table 19.1 Case study summary: production standards and ILM.

Initiative	Company/location	Certification standard	Landscape attributes in certification standard	How company is implementing landscape attribute	Results of landscape approach
1. Forest, Climate and Communities Alliance project to pilot field-level REDD+ implementation and community agroforestry applying sustainable cocoa practices in community forest areas as a tool for achieving biodiversity conservation outcomes and climate change adaptation	Olam/ Juabeso-Bia Region of Western Ghana	SAN, Rainforest Alliance Certification	SAN criteria for group certification on social and environmental standards to promote efficient agriculture, biodiversity conservation and sustainable community development.	Financing of: training on SAN standard and the voluntary SAN climate module; training to improve community knowledge to protect and improve tree-based ecosystems through application of climate-smart land-use practices; training to improve understanding of climate impacts and risks. Guaranteed premiums for certified cocoa.	• 2000 farmers on 6000 ha are certified • Increased revenue for farmers from increased yields due to climate-smart agricultural practices, plus an additional price premium based on quality and sustainability • Increased GHG mitigation; improved governance through the development of 12 cooperatives and a local authority for land management; REDD+ readiness capacity building

2. Pilot study increasing the effectiveness of biodiversity-related RSPO Principles and Criteria (2 phases with the second focused on HCV management and monitoring)	Wilmar International/ Indonesia, West Kalimantan and Sumatra	Roundtable on Sustainable Palm Oil	RSPO principle 5.2 and criteria on HCV forests: provides guidance to avoid affects on HCV or 'Rare, Threatened, and Endangered' areas/species that could be significantly affected by the grower or miller. Principle 5.6 seeks GHG emission reduction. Principle 6.1 and 6.2 focus on social impact assessment and community relations.	RSPO compliance and management of HCV areas within concession	HCV Threat Monitoring Protocol for the oil palm sector developed based on pilot efforts in Kalimantan and Sumatra
3. Round Table on Responsible Soy (e.g., biodiversity-friendly smallholder-produced soy)	Gebana Capanema/ State of Paraná, Brazil	Round Table on Responsible Soy	RTRS Section 4.4 on expansion of soy cultivation restricts expansion into native forests	A toolset for producers of agricultural commodities and preferential market access for RTRS certified smallholders	The majority of farmers protected riparian forest and legal reserve and used only land already cultivated and did not convert native vegetation after 2008

4. ETP	Twinings, Tetley Group, Marks and Spencer/ Kenya	ETP, Fairtrade, SAN/ Rainforest Alliance Certification, UTZ certified	ETP standard Principle 10.3 advises the establishment of new productions areas must be based on land use capacity studies that demonstrate long-term production capacity. Principle 10.4 advises that the tea estate avoids collateral damage to ecosystems outside of its boundaries. Principles on energy use, agrochemicals also look beyond the estate. Social provisions are strong.	Seeks to provide guidance for tea estates to adopt consistent practices around social and environmental issues and management	Engaged 10,000 smallholder farmers in Kenya on climate adaptation
5. Ensuring Best Practices in Cocoa-Agroforestry System for Improved Livelihood and Sustainable Environment	John Bitar Company Ltd/ Ghana	UTZ and FSC Certification	HCV identification, restricts expansion into primary forests	Sustainable cocoa livelihoods and biodiversity conservation, increased capacity to address land degradation	• 501 farmers were certified under the UTZ Certified standard over a total land area of 2476.2 acres • Area management plan created

6. Ecosystem stewardship in South Africa and Russia	Mondi/ South Africa and Russia	FSC and International Standards Organization (ISO)	HCV identification	FSC on 100% of managed lands; adopted Integrated Biodiversity Assessment Tool (IBAT) to map all biodiversity hotspots in their operations in 2013, then generated data and assessed results in 2014; implementing ecosystem management plans; controlling invasives and fire; valuation of ecosystem services, particularly riparian areas and wetlands (and assessing Mondi's impact on these).	• 26% of landholding set-aside for biodiversity, based on HCV assessments. • Commitment not to convert natural forests, riparian areas, wetlands or protected areas into plantations. • Conversion of grasslands or degraded agricultural lands pursued only with an environmental impact assessment and a national multi-stakeholder process.

7. The Carbon – Coffee Project	AMSA (Ecom Coffee Subsidiary)/ Coastal region of Oaxaca, Mexico	VCS Standard (A/R), Rainforest Alliance Certification, Fairtrade, UTZ, Café Practices, Organic and other certifications	SAN criteria for group certification on social and environmental standards to promote efficient agriculture, biodiversity conservation and sustainable community development. VCS Standard promotes restoration and reforestation of degraded lands, abandoned pasturelands, and low-intensity shaded coffee plots.	Training and technical assistance on improved coffee production practices, reforestation, and compliance with multiple standards; support to community-based awareness raising on project model and climate change issues; marketing and sales support for transactions of credits and/ or 'climate-friendly coffee'.	• Enhanced habitat connectivity in mosaics of degraded lands and secondary forests • Improved microclimate stability for coffee production • Increased investment in training and technical assistance on coffee productivity, quality and environmental conservation • Over 25,000 trees planted and 400 producers engaged • Grouped project model enables scaling over time

New Generation Plantation principles on Mondi's commercial forest plantations in South Africa. The experience demonstrated to Mondi the value of ecological networks and ecosystem functionality to sustainability of its business operations in a production landscape (WBCSD, 2012). The Round Table on Responsible Soy contains a principle to limit expansion of soy cultivation into native forests, restrict drift of agrochemicals to neighbouring areas, and seek coexistence with neighbouring production systems (RTRS, 2013).

The Rainforest Alliance model seeks to create sustainable landscapes by focusing on value chains, and harnessing the transformative power of markets. Many of the SAN criteria necessary for certification promote this by looking beyond the farm gate and focusing on the agriculture-forest interface. As such, other landscape elements such as ecosystem conservation of surrounding forest areas and other natural habitat, wildlife conservation, water conservation, and community relations all form critical components in helping to formulate a basis for such an approach. The SAN standard incorporates training and technical assistance to identify priorities beyond the farm-scale such as restoring ecosystem function and addressing climate risks. The application of the SAN Standard and its voluntary climate module in the Juabeso-Bia region of Ghana provides an example of how this worked. Project activities geared towards sustainable development and enhanced livelihoods, improved institutional and community governance, capacity for REDD+ readiness and improved market linkages through a leading cocoa buyer, laid critical foundations.

Beyond the case studies, new innovations are exploring how certification can serve public-private partnerships, low-carbon development plans and jurisdictional certification schemes, such that certifiers verify municipal, local or regional government conservation and development programmes. The Brazilian state of Acre's jurisdictional approach is one example, which is developed in partnership with the VCS, to deliver compliance-grade REDD+ credits based on the VCS Jurisdictional Nesting REDD+ framework. Jurisdictional approaches have the benefit of bringing all key stakeholders together—including producers, commodity buyers, governments, and standards bodies—to define solutions, which could include definition of ILM at the outset. There may be advantages in creating economies of scale, better linking producers to incentives and markets, and better coordinating management interventions. Another innovation involves recognition as an eligible activity or priority activity under a low-emission development or REDD+ national programme. In these scenarios, the government may invest, up-front, resources to support producers up the transition phase to implement improved management practices and prepare for certification. Once certification is achieved, government investment may not be necessary as producers can maintain implementation as part of normal operating costs.

4. Barriers to increased uptake and adoption

While certification and compliance with standards can provide benefits for farmers via price premiums (in some cases), improvements in productivity, quality and yields, and negotiated supply agreements and market access, the capacity to complete necessary reporting and capital to cover the costs of certification can be an obstacle, especially for smallholder farmers. Standards have been criticized for marginalizing small producers from horticultural export markets, due to costs associated with attaining the standard (Brenton et al., 2009). One risk is that smallholders may get squeezed out by larger producers that are more equipped to cover the costs and capacity needed. Certification systems must promote best practices and continuous improvement, but ensure that standards work for farmers, and do not create a disincentive to pursue certification.

Another barrier stems from the limitations in the boundaries of certification, as many systems limit their scope to the property boundaries of the producer or entity seeking certification. While criteria exist to promote collaboration and coordination beyond the scale of the farm and with the broader community, this is sometimes difficult to document and – more commonly – difficult for producers to comply with. Further consideration should be given to developing group certification systems that aggregate smallholders or small-scale activities into landscape-level certification schemes, similar to what has been achieved with FSC group certification for small woodlot owners or the SAN group certification that allows for expansion of participating members in a given landscape to join an existing group.

5. The business case for investment beyond the production unit

A major driver for investment by Olam in Juabeso-Bia was to reduce risk along their cocoa supply chain and threats to the stability of their production and supply. Some of the cases appear to demonstrate company interest for recognition as a first mover amongst peers in order to instigate market differentiation. While it is likely companies could achieve more efficient operations through value-chain and GHG emission reductions strategies across the landscapes they work in, more information is needed to test this hypothesis.

Working across landscapes enables companies to address a wider set of issues or limiting factors than those just at the farm level, such as working at the community-scale to improve malpractices rather than focusing on a limited number of scattered farms. Some businesses are motivated to reduce various forms of risk through their investment but also bring stability and quality to a valuable landscape, such as AMSA’s engagement in Oaxaca. Landscape approaches can also lead to businesses contributing to a stakeholder platform, providing a means to better engage with local governments to influence decision-making. This also often leads to public-private partnerships and innovative co-financing options to spread the burden and risk.

Perhaps similar to Olam’s motivations in Ghana, AMSA has assessed the long-term risks to securing coffee supplies in Oaxaca and identified growing threats from changing precipitation patterns and risks of extreme weather events, degraded forests, soils and waterways stressing coffee production, aged coffee bushes in need of replanting at scale, and a lack of access to technical inputs and training required to improve coffee production practices. Combined, these factors reduce profitability of coffee farming and drive producer out-migration to urban areas or foreign countries. Facing these threats has spurred AMSA to invest in and support initiatives like the carbon-coffee project, that go beyond coffee farm boundaries to improve ecosystem services provisioning and habitat quality, which they hope will contribute to revitalizing coffee production in the project area.

6. Opportunities to increase impact by linking to public sector priorities

Private sector investment in landscape initiatives can be leveraged if they are designed for compatibility with public sector ones. A notable example is Ghana, whose ER-PIN specifically focuses on cocoa mosaic forest landscapes and whose goal it is to reduce emissions driven by cocoa farming, "…in a manner that will secure the future of Ghana's forests, significantly improve livelihoods opportunities for farmers and forest users, and establish a results-based planning and implementation framework through which the government, the private sector, civil society, and local communities can collaborate" (Ghana Ministry of Forests, 2014). The cocoa sector also identified that yield decreases and lack of expansion opportunity put their sourcing at risk. This provides an opportunity to stack investment and resources (e.g., technical assistance, training) of public and private sectors to achieve a sustainably-intensified, forest-friendly cocoa sector. Doing so will also require the country's cocoa-sector strategy to be aligned with the national REDD+ strategy, which is still undetermined. Such alignment would require the agriculture and forestry sectors to work towards a harmonized approach, which could be generally defined at the national scale, but more closely coordinated in the landscapes. This could create the enabling conditions necessary to scale good management practices.

Certification can provide performance standards in contexts of weak environmental regulations or enforcement, providing a framework for key stakeholders and government to be informed and better link company objectives with public policy. For example, the Rainforest Alliance has achieved multi-stakeholder agreements and integration to policy platforms for the implementation of cropping and non-timber forest product systems based on FSC and SAN Standards in Ecuador and Peru. Such performance standards could be applied across whole jurisdictions, for purposes of 'landscape labelling' and/ or raising production standards across more than one commodity being produced in the jurisdiction.

Certification systems can also provide guidance to producers on how to address demand-side concerns about beyond-the-farm sustainability concerns. For instance, the Round Table for Responsible Soy has created a RTRS Annex for Biofuels to assist certified entities to comply with the requirements concerning indirect land use change and traceability regulated under the European Commission's Renewable Energy Directive (EU-RED).

7. Conclusions

The case examples explored herein demonstrate business and private sector application of certification standards as one tool to apply while implementing landscape approaches. The standards themselves provide varying points of guidance to look beyond the production unit. However, the cases also demonstrate a willingness (or interest) by companies and their civil society or government partners to define project parameters that seek ILM. While private sector commitment to, and application of, integrated landscape initiatives appears to be increasing, more assessment is needed of the long-term benefits beyond the production unit and concession-scale, and whether companies stick to the commitments and invest over the long-term. Similarly, there is a need for more evidence of effective coordination between government and private sector actors to support long-term commitment to landscape initiatives. More understanding is also needed of how certification bodies are incorporating a landscape lens into criteria and indicators for certification and measuring that performance over landscape spatial and temporal scales. This is particularly important for fast-expanding commodities such as oil palm, sugarcane, and soy, all of which can place strong pressures on land and water resources.

Endnotes

1 MSCI (2012) notes that 34% of companies surveyed have started to trace critical raw materials back to the farm to ensure that they come from sustainable sources.
2 The Sustainable Agriculture Network is a coalition of leading conservation groups that links responsible farmers with conscientious consumers by means of the Rainforest Alliance CertifiedTM seal of approval.

References

Brenton, P., Edwards-Jones, G., & Friis Jensen, M. (2009). Carbon Labelling and Low-income Country Exports: A Review of the Development Issues. *Development Policy Review, 27*(3), 243-267.

Consumer Goods Forum. (2014). Sustainability Pillar. Retrieved 10 May 2014 from http://www.theconsumergoodsforum.com/sustainability.aspx

Ethical Tea Partnership. (2013). ETP Global Standard (May 2013 version). Retrieved 8 May 2014 from http://www.ethicalteapartnership.org/tea-sustainability-programmes/monitoring-cert/monitoring-process/

FAO (Food and Agriculture Organization of the United Nations). (2009). *How to Feed the Word in 2050*. Discussion paper prepared for Expert Forum. Rome: FAO.

Foresight. (2011). *The Future of Food and Farming. Final Project Report.* London, UK: The Government Office for Science.

Ghana Ministry of Forests. (2014). *Ghana's Emission Reductions Program for the Cocoa Forest Mosaic Landscape (Cocoa Forest REDD+ Program).* Emission Reductions Program Idea Note (ER-PIN), submitted to Forest Carbon Partnership Facility. Retrieved 7 March 2014 from https://www.forestcarbonpartnership.org/sites/fcp/files/2014/February/Ghana%20ER-PIN%20CF9.pdf

IFC (International Finance Corporation). (2014). Biodiversity and Agricultural Commodities Program: Solidaridad summary page. IFC website. Retrieved 7 May 2014 from http://www.ifc.org/wps/wcm/connect/regprojects_ext_content/ifc_external_corporate_site/bacp/projects/projsummary_solidaridad

Kissinger, G. (2012). *Corporate social responsibility and supply agreements in the agricultural sector Decreasing land and climate pressures.* CCAFS Working Paper no. 14. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Kissinger, G., Brasser, A., & Gross, L. (2013). *Synthesis Report. Reducing Risk: Landscape Approaches to Sustainable Sourcing*. Washington, DC: Landscapes for People, Food and Nature Initiative.

Lee, B., Preston, F., Kooroshy, J., Bailey, R., & Lahn, G. (2012). *Resources Futures.* London, UK: Chatham House.

Milder, J.C., Gross, L., & Class, L. M. (2012). *Assessing the ecological impacts of agricultural eco-certification and standards: A global review of the science and practice.* Internal Report. Washington, DC: EcoAgriculture Parnters.

Mondi. (2013). *Sustainable Development report 2013*. Mondi. Retrieved from http://sd-report.mondigroup.com/2012/

MSCI (MSCI ESG Research). (2012). Industry Report: Food Products. Retrieved from http://www.msci.com/products/esg/about_msci_esg_research.html

Roundtable on Sustainable Palm Oil. (2013). Principles and Criteria for the production of sustainable palm oil, 2013 (including 15 November 2013 revisions).

Round Table for Responsible Soy. (2013). RTRS Standard for Responsible Soy Production Version 2.0_ENG.

Searchinger, T., Hanson, C., Ranganathan, J., Lipinski, B., Waite, R., Winterbottom, R., …. Heimlich, R. (2013). *Creating a Sustainable Food Future: Interim Findings; A menu of solutions to sustainably feed more than 9 billion people by 2050.* Washington DC: World Resources Institute.

Scherr, S. J., Shames, S., & Friedman, R. (2013). *Defining ILM for policy makers.* EcoAgriculture Policy Focus No. 10. Washington, DC: EcoAgriculture Partners.
Solidaridad. (2013). Solidaridad GDI Certification of Suhuma Forest Reserve in Ghana as biodiversity hotspots. Retrieved 7 May 2014 from http://v-c-a.org/files/VCA-1308004-GH-SUHUMA-PROPOSAL.pdf
TEEB Foundations. (2010). In: Kumar, P. (Eds.), *TEEB-The Economics of Ecosystems and Biodiversity (TEEB): Ecological and Economic Foundations.* London, U.K.: Earthscan.
Unilever. (2010). Sustainable Living Plan. London, UK.
UNEP (United Nations Environment Programme). (2011). *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*. Retrieved from http://www.unep.org/greeneconomy/GreenEconomyReport
WBCSD. (2012). *Biodiversity and ecosystem services scaling up business solutions: Company case studies that help achieve global biodiversity targets.* Retrieved from http://www.wbcsd.org/Pages/EDocument/EDocumentDetails.aspx?ID=14923&NoSearchContextKey=true

Vision for Change demonstration plots in Kragui in Côte d'Ivoire. Photo credit: World Agroforestry Centre

CHAPTER

20

Landscape approaches to sustainable supply chain management: the role of agribusinesses

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Highlights

- Sustainable supply chain programmes for food and other agricultural products are on the rise
- Whenever the sourcing area's quality and sustainability are priorities focus goes beyond the level of individual production units and takes a landscape approach
- Multiple tools and strategies are available to incorporate landscape sustainability into supply chains
- Efforts to incorporate sustainability parameters (e.g., reduce water, climate and community risks, losses and waste) and build sustainable supply chains require long-term investment and commitment among supply chain actors at all levels

1. The need for sustainability in agriculture supply chains

The world population is on the rise, and as a result, mankind faces the challenge of producing food and other raw materials to meet increasing demand. In order to achieve these targets, agricultural production must increase by 70 percent to meet the needs of the projected population of 9 billion by the year 2050 (Kissinger et al., 2013). Furthermore, available land and water have decreased proportionately resulting in major challenges for food security, poverty, climate change, and ecosystem degradation (Kissinger et al., 2013). These challenges are of increasing concern not only to governments, development organizations and research institutions, but also to the private sector, mainly agribusinesses. The private sector refers to the part of the economy that is not state controlled, and is run by individuals and companies for profit. Agribusinesses may include supply chain actors such as food and beverage businesses, small, medium and large scale farms (producers), processing firms, input suppliers and service providers (Da Silva et al., 2009). They are increasingly engaged in the quest for sustainability in their supply chains in response to global challenges of water and land scarcity as well as consumer demand for products that have been produced sustainably. Addressing these challenges will therefore require better natural resource management to maximize productivity, improve livelihoods, reduce negative impacts on the environment and thus, support the multifunctional role of the landscape. Furthermore, Gale (2000) has argued that there are tensions between economic specialization by firms leading to biodiversity degradation on the one hand, and the diversification principles by the ecosystem approach on the other hand, indicating the need for agribusinesses to take into account the multifunctional use of the landscapes in production of, and sourcing for, their inputs. Despite its importance, the involvement of agribusinesses in enhancing sustainability in food production and marketing has focused mainly on improving the ecological and social performance of some production processes such as farms, forests, and post-harvest operations, and has not taken an integrated view of the entire landscape. This traditional approach contrasts with ecological or landscape approach principles which require a holistic and integrated approach that goes beyond the level of individual production units and takes into account multiple stakeholders from the public, private, and civil society sectors. To date, many agribusinesses have not been widely engaged as partners in landscape management initiatives although interest is on the rise.

This chapter explores how agribusinesses can contribute and be engaged to adopt sustainable landscape approaches in their production and sourcing strategies. The chapter argues that the multifunctional goals of the landscape approach can be made compatible with the profit maximization principle of agribusinesses, which drives specialization in supply chains despite the apparent tension between the two. In particular, the chapter addresses the following questions:

- What is the rationale for landscape approaches in supply chain management?
- How can the private sector create a sustainable supply chain by applying a landscape approaches?
- What criteria and tools exist for integrating landscapes into supply chain management?

2. Defining value/supply chains

Before we begin to explore the role of agribusinesses in ensuring sustainable supply chains, we must have a common understanding of what a supply chain is and what it is not, including what may be considered as critical dimensions of supply chains. While the original definition of a value chain coined by Kaplinsky and Morris (2002) has undergone many modifications, there is a general consensus that a value chain/supply chain entails a vertical sequence of events that lead to the delivery, consumption and maintenance of goods and services. Some authors attempt to make distinctions between value chains and supply chains. For instance, Sturgeon (2001) proposes that value chain be used to denote the entire range of activities required to bring a particular set of products to the market while the term supply chain can be confined to those activities that arise as a response to the impetus of lead firms. In this chapter, value chain and supply chain are used interchangeably as synonyms.

3. Sustainable supply chains - what is about?

With the new challenges faced by supply chain actors, the concept of supply chain has evolved to incorporate sustainability, which was previously thought to be a preserve of economists and environmentalists. For instance, Seuring (2012) contends that globalization has placed demand on supply chain management to go beyond pure economic issues and to incorporate fair labour conditions and environmentally friendly production. The concept of sustainable supply chain can be best understood from the definition of sustainable supply chain management, provided by Seuring and Müller (2008) which defines it as the management of material, information and capital flows as well as cooperation among companies while incorporating goals from all the three dimensions of sustainable development, i.e., economic, environmental and social, which are derived from customer and stakeholder requirements. Therefore, for a supply chain to be sustainable, the actors need to fulfil environmental and social criteria in addition to economic ones. Thus, a supply chain is said to be sustainable when it contributes to sustainable development by delivering simultaneously economic, social and environmental benefits (Hart & Milstein, 2003). While the concept of supply chain sustainability is anchored on the principle of intergenerational equity considerations, further elaboration of the three dimensions of sustainable supply chains will suffice to help in understanding how sustainable chains are created.

3.1 The economic dimension

This dimension has been the most explored by supply chain actors and the most researched of the three dimensions (Seuring & Muller, 2008; Seuring, 2012). It focuses on efforts directed by firms towards enhancing total value while reducing supply chain costs. In this case, chain actors strive to maximize profits without compromising the environmental and social/ethical dimensions of sustainability.

3.2 The environmental dimension

This dimension of sustainability draws from the broader definition of sustainability, which is based upon the Brundtland's definition of "meeting the needs of the present without compromising the ability of the future generation to meet their own needs" (World Commission on Environment and Development, 1987). While organizations have been self-motivated in their attempt to achieve economic sustainability, environmental initiatives implemented in many organizations have been the response to imposed external regulations (Closs et al., 2011). Recently, however, the emerging challenges like the dwindling of the natural resource base, on which many supply chain activities are based, together with consumer demands, could be the driving force behind the quest for environmental sustainability initiatives being implemented by many organizations (Walker et al., 2008). However, organizational commitment to the environmental dimension is reported to vary across enterprises, although studies indicate that firms can increase profit by adopting environmentally sustainable practices (Siegel, 2009).

3.3 Social or ethical sustainability

Within the private sector context, the social dimension of sustainability often focuses on issues related to Corporate Social Responsibility (CSR). The most common definition of CSR is the "... social responsibility of business, which encompasses the economic, legal, ethical and discretionary expectations that a society has of organizations at a given point" (Carroll, 1979). Thus, managers achieve the ethical dimension of sustainability by making decisions that meet the society's expectations. The societal expectations are not necessarily defined from a legal perspective, but from broader ethical principles that drive the culture and decision-making outcomes within the firm. For instance, agribusinesses may establish schools and hospitals and register for fair trade certification as part of CSR initiatives. The ethical dimension can be classified into employee relations, community involvement and business management practices (Closs et al., 2011).

4. Landscape approaches in supply chain management

Global challenges related to food security, poverty, climate change, and ecosystem degradation are of increasing concern. More and better managed agricultural land is needed to meet the increasing global demand for food, feed, fuel and fibre. At the same time, up to 5 million hectares of productive agricultural land are lost each year due to soil erosion and degradation worldwide, while up to 290 million additional hectares are at high risk of desertification (Eswaran et al., 2001). As a result, there is a push for agriculture to become increasingly 'multifunctional' by contributing to food production as well as environmental, social, and cultural benefits at multiple scales. Under conventional supply chain approaches, firms aim to maximize their profit by adopting strategies which will enable them to produce or source their inputs in the most efficient and effective manner. This means that firms will pursue their profit maximization objectives without taking into account the overall consequence on the other supply chain actors including the environment and overall impact on the communities within which they operate, as long as it does not affect their productivity directly. Thus, traditional supply chain management might aim at designing, planning, executing, controlling, and monitoring supply chain activities with the objective of creating net value, and synchronizing supply with demand. However, a 'multifunctional' or landscape approach is different in that it deals with large-scale processes in an integrated and multidisciplinary manner, combining natural resources management with environmental and livelihood considerations (FAO, 2012).

Landscape approaches, as defined by Kissinger et al. (2013), provide a framework to carry out an integrated range of activities beyond the farm level to support food production, ecosystem conservation and rural livelihood activities. The necessity of such an approach in market and supply chain management lies in its capacity to capture new markets, mitigate risk, create opportunities at a large scale and improve business governance. For this reason, some agribusinesses are now investing in landscape approaches in the process of securing their sources of raw materials with the aim to positively support the lives of suppliers and reduce potential negative impacts on ecosystems. While such approaches are good steps forward, the sustainability initiatives in agribusiness and the food industry should not only focus primarily on ensuring sustainable supply chains, but it must also include a wider range of factors such as government policies, and social and environmental conditions (LPFN, 2012). These landscape factors include, but are not limited to, watershed health, biodiversity conservation and habitat connectivity, and land and resource tenure.

5. Why firms use landscape approaches?

Agribusinesses may invest in landscape approaches for some or all of the following reasons.

5.1 Achieving Corporate Social Responsibility (CSR)

This goes beyond compliance and engages in activities that promote some social good, beyond the interests of the firm and legal regulations. CSR influences a company's performance in non-financial areas, such as inclusion of social and environmental considerations in their operations, and embracing sustainability as a key business performance indicator (Kissinger et al., 2013).

5.2 Reducing reputational risk

Reputational risk is the risk that a company will lose potential business because its *modus operandi* has been questioned. For example, if it is revealed that a company has been cheating its suppliers for years or has been operating under extremely bad social and environmental conditions such as the use of child labour, it can negatively affect the businesses' 'social license'. Some agribusinesses might want to avoid this situation by adopting landscape approaches to their sourcing in order to strengthen the social and environmental sustainability in their supply chains.

5.3 Mitigating operational risk

This is vital when it is important to ensure the sustainability of the sourcing area. Agribusinesses which depend on specific commodities and inputs from sourcing regions, will seek resource security to maintain their supplies. In this case, the agribusiness may need to focus beyond the individual production unit, which is the farm, and make attempts to conserve the social, economic and environmental factors of production in its area of operation. For instance in the case study presented in Box 20.1, it can be found that Mars Incorporated is not only seeking to improve production and productivity, but is also trying to promote activities that will enhance the wellbeing of the cocoa farmers with the belief that it will ultimately lead to a more sustainable supply of cocoa.

5.4 Capturing markets

By adopting a landscape approach, agribusinesses are likely to build strong business cases for improving and demonstrating their CSR. Benefits might include better alignment with consumer concerns over environmental issues, working conditions and health of workers. In this way they may capture markets that pay premiums when particular concerns are being addressed.

5.5 Increasing partnership, sharing risk and reducing conflicts

Most agribusinesses operate in an environment characterized by multifaceted and complex problems that cannot be addressed by a single actor or company. To address such problems collective action and partnership between public and private actors are often recommended. Multi-stakeholder platforms are now considered as universal solutions to complex problems that businesses, governments, and communities cannot solve individually. By engaging in such participatory, multi-stakeholder platforms there is the opportunity for agribusinesses to share risk and improve the business governance by building collaborations and identifying integrated solutions (Raynard & Forstater, 2002; Kissinger et al., 2013; Ferris et al., 2014).

6. Tools for integrating landscapes into supply chain management

There are many criteria and tools that can be used to integrate the landscape approach into sustainable supply chains. The most important factors in developing more sustainable supply chains are the type of supply chain involved and the individual business's attitude to extending responsibility for product quality into social and environmental performance within their own supply chains (Smith, 2008). The modes for investing in landscape approaches follow a pattern, largely based on the type of risk faced, the rationale for the business to invest, and the entry point. Most commonly observed criteria are regional producer support programmes, multi-stakeholder dialogues and vertical and horizontal integrations (Kissinger et al., 2013).

6.1 Regional producer support programmes

Regional producer support programmes can also be used to enhance integration of landscape approaches into supply chain management. The producer support programme comprises several different support activities, including participatory risk assessments, information sharing and learning, technical support, systemic interventions and funding opportunities and mechanisms (FLO, 2011). These can be for a single commodity or for a combination of commodities, which in both cases often lead agribusinesses to define interventions beyond the farm-scale. To achieve a balance in tradeoffs at the landscape scale, the primary objective for such programmes should be integrated landscape management. For instance, Starbucks is integrating climate resilience into the coffee sector in many parts of the world where it sources its raw materials by addressing livelihood needs through higher prices paid for beans and supplemental income from carbon payments giving farmers incentives to not expand coffee growing areas into surrounding forests (Kissinger et al., 2013).

6.2 Multi-stakeholder dialogues

Multi-stakeholder dialogues refer to an interactive working communication process that involves various stakeholders in decision-making and implementation of efforts (Pederson, 2006). An example of the multi-stakeholder dialogues is the global sustainability initiatives such as the UN Global Compact, which is a strategic policy initiative for businesses that are committed to aligning their operations and strategies with ten universally accepted principles[1]. This covers the broad areas of human rights, labour, environment and anti-corruption. This overall aim is to ensure that businesses, as a primary driver of globalization, operate such that markets, commerce, technology and finance advance in ways that benefit economies, societies and the environment everywhere. Another example is the Sustainable Agriculture Initiative (SAI) platform which is the main food and drink industry sustainability initiative supporting the development of sustainable agriculture worldwide. The SAI seeks involvement from all food chain stakeholders who are willing to play an active role in the development, recognition and implementation of sustainable practices for mainstream agriculture. Community-based Innovation Platforms (IPs) are another example of multi-stakeholder dialogues facilitated by support organizations to help increase awareness and recognition that commitment and communication are essential to help smallholders benefit from value chains. IPs are usually made up of groups of individuals (who often represent organizations) with different backgrounds and interests who come together to diagnose problems, identify opportunities, and find ways to achieve their goals. The IPs can bring stakeholders to work together (at micro-community, meso-landscape and macro-national and regional levels) for sustainable value chains development (Walters, 2013; van Paassen et al., 2013).

6.3 Vertical and horizontal integration

Vertical and horizontal integrations can be used as tools to integrate landscape approaches into supply chain management. The vertical integration focuses on vertical relationships between buyers and suppliers, and the movement of goods or services from producers to consumers such as the flow of material resources, finance, knowledge and information between buyers and suppliers (Bolwig et al., 2010). For instance, out grower

Box 20.1

Case study: Vision for Change project between Mars Inc. and the World Agroforestry Centre (ICRAF)[2]

The Vision for Change (V4C) project financed by Mars Inc. and implemented by ICRAF aims to revitalize the cocoa sector in Côte d'Ivoire which has one of the lowest levels of productivity from around the globe. The project aims to achieve this by empowering farmers to produce cocoa on diversified farms with higher productivity, improved quality of beans and higher profitable returns in rural communities. Although the primary aim of the project is to create a sustainable supply of cocoa by addressing various bottlenecks in the cocoa supply chain (including the use of poor planting materials, non-efficient extension, etc.), it does so by taking other social and environmental concerns into consideration. For instance, the project has taken a landscape approach by promoting tree planting on cocoa farms as a means to enhance ecological and income diversification in the cocoa communities. Furthermore, the project has established Cocoa Village Centers (CVCs) where it trains rural entrepreneurs to produce quality tree germplasm and to provide extension information as well as farm rehabilitation services to farmers. The planting material produced comprises not only of cocoa, but also other native and exotic tree species which can be interplanted with cocoa to provide shade and create environmental benefits which is expected to increase resilience to climate change risks. Farmers have been trained to establish and manage their own nurseries which are providing additional/alternative sources of income. The project is also promoting the development of the value chains of other tree species such as *Ricinodendron heudelotii* (called akpi in local language) some timber species, mango, citrus and oil palm, which can be planted in and outside of cocoa farms thereby enhancing multi-product supply chain in the communities.

Figure 20.1 Vision for Change project. Photo credit: World Agroforestry Centre

schemes, also known as contract farming, can used by many large agri-food firms to ensure sustainability in their supply chains (OECD, 2008). An out grower scheme is a binding arrangement through which a firm ensures its supply of agricultural products by individuals or groups of farmers and aims to replace *ad hoc* trade arrangements with more coordinated commercial relationships (Felgenhauer & Wolter, 2008). They provide opportunities for firms to have more control over the production processes of smallholder farmers when the contract specifications include sustainability indicators in the production processes. For instance the South Africa Brewery, SABmiller, initiated contracts with farmers in South Africa and India as a means to ensure implementation of quality standards (Felgenhauer & Wolter, 2008). The horizontal integration will occur when firms doing the same business within the supply chain merge to increase in size and enjoy economies of scale. An existing way of linking vertical and horizontal concerns in supply chain management has been through the examination of social, labour and environmental standards and certifications (Bolwig et al., 2010). Certification and product standards can also be used by agribusinesses while aiming for stable commodity sourcing and supply chain efficiencies. According to Ponte (2008), standards and certifications that protect workers, the environment and social conditions of production have 'positive' impact on the supposed beneficiaries in the supply chain. Such standards and certifications are used to ensure good working conditions, preventing the use of unethical production methods such as child labour, while making sure both livelihoods' and environmental issues are taken into consideration.

7. Conclusion

Sustainability of supply chains is increasingly gaining momentum among agribusinesses although the overall level is still low. Adopting landscape approaches provides an opportunity for firms to introduce sustainable sourcing strategies into their operations by enabling them to achieve multiple and multifunctional objectives. This may include improving productivity whilst at the same time enhancing social and ethical standards (such as promoting quality education, providing proper health care services and other social amenities), and improving ecosystem services (such as protecting water bodies, protecting wildlife and conserving biodiversity) in the areas where they operate. The landscape approach in supply chain management goes beyond the individual production units and considers the overall development and wellbeing of the local producer communities.

From the social perspective, the project aims to invigorate the rural communities by improving the living standards of farmers in the cocoa communities, removing extreme forms of child labour and making cocoa production more attractive to younger farmers by increasing farmers' incomes through diversification. The economic, environmental and social goals of the interventions are intended to demonstrate proof of application of the approach to catalyse replication in other locations throughout Côte d'Ivoire and West Africa. It is believed that in the future, sustainable intensification of production systems, taking into consideration social and environmental factors, will be the only means for accessing markets for cocoa. Farmers are expected to enjoy price premiums from certification bodies such as the Rainforest Alliance, UTZ and Fair Trade for using environmentally sustainable and socially acceptable production processes.

Endnotes

1 For detailed information about the UN Global Compact, refer to: https://www.unglobalcompact.org/
2 Based upon Vision for Change project proposal and personal interview with project manager, Dr. Christophe Kouame

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References

Bolwig, S., Ponte, S., Du Toit, A., Riisgaard, L., & Halberg, N. (2010). Integrating Poverty and Environmental Concerns into Value-Chain Analysis: A Conceptual Framework. *Development Policy Review, 28*(2), 173-194.

Carroll, A. B. (1979). A three-dimensional conceptual model of corporate performance. *Academy of Management Review, 4*(4): 497-505.

Closs, J. D., Speier, C., & Meacham, N. (2011). Sustainability to support end-to-end value chains: the role of supply chain management. *Journal of the Academy of Marketing Sciences, 39*(1):101-116.

Da Silva, C. A, Baker, D., Shepherd, A. W., Jenane, C., & Miranda-da-cruze, S. (2009). *Agro-industries for development*. Wallingford, UK: CABI.

Eswaran, H., Lal, R., & Reich, P. F. (2001). Land degradation: an overview. In: Bridges, E. M., Hannam, I. D., Oldeman, L. R., Pening de Vries, F. W. T, Scherr, S. J., & Sompatpanit, S. (Eds.) *Responses to Land Degradation. Proc. 2nd. International Conference on Land Degradation and Desertification, Khon Kaen, Thailand.* New Delhi, India: Oxford Press.

Felgenhauer, K., & Wolter, D. (2008). *Outgrower Schemes – Why Big Multinationals Link up with African Smallholders.* Paris: OECD.

Ferris, S., Robbins, P., Best, R., Seville, D., Buxton, A., Shriver, J., & Wei, E. (2014). *Linking smallholder farmers to markets and the implications for extension and advisory services.* Modernizing Extension and Advisory Services (MEAS) Discussion Paper Series on Good Practices and Best Fit Approaches in Extension and Advisory Service Provision Number 4. MEAS.

FLO (Fairtrade International). (2011). *Fairtrade producer support programme for climate change adaptation and mitigation.* Fairtrade International.

Food and Agriculture Organization of the United Nations (FAO). (2012). *Mainstreaming Climate-smart Agriculture into a broader Landscape Approach.* Background paper for the second Global Conference on Agriculture, Food Security and Climate Change. Hanoi, Vietnam: FAO.

Gale, F. P. (2000). Economic specialization versus ecological diversification: the trade policy implications of taking the ecosystem approach seriously. *Ecological Economics, 34*(3), 285–292.

Hart, L. S., & Milstein, B. M. (2003). Creating sustainable value. *Academy of Management Executive, 17*(2), 56-67.

Kaplinsky, R., & Morris, M. (2002). *A Handbook for Value Chain Research.* UK: Institute for Development Studies.

Kissinger, G., Brasser, A., & Gross, L. (2013). *Scoping study. Reducing Risk: Landscape Approaches to Sustainable Sourcing. Washington, DC: Landscapes for People, Food and Nature Initiative.*

LPFN (Landscapes for People, Food and Nature). (2012). *Landscapes for People, Food and Nature Initiative: Action and Advocacy Strategy, 2012-2014.* LPFN.

OECD (Organization for Economic Cooperation and Development Centre). (2008). Business for development: promoting commercial agriculture in Africa. OECD.

Pederson, E. R. (2006). Making corporate social responsibility (CSR) operable: How companies translate stakeholder dialogues into practice. *Business and Society Review, 111*(2), 137-163.

Ponte, S. (2008). Greener than Thou: The political economy of fish Eco labeling and its local manifestations in South Africa. *World Development*, 36 (1) 159-175.

Pretty, J., & Hine, R. (2001). *Reducing food poverty with sustainable agriculture: a summary of new evidence.* Final Report from the SAFE-World Research Project. Colchester, U.K.: University of Essex.

Raynard, P., & Forstater, M. (2002). *Corporate social responsibility: Implications for small and medium enterprises in developing countries.* Vienna, Austria: United Nations Industrial Development Organization.

Robèrt, K.-H., Schmidt-Bleek, B., Aloisi de Larderel, J., Basile, G., Jansen, J. L., & Kuehr, R (2002). Strategic sustainable development — selection, design and synergies of applied tools. *Journal of Cleaner Production, 10*(3), 197–214.

Seuring, S. (2012). A review of modeling approaches for sustainable supply chain management. *Decision Support Systems, 54*(3), 1513-1520.

Seuring, S., & Müller, M. (2008). From literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production, 16*(15), 1699-1710.

Siegel, D. S. (2009). Green management matters only if it yields more green: an economic/strategic perspective. *Academy of Management Perspectives, 26*(2), 5-16.

Smith, B. G. (2008). Developing sustainable food supply chains. *Philosophical Transactions of the Royal Society B: Biological Sciences, 363*(1492), 849-861.

Sturgeon, J. T. (2001). How do we define value chains and production networks? *IDS Bulletin, 32*(3), 9-18.

van Paassen, A., Klerkx, L., Adjei-Nsiah, S., Adu-Acheampong, R., Ouologuem, B., Zannou, E., … Traore, M. (2013). Choice-making in facilitation of agricultural innovation platforms in different contexts in West Africa: experiences from Benin, Ghana and Mali. *Knowledge Management for Development Journal,* 9, 79-94.

Walker, H., Sisto, D. L., & McBain, D. (2008). Drivers and barriers to environmental supply management practices: lessons from the public and private sector. J*ournal of Purchasing and Supply Management, 14*(1), 69-85.

Walters, H. (2013). Changing our ways: making sense of complex multi-stakeholder systems change by using the four quadrant model. *Knowledge Management for Development Journal, 9,* 153-166.

World Commission on Environment and Development. (1987). *Our common future.* Oxford, U.K.: Oxford University Press.

Discussions between a World Agroforestry Centre researcher, a Nairobi City Water and Sewerage Company worker and a farmer on management of a weir and impacts of upland practices. Photo credit: John Gathenya

CHAPTER 21

Private sector engagement in landscape-based approaches - lessons from cases in East Africa

Sara Namirembe and Florence Bernard

Highlights

- The private sector depends on ecosystem sustainability and is a key stakeholder in operationalizing landscape-based approaches
- A business case is crucial in motivating individual or collective private sector participation in landscape-based approaches and data and tools are needed to support companies' decision-making
- Effective feasibility of landscape-based initiatives with private sector involvement will require concomitant adjustment of regulatory and institutional boundaries
- The co-investment approach allows for innovative financial mechanisms for public and private investments and is needed for achieving multiple landscape-level objectives
- Private sector demand for landscape-based approaches needs to be increased through information awareness and dialogue

1. Introduction

Climate change, ecosystem degradation, and increasing competition over limited resources pose significant risks to the well-being of different stakeholders, either directly or indirectly. Agricultural landscapes, including forests, are particularly experiencing great environmental stress from the production of agricultural products and commodities and their declining capacity to deliver key ecosystem goods and services is of great concern (Millennium Ecosystem Assessment, 2005). Currently, ecosystem management is mostly in the public domain where different functions, managed under different sectors, are not adequately coordinated. Management approaches are often inadequate due to low budget allocations and lack of data on the true value of ecosystem services. The private sector is more and more concerned with global challenges related to food security, climate change, and ecosystem degradation, and being a key player in landscapes, it does have a key role to play in addressing those challenges. However its full potential has not yet been realized (Bishop et al., 2008).

The private sector is highly diversified ranging from multi-national corporations, to large national actors, to emerging small and medium enterprises and smallholders. Their actions and impact on environmental services differ depending on whether businesses directly rely on and impact landscape resources by virtue of their location (e.g., water bottling companies, tourism camps), as a source of raw-material (e.g., saw mills) or a sink of their effluent (e.g., brewing, leather tanning industries) compared to those that are remote from the landscape (e.g., banks, telecommunications).

Traditionally, private sector involvement in sustainability initiatives has been framed by normative regulatory mechanisms (McIntyre et al., 2009; Henneman, 2013; Maxwell et al., 2014), profitability and value-driven image concerns (Villamor et al., 2007). Normative measures influence business behaviour through regulation by defining and enforcing acceptable criteria or standards at global or country level, or through pressure from consumers or fellow private entities. Profitability motivation works in situations where addressing ecosystem sustainability challenges can at the same time improve business performance by reducing costs, enhancing reputation, satisfying customers (Williamson et al., 2006), creating moral relations with stakeholders (Halal, 2000) and/or creating an exploitable niche advantage over the competition (Torriti & Lostedt, 2009). Image motivations related to building a reputation or brand have been applied mainly in reducing negative impact on ecosystems across product life cycles (Crane, 2000) or through corporate social responsibility actions. Many of these sustainability initiatives have focused on improving the environmental and social performance of specific operations in corporate supply chains (Kissinger et al., 2013*a*), but they have not been adequate in addressing challenges such as risks arising from water shortage, climate change and community relations as these require additional solutions operating beyond business boundaries (Kissinger et al., 2013*a*).

The landscape-based approach is a relatively novel and a potentially better way to achieve sustainability by departing from simplistic disjointed actions, towards deliberate involvement of multiple stakeholders and focus on multiple ecosystem functions and their inter-dependencies. It is based on principles of participation, adaptive management, shared learning and inter-sectoral coordination (Milder et al., 2014) aimed at increased productivity, improved livelihoods, and enhanced or large-scale management of ecosystem services (e.g., biodiversity conservation and carbon sequestration) (Scherr et al., 2012).

Various models of landscape-based approaches (e.g., vision-based plans, payments for ecosystem services (PES), Reduced Emissions from Deforestation and forest Degradation and enhanced carbon stocks (REDD+), integrated or collaborative management plans for conserving forests, biodiversity and watersheds, etc.) have been piloted, mostly by non-governmental organizations (NGOs), but the potential of the private sector in these has not been fully realized. Indeed, of 104 integrated landscape initiatives documented in Latin America by the Landscapes for People, Food and Nature initiative, only 24 involved the private sector with 10 out of the 87 initiatives in Africa doing so (Milder et al., 2014). This tendency to leave the private sector out of landscape-based processes is possibly due to lack of skills or limitations in the existing methodologies in managing power relations or presenting information in a language the business sector understands. Private sector engagement can also present risks to landscape-based approaches such as suppression of smaller local business initiatives, derailing of objectives from being multi functional and inclusive to narrow commodity focus, profiteering and greenwashing. Yet, the private sector has a pivotal role to play, some in adopting climate-smart practices themselves and some in the design of sustainable financing mechanisms for landscape-based approaches due to its specialized strength in identifying and providing start-up finances for for-profit business opportunities, creating jobs and providing business technical expertise, information and linkages to market outlets. There is growing evidence that inter-dependencies within landscape-based approaches could be in the interest of the private sector in ensuring ecosystem sustainability and mitigating climate change, not always achievable by supply chain approaches (Kissinger et al., 2013*a*). In spite of this, to date, private sector actors have not been widely engaged as partners in landscape management initiatives, and there have been even less private sector-initiated landscape approaches. This chapter therefore highlights some key recommendations for enhancing engagement of the private sector in future landscape-based initiatives, building upon some cases within East Africa. It focuses on the market-based private sector, or in other words, the business sector.

2. Key recommendations for increasing private sector engagement

2.1 Develop a business case

A good business case, whether it is an increase in profit or reduction in cost or risk, is a major consideration for private sector decisions to engage in landscape-based initiatives. Determining this requires prior analysis based on information that sets standards and assigns value to not only the ecosystem services' impacts, benefits and risks, but to all the interactions entailed in the model (Hartmann, 2012). Clear data and indicators enable businesses to set measurable aims in order to monitor performance in both financial and ecosystem sustainability terms. Current methods are accumulating data on valuing ecosystems and services thereof. The way these are reported needs to be translated from purely environmental (i.e., non-business) purposes to those aspects of relevance within corporate decision-making frameworks. The inter-connections and inter-relations are currently not valued, but are assumed to be achieved if analysis goes as far as proving that overall efficiency is improved.

Online platforms and hubs are providing support information on opportunities and methods of engagement and their potential costs and benefits (Veolia, 2014). For example, the ecosystem stewardship standards help companies to evaluate their dependence and impacts on ecosystems (U.S. Chamber of Commerce Foundation, 2014), the Applied Information Economics tool (Hubbard Decision Research, 2014) helps to assign quantitative values on parameters in business models that had been considered to be non-measurable and the Natural Capital Coalition has developed a guide recommending ways accountants can frame risks and opportunities in business terms and embed natural capital into corporate decision-making. The British American Tobacco Biodiversity Partnership has developed the Biodiversity Risk and Opportunity Assessment (BROA) tool which assesses risk to biodiversity and ecosystem services dependencies and opportunities at the landscape scale for companies with agricultural supply chains (Kissinger et al., 2013*a*). Such tools, if fine-tuned to meet business needs, can be applied to support companies' decision-making processes to take a stronger leadership role and invest more capital in natural resource management. Furthermore, it will be important to make the business case not only for multinationals but also for the local medium- and small-sized local enterprises whose potential should not be neglected. Nonetheless, a business case is just one of the steps required and does not necessarily lead to private sector decisions to engage, as other enabling factors (e.g., political, social and environmental) have to be considered as will be discussed in the next section.

2.2 Ensure feasibility in regulatory and institutional frameworks

Regulatory and institutional boundaries define acceptable standards and set the frameworks at national or global scales within which businesses must operate. They supersede all other voluntary drivers of decision-making (Bansal & Roth, 2000). Because landscape approaches entail new inter-connections presenting new governance challenges, only in a few instances will they fit well in existing frameworks and some level of adjustment may be required. For example, in Sasumua Watershed (Box 21.1), regulatory challenges of implementing PES in the existing institutional framework contributed to reluctance of the Nairobi City Water and Sewerage Company (NWSC) to implement PES for controlling sedimentation of its dam in spite of a good potential business case.

The challenge in addressing institutional restrictions is that landscape approaches tend to have context specific requirements yet frameworks operate at much broader scales and influencing their adjustment might take longer timeframes and may require information across different contexts. Background assessment of institutional feasibility is therefore essential for implementing a good landscape initiative. Additionally, early partnering with governments is crucial as they have the mandate to create the needed enabling conditions that will allow landscape-based initiatives to function.

Box 21.1

Developing private-financed PES in Sasumua watershed, Kenya: a strong business case challenged by the national institutional framework (Mwangi et al., 2011)

The Sasumua reservoir, operated by Nairobi City Water and Sewerage Company (NWSC), a parastatal company, supplies Nairobi, with 20% of its water. The company incurs high water treatment costs because of sedimentation from cultivated farms (1.1 ha per household) where 67% of its water originates from. Using the Soil and Water Assessment Tool (SWAT) model (Arnold et al., 1999), potential quantities of sediment flow reduction and dry weather water flow improvement from soil and water conservation practices were estimated. Because cultivated farms are under private ownership, adoption of such practices cannot be achieved within the existing water catchment management structure. The potential for a PES approach was explored building upon workshops with all different stakeholders of the Sasumua landscape to plan integrated management practices for watershed management. It was established that a strong business case (about $122,924/year Net Present Value) existed for PES between NWSC and upland farmers, already organized in a Water Resource Users' Association (WRUA). However, implementing PES was found to be potentially problematic within the existing institutional framework where NWSC already pays fees for watershed management to the Water Resource Management Authority. Although it was established that over 40% of water consumers in Nairobi were willing to pay an extra US$1.25 above their monthly water bill to finance watershed conservation (Balana et al., 2012), the Water Services Regulatory Board and not NWSC has the authority to increase water tariffs. These institutional structures govern the whole country and could not be changed based on only the context of Sasumua.

Box 21.2

Imarisha Naivasha Partnership for Sustainable Development: a government-led landscape initiative with strong involvement of the private sector (Kissinger, 2014)

The Lake Naivasha landscape is located in the eastern Rift Valley and encompasses some 3,400 km^2 of the Lake Naivasha watershed. The lake is an area of high biological diversity and of recreational value, a crucial stopover point for migratory waterfowl, a key freshwater resource and a source of livelihood for an increasing population around the lake. The lake supports intensive irrigation-based agriculture for cut flowers, livestock and dairy farming, geothermal power production, aquaculture and a tourism industry. Growing concerns about environmental degradation and the 2008-2009 drought that demonstrated the vulnerability of a range of stakeholders in the watershed, led the Kenyan government to create the Imarisha Naivasha public-private partnership (PPP). While it is a government-led initiative, there is very strong private sector engagement, particularly with the large floriculture sector serving the European flower market. This PPP is composed of representatives of key government ministries, commercial flower growers, water resource users, forest resource users, beach management units, pastoralists, and civil society organizations. It is tasked with the coordination and development of a plan to restore the degraded watershed and establish a sustainable development programme with the participation of all stakeholders. The PPP aims at supporting local industries improve their environmental impacts and channelling financing to key ecosystem services stewards like up-catchment smallholders to reward good practices. Key factors of success of this partnership include the fact that the Imarisha Naivasha PPP has a legal mandate and also a strong visibility which entices the stakeholders to collaborate and participate in the multi-stakeholder forums. Another key strength of the PPP is that it gathers technical capacity among the collaborative partner institutions as well as the ability to mobilize financial resources, and communicate with and influence high policy spheres. The PPP also has strong ability for leadership, negotiation and consensus building.

2.3 Promote a co-investment approach

The co-investment approach is based on models that allow collective or shared responsibility with various stakeholders within the landscape (Namirembe et al., 2013). Situations where the threshold of profit is large enough to motivate engagement of individual private sector entities in landscape-based ventures are rare. Most often, the scope and complexity entailed in implementing landscape-based approaches transcend what single companies or firms can handle. Where multiple market-based entities with strong financing capacity were engaged, co-investment thrived because of collective financing sources created. For example, the Succulent Karoo Ecosystem Programme in South Africa uses collective investments from private firms such as the Development Bank of South Africa, Citigroup Foundation, and DeBeers South Africa, as well as municipal and federal governments (US Chamber of Commerce Foundation, 2014). Another successful example is the Lake Naivasha PES scheme (Box 21.2) which is financed by the Imarisha Naivasha public-private partnership, which includes the Ministry of Water, Environment, and Natural Resources, Kenya, Equity Bank, commercial flower growers, retailers in the UK and foreign aid (Kissinger, 2014).

New models are also emerging where rather than working individually, private entities are coalescing to form a shared image or brand. One example of this is the Roundtable on Sustainable Palm Oil where companies share production values (Laurance et al., 2010). Such initiatives have the potential to evolve beyond single commodity focus to include other stakeholders in order to address the inter-connections to other landscape functions. Although it might not be possible for landscape approaches to foster inter-relations between business entities, they can loop into such already existing ones in order to motivate participation and investment in landscape actions. This has the potential to bring in investment from players that are not based within the landscape. For example, Wildlife Works Carbon (WWC), a for-profit company, based in Kenya and the USA, which developed the REDD+ Kasigau corridor project in Kenya, was able to secure external private-sector investment at the beginning of the project process. They obtained funding through an agreement with a South African bank, Nedbank, which provided the start-up capital in return for an 'option', buying the resulting credits at a concessionary rate and made a similar arrangement with BNP Paribas for the expansion of the project (Bernard & Adkins, 2014).

One downside however is that some co-investment models have not engaged private sector entities and/or have focused more on facilitating management plans where stakeholders share responsibilities. In those instances, entry points for the private sector are not clear as tools or language used have tended to focus too much on local participation, building trust and biophysical enhancement without identifying business models that could at the same time improve human well-being and make the initiative self-sustaining (e.g., Kasyoha-Kitomi and Kakasi (KKK) Forest Landscape Management Plan, Uganda; see Box 21.3).

Box 21.3

Vision-based planning for Kasyoha-Kitomi and Kakasi Forests, Uganda: unclear entry points for the private sector (PEMA, 2005)

The Participatory Environment Management (PEMA) Project of the World Wildlife Fund (WWF), CARE, Nature Uganda and the Danish Institute of International Studies found that the condition of Kasyoha-Kitomi and Kakasi (KKK) Forest Reserves in Uganda was declining, threatened mainly by encroachment of small-scale cultivation, illegal logging, wildlife hunting and fires. The forest reserves are under direct jurisdiction of the National Forestry Authority. To enhance forest resource management, the project facilitated relevant stakeholders to develop a joint five-year management plan based on a visioning process towards a harmonized desirable future scenario. The plan outlined how responsibilities and benefits would be shared and set in place a multi-stakeholder platform for coordination. However, no specific private sector-focused actions were taken in the planning process and although the major market-based entity, Igara Tea Factory, participated in the planning process, no clear entry point was identified for it. The only other private stakeholders were small and medium enterprises of artisanal timber, herbal medicine and crafts. Financing was assumed to come from contributions of the various member institutions through their own budgets since roles were shared according to mandates. However, the landscape, in general, was rural and the majority of stakeholders were NGOs, community-based and public entities with little budget flexibility. Actions requiring inter-sectoral-budgeting in government were almost impossible to implement. Therefore, in the end, the plan was only partially implemented mainly because of financing and capacity challenges. In this case, private sector buy-in was very low because their role was not clearly defined and the costs and complexity involved made the venture unattractive.

2.4 Foster multi-sectoral linkages and private-public partnerships

Breaking stakeholders out of their silos is crucial to promote synergistic landscape-scale collaborations. However, developing multi-stakeholder and inter-sectoral linkages is the hardest part of landscape initiatives entailing drawn-out negotiations between sectors or users over competing demands for ecosystem services and capacity building to bring on board relevant stakeholders. Capacity of such platforms for stakeholder dialogue, negotiation and consensus building is a key strength for operationalizing successful landscape approaches (e.g., Imarisha Naivasha Partnership for Sustainable Development, Box 21.2). It is where NGOs and public sector entities play a critical role in the process of facilitation and 'soft' skills capacity development. This should soften the ground for private sector engagement as it addresses a major hurdle and could potentially build trust and mutual understanding with community and public entities. Therefore, understanding sustainability concerns of private businesses early on can provide a starting point for determining the language in which landscape issues should be presented. The landscape process is often dynamic starting with a few linkages that create a nucleus around which new relationships develop and some old ones are dropped. Conducive climate for private sector engagement may well develop late in the process. Therefore, maintaining constant dialogue and some sort of information platform is essential to influence such decisions when the time is right. Negotiation processes are however long, involving a series of meetings and workshops that the private sector often do not want to commit time to. Another key challenge is finding the balance between mutually competing views of public entities (e.g., participation and inclusivity) and private entities (e.g., uniqueness and exclusivity). No single model will work in every setting. Each landscape has its own context, stakeholders and power relationships that will affect what is needed in a particular location.

3. Conclusions

Developing and implementing a landscape approach takes time, effort, dedication and money. Since the private sector depends on, and has a large impact on ecosystem services, it should be a key player whether its interests are direct or indirect. Many private entities are yet to reorient their businesses to address sustainability challenges internally linked to their value chain, and taking on landscape-based functions may be a very distant consideration. However, business decisions to participate in landscape-based approaches can be greatly enhanced if ecosystem sustainability concerns and parameters are translated from biophysical- and community- or public-good language to values that are relevant for business. Demonstrating a business case reflecting potential for a landscape-based approach to be cost-effective compared to simplistic sustainability strategies can fast-track decisions for such entities to engage. This is often challenging, as some unique aspects of the landscape-based approach are not easily quantifiable, but here, research institutions and other entities that provide such information and skills can play a major role.

Regulatory boundaries determine the feasibility of landscape-based approaches irrespective of the strength of the business case. Review of existing regulatory and institutional frameworks may be needed to accommodate new linkages and governance challenges that may develop from them. In this regard, the public sector has a critical role to play in dialogue initiation and process facilitation that ease and support private sector participation in multi-sectoral partnerships.

Most existing landscape-based approaches are supply-driven providing potential business options that the private sector is not necessarily demanding. Motivating private sector buy-in to these options has been challenging due to limited capacity to communicate ecosystem and climate matters in business terms. Creating private sector demand for landscape-based approaches through an externally driven normative setting of standards and targets can only go so far and has the danger of stifling voluntary initiatives. Internal drivers of demand such as image and profitability are also quite limited in motivating participation in landscape-based approaches. Therefore, awareness creation specifically targeting the business sector needs to be strengthened focusing on the benefits of landscape-based approaches in order to stimulate buy-in. Information and data on multiple-functions of ecosystems should be made available and dialogue created to motivate participation. Increased understanding through information and dialogue has the potential to influence all the other drivers towards improved ecosystem management. As shown in the global climate change discourses, such negotiations can be drawn out and expensive, but necessary to create understanding of ecosystem trends around which demand for sustainable management mechanisms can develop.

References

Arnold, J. G., Williams, J. R., Srinivasan, R., & King, K. W. (1999). *Soil and water assessment tool.* Temple TX: USDA, 92.

Balana, B. B., Catacutan, D., & Mäkelä, M. (2012). Assessing the willingness to pay for reliable domestic water supply via catchment management: results from a contingent valuation survey in Nairobi City, Kenya. *Journal of Environmental Planning and Management, 56*(13), 1511-1531. doi:10.1080/09640568.2012.732934

Bansal, P., & Roth, K. (2000). Why companies go green: a model of ecological responsiveness. *Academy of Management Journal, 4*3(4), 717-736.

Bernard, F., & Adkins, B. (2014). *Lessons learnt for operationalization for REDD+ in the Kasigau corridor project of Kenya.* ASB Policy Brief No. 44. Nairobi, Kenya: ASB Partnership for the Tropical Forest Margins.

Bishop, J., Kapila, S., Hicks, F., Mitchell, P., & Vorhies, F. (2008). *Building Biodiversity Business.* London, UK and Gland, Switzerland: Shell International Limited and the International Union for Conservation of Nature. 164.

Crane, A. (2000). Marketing and the Natural Environment: What Role for Morality? *Journal of Macromarketing,* 20, 144. doi: 10.1177/0276146700202004

Halal, W. E. (2000). Corporate community: a theory of the firm uniting profitability and responsibility. *Strategy & Leadership, 28*(2), 10 – 16. doi: 10.1108/10878570010341582

Hennemann, I. (2013). *Value chains and agro-food systems from a landscape perspective.* Wageningen, Netherlands: Centre for Development Innovation, Wageningen UR

Hartmann, T. 2012. Making Corporate Ecosystem Valuation practical for the business sector – Valuation methods and their integration into decision-making. Presented at TEEB Conference, Leipzig, Germany. Retrieved from http://www.business-biodiversity.eu/default.asp?Menue=89&Project=771

Hubbard Decision Research. (2014). Applied Information Economics: a powerful way for quantifying IT value. Glen Ellyn, US: Hubbard Decision Research. Retrieved from http://www.howtomeasureanything.com/wp-content/uploads/2014/02/IT-White-Paper-2014.pdf

Kissinger, G., Brasser, A., & Gross L. (2013a). *Reducing Risk: Landscape Approaches to Sustainable Sourcing.* Washington, DC: EcoAgriculture Partners, on behalf of the Landscapes for People, Food and Nature Initiative.

Kissinger, G., Brasser, A. & Gross, L. (2013b). *Scoping study. Reducing Risk: Landscape Approaches to Sustainable Sourcing.* Washington, DC: EcoAgriculture Partners, on behalf of the Landscapes for People, Food and Nature Initiative.

Kissinger, G. (2014). Case Study: Imarisha Naivasha, Kenya, In Shames, S. (Ed.) *Financing Strategies for Integrated Landscape Investment.* Washington, DC: EcoAgriculture Partners, on behalf of the Landscapes for People, Food and Nature Initiative.

Laurance W. F., Koh L. P., Butler R., Sodhi N. S., Bradshaw C. J. A., Neidel J. D., … Vega J. M. (2010). Improving the Performance of the Roundtable on Sustainable Palm Oil for Nature Conservation. *Conservation Biology, 4*(2), 377–381. doi: 10.1111/j.1523-1739.2010.01448.x

McIntyre, J. R., Ivanaj S., & Ivanaj V. (2009). *Multinational enterprises and the challenge of sustainable development.* Cheltenham, UK: Edward Elgar publishing.

Maxwell, D., McKenzie E., & Traldi R. (2014). *Valuing natural capital in business towards a harmonized protocol.* London, UK: Institute of Chartered Accountants in England and Wales.

Millennium Ecosystem Assessment. (2005). *Ecosystems and Human Well-being: Synthesis.* Washington, DC: Island Press.

Milder, J. C., Hart, A. K., Dobie, P., Minai, J., & Zaleski, C. (2014). Integrated Landscape Initiatives for African Agriculture, Development, and Conservation: A Region-Wide Assessment. *World Development*, 54, 68-80.

Mwangi, J. K., Gathenya, J. M., Namirembe, S., & Mwangi, H. (2011). *Institutional and policy requirements for payments for watershed services in Kenya-a case study of Sasumua watershed, Kenya*. Nairobi, Kenya: ICRAF. Retrieved from http://presa.worldagroforestry.org/blog/2012/01/10/recommendations-for-kenya-water-sector-in-new-presa-policy-brief/

Namirembe, S., Leimona, B., Meine van Noordwijk, M., Bernard, F., & Bacwayo, K. E. (2013). Co-investment paradigms as alternatives to payments for tree-based ecosystem services in Africa. *Current Opinion in Environmental Sustainability*, 6, 1–9. doi:http://dx.doi.org/10.1016/j.cosust.2013.10.016

PEMA (Participatory Environment Management). (2005). *Collaborative Action Planning Report for Kasyoha-Kitomi Landscape*. Kampala, Uganda: Nature Uganda.

Scherr, S. J., Shames, S., & Friedman, R. (2012). From climate-smart agriculture to climate-smart landscapes. *Agriculture & Food Security, 1*(12). doi: 10.1186/2048-7010-1-12

Torriti, J., & Löfstedt, R. (2009). EU-U.S.: to compete or to cooperate? This is an Impact Assessment question. In Swinnen, J., Vogel, D., Marx, A., Riss, H., & Wouters, J. (Eds.) *Handling Global Challenges*, 38-55. Leuven, Belgium: Leuven Centre for Global Governance Studies.

U.S. Chamber of Commerce Foundation. (2014). *Achieving Energy and Water Security: Scalable Solutions from the Private Sector.* Washington, DC: Corporate Citizenship Centre

Veolia. (2014). True Cost of Water Methodology and Tool. In U.S. Chamber of Commerce Foundation Corporate Citizenship Centre (Ed.) *Achieving Energy and Water Security: Scalable Solutions from the Private Sector.* Washington, DC: Corporate Citizenship Centre

Villamor, G., van Noordwijk, M., Agra, F., & Catacutan, D. (2007). *Buyers' perspectives on environmental services (ES) and commoditization as an approach to liberate ES markets in the Philippines.* Bogor, Indonesia: World Agroforestry Centre.

Williamson, D., Lynch-Wood, G., & Ramsay, J. (2006). Drivers of Environmental Behaviour in Manufacturing SMEs and the Implications for CSR. *Journal of Business Ethics, 67*(3), 317-330.

PART

5

Contextualized Experience

A mosaic of tea, maize and other annual crop production, eucalyptus woodlots and forest fragments comprises much of the Kericho landscape.
Photo credit: Mark Moroge

CHAPTER

22

Operationalizing climate-smart agricultural landscapes: the case of a tea-producing landscape in Kericho, Kenya

Jeffrey C. Milder, Mark Moroge and Seth Shames

Highlights

- Despite the conceptual appeal of climate-smart landscape approaches, there is little information available on how to operationalize them
- We developed an assessment tool to evaluate climate-smart landscape needs and opportunities in six key activity domains: on-farm management practices, landscape planning and coordination, energy systems, training and technical assistance, policy support, and technology and information
- We applied the tool in the agricultural landscape around Kericho, Kenya, an important tea-growing region where agriculture and ecosystem services are expected to be strongly affected by climate change
- The assessment revealed a strong foundation of existing activities and actors supporting climate-smart agriculture in Kericho and also highlighted priority areas for additional investment that could leverage current activities and fill critical gaps
- Structured tools such as the one profiled here can help translate climate-smart agriculture from a general concept into an operational strategy advanced through tangible sets of priorities and investments in specific landscapes

1. Introduction

The term 'climate-smart agriculture' (CSA) refers to production systems designed to increase food security, improve the resilience of agriculture to environmental change, and mitigate climate change (FAO, 2010; World Bank, 2011). While recently framed as a concept for the climate change and agricultural development communities, CSA includes many field- and farm-scale agricultural practices already well documented and in wide use, such as conservation tillage, agroforestry, crop residue management, water harvesting, agrobiodiversity conservation and use, and others (Campbell et al., 2011; World Bank, 2011; FAO, 2013).

Much of the focus of CSA has been on applying and improving these field- and farm-level practices to increase farm and household resilience in the context of a changing climate.

However, proponents of CSA have recognized that resilient agricultural systems also require appropriate land management and institutional support beyond the farm scale. Others have argued that for the CSA concept to drive transformational change, it must be understood and applied through holistic management and governance of socio-ecological systems (Neufeldt et al., 2013). Accordingly, CSA has been defined as requiring landscape level, ecosystem-based management as well as improved policy, investment, and institutional frameworks (FAO, 2011).

Landscape approaches to climate-smart agriculture, or 'climate-smart landscapes' (Scherr et al., 2012; Harvey et al., 2013), apply the principles of integrated landscape management to incorporate climate change adaptation and mitigation goals into multifunctional rural landscapes. Specifically, such approaches seek to increase positive synergies and reduce tradeoffs among stakeholder objectives related to food production, ecosystem conservation, and rural livelihoods. They do so by carrying out landscape-scale planning, policy, land management, or support activities; improving coordination and alignment of activities, policies, and investments among sectors and scales (e.g., ministries, local government entities, farmer and community organizations, and the private sector); and fostering participatory adaptive management processes that build capacity for climate change adaptation (Estrada-Carmona et al., 2014; Milder et al., 2014). In practical terms, climate-smart landscape management may entail activities such as watershed management that links farm and community water harvesting at local scales to water planning and allocation at larger scales. It typically also involves management of diverse land uses, species, and crop and livestock varieties to help build ecosystem resilience and livelihood diversification, thereby reducing vulnerability in the face of environmental variability.

But while the landscape approach has been identified as an important component of CSA, operationalizing it may require land managers, development professionals, policymakers, and rural communities to work in new ways, beyond what has typically been their purview, area of expertise, or frame of reference. New tools can help support this process by clarifying the needs and opportunities for landscape-scale management to help deliver CSA objectives for multiple stakeholders. To this end, the purpose of this study was to develop and test a methodology for assessing the status, needs, and gaps for CSA landscape implementation. In this chapter, we first summarize the assessment method and the process of developing it. We then report results from a field trial of this methodology in a tea-producing landscape around Kericho, Kenya. We conclude with reflections on the utility of the methodology and opportunities to support stakeholders in operationalizing climate-smart landscapes in regions of critical need.

2. Methodology

2.1 Assessment method

The CSA assessment method is a structured tool that guides the collection of information related to six 'domains': on-farm management practices, landscape planning and coordination, energy systems, training and technical assistance, policy support, and technology and information. The tool facilitates systematization of information on these themes by prompting users to develop an inventory and description of current activities in the landscape as well as gaps and opportunities (i.e., potential future activities) related to implementing a climate-smart landscape approach. For current and potential future activities, the implementing actors, indicative costs (when available), and source(s) of funding are also identified. For potential future activities, users are also prompted to identify the benefits, challenges, and barriers related to implementation, and to define potential supporting actors. The tool organizes and systematizes this information in a series of matrices.

The assessment tool is designed to be applied by multi-stakeholder groups in rural landscapes for the purpose of diagnosing and designing CSA activities, investments, or projects, including both externally funded efforts and community-led initiatives. Data are provided by landscape stakeholders through one-on-one interviews, small focus groups, workshops, or any combination of these. Typically, the assessment process would be facilitated by a community leader, local government entity, researcher, or non-governmental organization (NGO).

2.2 Site description

We field-tested the assessment tool in the tea-growing landscape around Kericho, Kenya (hereafter the "Kericho landscape"). This landscape is a cool, fertile, highlands region of the Rift Valley Province of western Kenya, located just west of the Great Rift Valley (Figure 22.1). The landscape is a mosaic of tea production areas, annual crop parcels producing potatoes, corn, beans, and other crops, small-scale eucalyptus woodlots, forest conservation areas, and urban and rural settlements (Figure 22.2). The landscape's

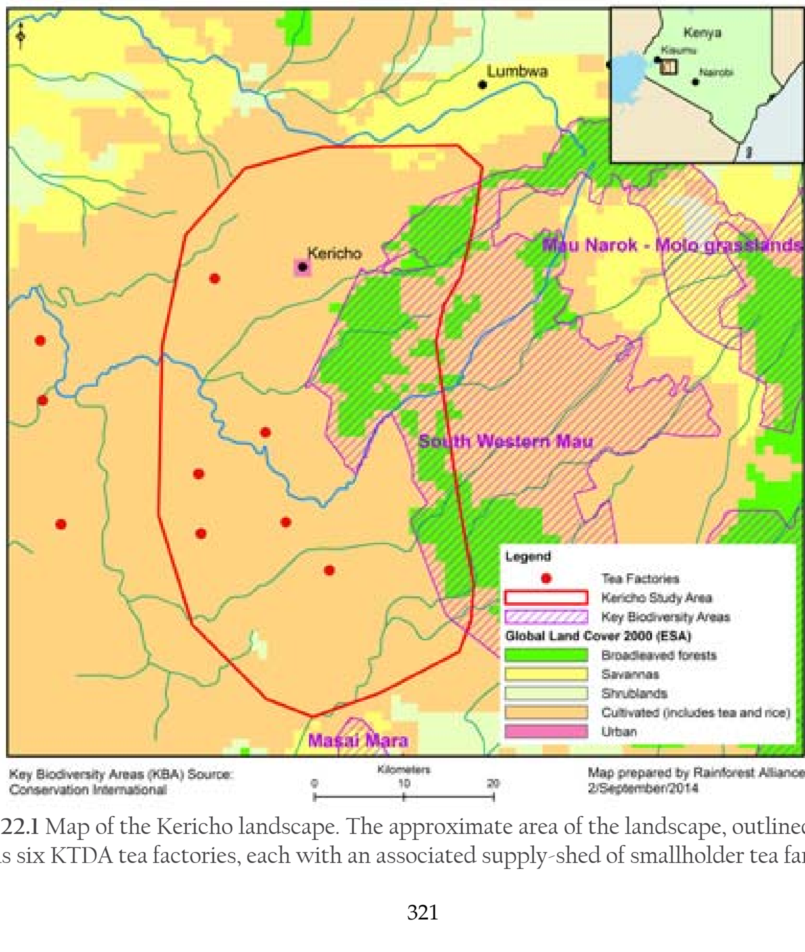

Figure 22.1 Map of the Kericho landscape. The approximate area of the landscape, outlined in red, contains six KTDA tea factories, each with an associated supply-shed of smallholder tea farms.

Figure 22.2 View of the Kericho landscape, which consists of a mosaic of tea production areas, annual crop parcels, eucalyptus woodlots, forest conservation areas, and human settlements.

unifying feature is tea, which is produced by large estates as well as smallholder farmers between the altitudes of approximately 1,800 and 2,200 meters. Smallholder farms are typically less than half a hectare in size, with most of the land planted with tea and usually no more than 20% reserved for food crops. Rural livelihoods reflect the composition of the land-use mosaic, with tea providing a primary income source, through wage labour on large tea estates as well as the sale of smallholder-grown tea. Additional livelihood sources include annual crop production for household consumption or sale in local markets and the sale of eucalyptus trees.

Above the tea-growing zone is the 135,000 hectare Mau forest complex, including the largest closed-canopy forest system in Kenya and the source of water for millions of Kenyans by way of twelve rivers and six major lakes fed by this headwaters area. Kericho County has a population of about 750,000 and covers an area of 247,900 hectares. Kericho town, the area's largest urban centre, has a population of about 100,000 (CRA, 2011). The Mau forest complex has a far lower population density, but is still inhabited by about 35,000 households.

The Kericho landscape is a prime tea producing area for Kenya, which is the world's largest exporter of black tea (Intergovernmental Group on Tea, 2012). As a crop, tea is potentially vulnerable to climate change, and such vulnerabilities are manifest in Kericho. First, the climate has been warming progressively over the past three decades (Omumbo et al., 2011), a trend that is likely to shift the optimal altitudinal band for growing tea and may pose new agronomic challenges or exacerbate existing ones. Second, the landscape is experiencing increased demand for eucalyptus, the preferred fuel source for tea processing, but a notoriously water-intensive species that is competing with tea, subsistence farming and natural forest cover for space in the landscape. Third, the Mau forest has experienced

Box 22.1

Sustainable agriculture certification in the tea sector

The global tea industry is in the midst of a transition to sustainable agriculture certification. In 2007, Unilever announced all Lipton tea-branded products (global market share of roughly 12%) would be entirely sourced from Rainforest Alliance Certified™ farms by 2015. More recently, Tata Global Beverages committed to sourcing all tea for its Tetley brand – another large global brand – from Rainforest Alliance Certified farms by 2016. More broadly, the Ethical Tea Partnership, an alliance of tea packers totalling around 50 brands, is working to improve the sustainability of the tea sector by setting a global sustainability standard and benchmarking it against leading standards such as Fairtrade, Sustainable Agriculture Network / Rainforest Alliance, and UTZ Certified to help reduce costs, avoid duplication, and mainstream sustainable practices throughout the sector.

Commitments from these global brands and alliances have spurred the widespread adoption of improved farming practices in the Kenyan tea industry. Smallholders and estates alike pursue certification to improve social and environmental management practices, increase productivity and product quality, and participate in the burgeoning market for certified tea. Most notably, the Kenya Tea Development Agency (KTDA), in collaboration with Unilever and Rainforest Alliance, has now nearly met its ambitious goal of having all of its factories achieve Rainforest Alliance Certification. KTDA has more than 65 factories sourcing from over 600,000 smallholder farmers. As of April 2014, over 430,000 hectares of tea have been Rainforest Alliance certified in Kenya. On the ground, Rainforest Alliance certification requires farms to adhere to the Sustainable Agriculture Network (SAN) Sustainable Agriculture Standard, which requires improved practices such as conserving and restoring forests, implementing boundary plantings and reforestation with native species, minimizing use of agrochemicals, applying integrated management plans to conserve water and recycle waste, and providing improved working conditions and worker benefits on plantations (SAN, 2010; Ochieng, 2013). Many of the agronomic requirements of the SAN standard are consistent with CSA principles.

extensive deforestation in recent decades, threatening biodiversity and the forest's critical watershed protection function (see Figure 22.1). Collectively, these trends highlight the need for integrated landscape management strategies that consider multiple scales of management and emphasize climate change adaptation.

Numerous actors are taking these challenges seriously and considering how best to respond to climate change and increasing pressure on land, water, and biomass resources to ensure the continued viability of tea production. Among other initiatives, tea producers have obtained Rainforest Alliance certification to gain market recognition for adopting socially and environmentally sustainable practices on their farms (see Box 22.1). In this context, the Kericho landscape provides an excellent setting in which to explore the feasibility of operationalizing CSA at the landscape scale and to apply the assessment method in support of this goal.

2.3 Field-testing the assessment method

We applied the assessment tool in March 2012 through approximately two dozen semi-structured interviews with key landscape stakeholders, in addition to a day-long workshop with a subset of these individuals. Several of these discussions took place during visits to tea farms and processing factories to help triangulate conditions on the ground with stakeholder knowledge. The involved stakeholders included representatives of private sector tea businesses, government and multilateral agencies, technical assistance providers, and NGOs active in the tea industry. Given that the main purpose of applying this tool in the Kericho landscape was to identify CSA priorities and opportunities for the tea sector, our focus was on stakeholders associated with tea production. Other key landscape actors—such as protected area managers and groups focused on staple crop production—were not directly involved in the assessment.

3. Results

Results of the assessment are organized according to the six climate-smart landscape domains described above. These are summarized in Table 22.1 and discussed further below. For each domain, we characterize existing climate-smart activities as well as key gaps and opportunities identified by stakeholders to improve climate change adaptation and mitigation in the Kericho landscape.

3.1 On-farm management practices

Among tea estates and smallholders, there has already been significant adoption of farming practices that increase productivity, improve water management and drought resistance, and protect and restore native vegetation (Table 22.1). Practices that may especially support CSA include integrated pest management, construction of lagoons and wetlands on farms to increase water storage, conservation of riparian buffers, and improved soil fertility management. These practices are encouraged by voluntary certification programmes and government recommendations alike. In the case of the Sustainable Agriculture Network (SAN) Standard, certification is a whole-farm approach, such that CSA practices are applied not only to tea production areas but also to food crop parcels and conservation areas. Several local tea estates have begun implementing additional climate change adaptation and mitigation practices identified in the SAN Climate Module, a voluntary add-on to the basic SAN standard (SAN, 2011). Extension services that promote CSA practices to tea smallholders are delivered through multiple channels, typically in the context of KTDA supply-sheds, and are supported by tea-buying companies, donors, and other actors.

Gaps and opportunities: Stakeholders believed that the existing suite of climate-smart farming practices being adopted and promoted in the landscape was appropriate; therefore, the primary identified need was to scale up adoption. Doing so will require addressing barriers to adoption through additional farmer training and technical assistance, information dissemination, and efforts to improve the effectiveness and profitability of CSA practices. Stakeholders also identified the need for improved tea varieties that are likely to thrive under future climatic conditions. The Tea Research Foundation of Kenya and several private companies are developing drought resistant clonal tea varieties, but further research, pilot-testing, and dissemination efforts will be needed before such varieties can become widely available to smallholders.

3.2 Landscape planning and coordination

Due to the scale and clout of the tea industry in Kenya, as well as the national and international importance of the Mau Forest complex, the Kericho landscape is the subject of several efforts to foster cross-scale coordination, decision-making, and synergistic

Table 22.1 Highlights of results of the climate-smart landscape assessment process in each of the six activity domains. In each domain, stakeholders identified existing climate-smart agriculture (CSA) activities in the Kericho landscape as well as key opportunities and gaps ('potential activities') to support CSA in the future.

Current activities	Potential activities
On-farm management practices	
On-farm agricultural production practices, including: • Planting of trees on farms, including native species • More efficient and targeted use of fertilizers based on regular nutrient analyses • Integrated Pest Management practices • Tea bush infilling to increase productivity and reduce erosion risk • Tea plucking at more frequent intervals to increase productivity and quality Ecosystem conservation on, and adjacent to, farms: • Protection of riparian buffers • Protection of forest reserves on farms, particularly adjacent to the Mau forest • Construction of lagoons and wetlands for water conservation and water quality	Continue and expand current practices on estates and small farms (scaling-up improved practices) Analyze economic opportunities and tradeoffs for smallholders to transition from seedling tea to drought-resistant clonal varieties

Current activities	Potential activities
Landscape planning and coordination	
Climate Change Adaptation Working Group convenes tea companies, KTDA, FAO, government ministries, and NGOs to coordinate industry-wide to address climate change KTDA and the Tea Board of Kenya help align NGO activities so that they can be implemented across all factories in an area to improve service delivery	Strengthen the landscape planning and coordination functions of the Climate Change Adaptation Working Group Conduct feasibility assessment for a landscape label for Kericho products and for value-added processing businesses based in the landscape Coordinate tea industry efforts with Mau Forest protection and restoration efforts Establish a pre-competitive community of practice to share knowledge, experience, and best practices for climate-smart tea production
Energy systems	
Limited implementation of energy efficiency technologies in tea facilities, including: • Energy efficient dryers, graters, cyclones and other machinery • Solarwall technology that pre-heats boiler intake air and reduces fuelwood demand • High efficiency, triple pass boilers for tea processing • Infrared drying for tea processing Improved cookstoves for smallholders to reduce fuelwood consumption and improve indoor air quality	Improve management of eucalyptus woodlots by introducing longer rotation periods combined with periodic thinning and coppicing Conduct research to clarify optimal scenarios for smallholder eucalyptus production, considering both vegetative propagation techniques and superior seed sources Conduct energy audits of tea factories to identify hotspots of energy use and emissions and prescribe appropriate technologies to improve efficiency Evaluate water conserving fuelwood alternatives to eucalyptus Introduce Forest Stewardship Council management principles and certification to improve eucalyptus management Reduce wood demand through improved fuelwood storage methods and alternative materials for transport pallets

Current activities	Potential activities
Training and technical assistance	
Smallholder training on sustainable agriculture delivered by the Rainforest Alliance and partners in the context of SAN/Rainforest Alliance certification, and coordinated by KTDA at the factory level Smallholder training offered by tea companies, NGOs, and the Tea Research Foundation of Kenya on sustainable agriculture practices, product quality, and climate change adaptation	Expand current successful programmes to reach additional farmers, support continuous improvement, and incorporate climate change themes more strongly into existing programmes Expand and strengthen existing technology transfer between company tea estates and KTDA smallholders to promote improved practices and higher productivity and quality of smallholder-grown tea (some of which is purchased by company-owned factories)
Policy support	
Agriculture Sector Reform will establish tea industry development funds and dispute resolution mechanisms Kenya's National Climate Change Response Strategy includes plans for adaptation and mitigation in agriculture, including the tea industry FAO is supporting a national programme to promote CSA in the tea industry	Through the authority of the Tea Board of Kenya, establish regulations or economic incentives for the tea industry to adopt climate-smart practices and support climate-smart landscape initiatives Strengthen engagement of tea industry actors in climate change policymaking at the national and international level Strengthen alignment of CSA investments between the public and private sectors; for instance, establish a coordination mechanism to blend investment across different time horizons or activities to cover smallholder transition costs to adopt improved practices
Technology and information	
Research organizations and tea companies are developing drought- and frost-tolerant clonal tea bushes Companies are developing early warning systems to prepare for extreme weather events Several local actors are collecting temperature and precipitation data to guide agricultural management decisions The Tea Research Foundation of Kenya advances a tea research program, including on CSA topics	Incorporate newly improved climate change models to guide tea planting decisions; for instance, revise the 'brown line' designations established by the tea industry to delineate where tea should and should not be planted, in consideration of potential climate changes Develop new technologies and management systems to improve yields and water efficiency of fuelwood production

landscape management. The tea industry has worked proactively to address the potential effects of climate change. For instance, the Tea Board of Kenya has established a Climate Change Adaptation Working Group, which convenes the multinational tea companies, KTDA, relevant government ministries, the Kenya office of the UN Food and Agriculture Organization (FAO), the Ethical Tea Partnership, and NGOs such as the Rainforest Alliance. The working group addresses shared priorities including the assessment of potential climate change impacts on the sector and coordination of industry responses to climate change. Additionally, the entire tea industry has prioritized the sustainable management of fuelwood resources. At a local level, KTDA coordinates farmer field schools to support groups of smallholders within a catchment or other geographic area to conduct participatory assessments of priority issues and then receive training on these topics. The process can be slow-moving, and KTDA needs additional capacity to implement it effectively, but stakeholders report that the participatory process promotes commitment and follow-up among farmers.

Gaps and opportunities: To date, the proliferation of initiatives related to sustainable tea production has been coordinated only to a very limited degree. Similarly, there are nascent efforts toward landscape-level coordination in the Kericho landscape, but key stakeholder commitments and appropriate institutions to support such collaboration are mostly lacking. Stakeholders identified the Climate Change Adaptation Working Group as a promising platform, which, with additional resources and facilitation, could address landscape-scale issues that no single actor can effectively solve, such as water conservation, fuelwood management, and ecosystem-based adaptation. Other platforms for pre-competitive collaboration may also be needed, particularly to share knowledge and experience, best farming practices, and new technologies related to climate change adaptation. A more innovative opportunity identified through the assessment was to create a 'landscape label' (see Ghazoul et al., 2009) for the Kericho landscape to recognize tea produced in ways that are climate-smart and protective of the landscape's forests. Building on current acceptance of certification, this approach could provide additional market incentives to support CSA investment in the Kericho landscape.

3.3 Energy systems

Stakeholders emphasized that the sustainability of wood supplies to fuel the tea drying process is one of the most urgent issues facing Kenya's tea industry. For every three hectares of tea fields, roughly one hectare of high calorific value fuelwood (such as eucalyptus) is required as energy for tea drying. Currently, the majority of fuelwood used for drying in the KTDA factories in the Kericho landscape is sourced from off-farm. In the absence of strong governance of forest resources, this demand can contribute to deforestation and forest degradation, leading to greenhouse gas emissions, a priority concern identified under Kenya's Reducing Emissions from Deforestation and Forest Degradation (REDD)+ Readiness Preparation Proposal (KFS, 2010).

In response to these challenges, tea industry stakeholders have begun pursuing new alternatives that could reduce energy needs and help conserve natural forests. Local companies are experimenting with a variety of energy efficiency innovations (Table 22.1). Recognizing that domestic cooking is another major use of fuelwood in the landscape, several organizations are also supporting efficient cookstoves for smallholder households.

Gaps and opportunities: Stakeholders noted that all of the energy efficiency technologies now being promoted locally have the potential to be scaled up. For energy-efficient tea drying systems, investment cost is a major barrier. For cookstoves, access and knowledge are key challenges, but could be addressed, in part, through more intensive outreach to women's groups and cooperatives. Beyond energy efficiency initiatives, stakeholders suggested that local wood demand could be reduced through improved storage (to prevent wood dampening) and by substituting alternative materials for wood transport pallets. On the supply side, improved management of both natural forests and exotic tree plantations is critically needed. Such improvements will require action on the part of forestry technical assistance providers, multinational estates (through the development and implementation of forest management plans), the Kenya Forest Service, and the Kenya Forestry Research Institute. More sustainable management of forest resources may entail, for instance, longer rotation periods for eucalyptus woodlots combined with periodic thinning and coppicing. Stakeholders identified the Forest Stewardship Council certification system as a potentially promising framework for defining best management principles to improve forest productivity and conservation values.

3.4 Farmer training and technical assistance

Currently, smallholder training and technical assistance is delivered through methods such as farmer field schools (FFS) and lead farmer/model farmer systems, both designed to reach large numbers of farmers. The KTDA, local partners and the Rainforest Alliance coordinate closely to provide farmer training on sustainable tea production, particularly for smallholders. This training takes a whole-farm perspective, considering not only the tea crop but also food crops and trees on smallholder farms. Many other actors also provide farmer training in support of CSA, including larger tea estates (e.g., James Finlay, George Williamson) with their smallholder outgrowers. KTDA coordinates technical assistance programmes for smallholders by working through existing tea factory organizational structures on agricultural and non-agricultural topics identified by the farmers such as crop diversification, productivity improvements, shade planting, livestock management, education, and health. Other programmes on sustainable agriculture, product quality, and climate change adaptation and mitigation are offered by a combination of private consultants, NGOs, and research institutions such as the Tea Research Foundation of Kenya. Collectively, these programmes have already delivered foundational training on sustainable agricultural practices to over 250,000 smallholder tea farmers in the Kericho landscape.

Gaps and opportunities: Despite the major training accomplishments to date, smallholders still apply climate-smart practices at a far lower rate than tea estates, and commonly achieve tea yields of only one-third of those achieved on the estates. Many smallholders are still not aware of the potential impacts of climate change on tea production, or of the actions they can take to support long-term productivity in a changing climate. Recognizing these challenges, stakeholders identified scaling-up smallholder training to reach all farmers as a top priority, but noted that funding and capacity limitations have constrained these efforts. Stakeholders also suggested that the KTDA training programme could include climate change adaptation and mitigation themes more explicitly, including information on emerging best practices and technologies to ensure that there is not a lag in reaching smallholders with these innovations. Participatory climate adaptation planning, which is required under the SAN Climate Module and also promoted by KTDA, was seen as a useful means for farmers to pro-actively identify climate change vulnerabilities and define actions and training needs to address them.

3.5 Policy support

Kenyan agricultural and climate change policy affecting the tea sector has been developed largely at the national level. As part of Kenya's Vision 2030 development planning process (GoK, 2007), the country has developed an Agriculture Sector Reform Bill that earmarks tea industry development funds and establishes dispute resolution mechanisms. Kenya's National Climate Change Response Strategy (GoK, 2010) and companion Action Plan (GoK, 2013) include agriculture as part of a broad plan to integrate climate change adaptation and mitigation measures into all government planning, budgeting and development objectives. However, the funding and implementation mechanisms remain unclear. Simultaneously, FAO is helping to develop a national programme to support CSA in the tea industry. Finally, the Tea Board of Kenya establishes regulations with which the KTDA and estates must comply. Current regulations do not explicitly address climate change, but the Board has considered new regulations for tea farming that would improve adaptive capacity and help reduce greenhouse gas emissions.

Gaps and opportunities: Stakeholders highlighted the opportunity to support CSA in the tea sector through targeted national policies, regulations, and industry standards. For example, minimum energy efficiency requirements for factory processing equipment could reduce costs, greenhouse gas emissions, and pressure on natural and planted forests. Regulation could also address on-farm management to ensure that recognized best practices for adaptation in the tea industry are operationalized, including best practices for fuelwood management and use. Stakeholders also noted that the tea industry could be more proactive in climate change policy-making processes at the national and international level, including in REDD+ discussions, which are relevant for the Kericho landscape and its bordering forests.

3.6 Technology and information

The sensitivity of tea productivity and quality to climate change has motivated the tea industry to develop new tea varieties, collect critical climate data, and identify best practices for adapting tea production systems to climate change. Much of the tea-related research in Kenya is conducted by multinational companies and by the Tea Research Foundation of Kenya. The latter, for instance, is breeding drought-tolerant tea varieties and collecting temperature and precipitation data in tea zones. The tea companies collect their own data on local climate and biodiversity, and have worked on early warning systems to prepare for extreme weather events. The Tea Research Foundation of Kenya organizes a quarterly tea industry stakeholder forum to disseminate research results and guide future research agendas through a multi-stakeholder advisory board.

Gaps and opportunities: Although important developments are being made in technology and research to support CSA in the Kericho landscape, stakeholders identified a long list of additional needs. Key among these was the need to localize climate change data and innovative CSA strategies to the local context. A top priority, for instance, is to use the latest climate change models to revise the 'brown lines' established by the tea industry to delineate where tea should and should not be planted. New technology is also needed to devise solutions to the landscape's fuelwood constraints. For instance, stakeholders suggested that vegetative propagation techniques could help increase eucalyptus yields, or more water-efficient alternatives to eucalyptus could be sought.

4. Discussion

4.1 CSA in the Kericho landscape

The assessment process revealed that numerous CSA activities are already ongoing in the Kericho landscape, and several institutions are active in seeking solutions to climate-related challenges. However, the assessment also identified significant gaps and needs, particularly related to building capacity and mainstreaming climate-smart practices among smallholders and to addressing fuelwood energy needs and associated deforestation. In addition, stakeholders recognized the need for improved coordination of the proliferation of initiatives around tea sustainability to achieve greater impact. The assessment revealed that the Kericho landscape has an important advantage in this regard in that substantial elements of a coordination framework are already in place due to a strong and relatively consolidated tea industry. There also appears to be significant capacity and commitment by some industry actors to support not only those climate-smart activities that will provide direct benefits to them, but also those that will benefit the wider landscape and its communities. These types of commitments—such as investments in improved cookstoves for smallholders, research on climate-resilient tea varieties and cultivation practices, and efforts to mitigate the landscape-wide fuelwood shortage—stem from an awareness of the collective nature of both the problems and potential solutions related to natural resource limitations and climate change.

Our focus for this study was on the stakeholders in the Kericho landscape most closely related to the tea industry. Stakeholders related to the Mau Forest were underrepresented in the assessment process, though recognized as important actors in the landscape. A next step to address more comprehensively the context and needs for CSA in the Kericho landscape would be to expand the assessment to incorporate perspectives from these stakeholder groups.

4.2 An assessment tool to support CSA

The field-test of the assessment tool highlights the benefit of taking a structured approach to CSA assessment and planning. Specifically, given that CSA and climate-smart landscapes are construed as depending on multiple interacting social, ecological, and agronomic systems, it is helpful to characterize these elements systematically to understand the context for CSA as holistically as possible. An inclusive, stakeholder-centric approach is essential, as knowledge on these different components resides with diverse individuals and institutions within a landscape. The assessment tool, developed and tested here, is quite simple and could be applied or adapted by local NGOs, government agencies, or community groups as the first step in planning for a set of CSA projects or initiatives. We estimate that the application of this tool in the Kericho landscape cost between US $20,000 and $30,000 inclusive of personnel, international and local travel, and other expenses for the in-person interviews and workshop, data analysis and systematization, and development of a synthesis report. The modest cost suggests that multi-stakeholder assessments for climate-smart landscape development should be widely feasible to implement in the places where they are warranted.

4.3 Implications for CSA finance and policy

As illustrated through the assessment process, CSA investments are being supported by a wide range of stakeholders, from private industry to individual smallholder farmers to government and civil society actors. Major tea industry actors have already invested significantly in CSA in Kenya and appear poised to invest further to address critical natural resource- and climate-related challenges that could pose substantial business risks. Small-scale farmers have exhibited interest and some ability to invest in CSA practices, but access to affordable capital remains a significant barrier. Finance constraints are likely to be greater for investments with a longer payoff window, such as tea bush renovation. These observations point to ways in which national and international 'climate finance' streams might best be targeted to fill critical gaps in the existing mosaic of resources being deployed to support CSA. Of the many potential investments that stakeholders identified across the six domains, landscape planning and coordination efforts may be among the most strategic, potentially requiring modest investment while helping to leverage existing activities and investments across the landscape to greater effect.

4.4 Conclusion

Effective implementation of CSA often requires an integrated landscape management strategy that synergistically combines a diversity of land uses and economic activities. The Kericho landscape was a useful case for considering how local stakeholders could play an active role in assessing and defining a holistic programme of CSA investment within a priority landscape. Research and planning tools, such as the one developed for this study, provide a framework for landscape stakeholders to identify the concrete steps that can move them toward a climate-smart landscape. Such tools should continue to be refined, and, as more landscapes begin to plan and implement climate-smart activities, experiences from using them should be documented systematically and shared widely to support the mainstream practice of climate-smart agriculture.

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References

Campbell, B., Mann, W., Meléndez-Ortiz, R., Streck, C., & Tennigkeit, T. (2011). *Agriculture and climate change: a scoping report.* Washington, DC: Meridian Institute.

CRA (Commission on Revenue Allocation). (2011). *Kenya: County Fact Sheets.* Nairobi: CRA.

Estrada-Carmona, N., Hart, A. K., DeClerck, F. A. J., Harvey, C. A., & Milder, J. C. (2014). Integrated landscape management for agriculture, rural livelihoods, and ecosystem conservation: An assessment of experience from Latin America and the Caribbean. *Landscape and Urban Planning*, 129, 1-11.

FAO (Food and Agriculture Organization of the United Nations). (2010). *"Climate-Smart" agriculture: policies, practices and financing for food security, adaptation and mitigation.* Rome: FAO.

FAO. (2011). *Climate-smart agriculture: managing ecosystems for sustainable livelihoods.* Rome: FAO.

FAO. (2013). *Climate-smart agriculture sourcebook.* Rome: FAO.

Ghazoul, J., Garcia, C., & Kushalappa, C.G. (2009). Landscape labelling: a concept for next-generation payment for ecosystem service schemes. *Forest Ecology and Management*, 258, 1889-1895.

GoK (Government of Kenya). (2007). *Kenya Vision 2030*. Nairobi, Kenya: GoK.
GoK. (2010). *National Climate Change Response Strategy*. Nairobi, Kenya: GoK.
GoK. (2013). *National Climate Change Action Plan 2013 – 2017*. Nairobi, Kenya: GoK.
Harvey, C. A., Chacón, M., Donatti, C. I., Garen, E., Hannah, L., Andrade, A., ... Wollenberg, E. (2013). Climate-smart landscapes: opportunities and challenges for integrating adaptation and mitigation in tropical agriculture. *Conservation Letters*, 7, 77-90.
Intergovernmental Group on Tea. (2012). *Current situation and medium term outlook for tea*. Presented at Committee on Commodity Problems, January 30-February 1, 2012, Colombo, Sri Lanka. Retrieved from http://www.fao.org/fileadmin/templates/est/COMM_MARKETS_MONITORING/Tea/Documents/IGG_20/12-CRS7-CurrentSit_01.pdf.
KFS (Kenya Forest Service). (2010). *REDD Readiness Preparation Proposal*. Nairobi, Kenya: KFS.
Milder, J. C., Hart, A. K., Dobie, P., Minai, J. O., & Zaleski, C. (2014). Integrated landscape initiatives for African agriculture, development, and conservation: a region-wide assessment. *World Development*, 54, 68-80.
Neufeldt, H., Jahn, M., Campbell, B. M., Beddington, J. R., DeClerck, F., De Pinto, A., ... Zougmoré, R. (2013). Beyond climate-smart agriculture: toward safe operating spaces for global food systems. *Agriculture & Food Security*, 2, 12.
Ochieng, B.O., Hughey, K. F. D., & Bigsby, H. (2013). Rainforest Alliance certification of Kenyan tea farms: a contribution to sustainability or tokenism? *Journal of Cleaner Production*, 39, 285-293.
Omumbo, J. A., Lyon, B., Waweru, S. M., Connor, S. J., & Thomson, M. C. 2011. Raised temperatures over the Kericho tea estates: revisiting the climate in the East African highlands malaria debate. *Malaria Journal*, 10, 12. Retrieved from http://www.malariajournal.com/content/10/1/12.
SAN (Sustainable Agriculture Network). (2010). *Sustainable agriculture standard*. San José, Costa Rica: SAN Secretariat.
SAN. (2011). *SAN climate module*. San José, Costa Rica: SAN Secretariat.
Scherr, S.J., Shames, S., & Friedman, R. (2012). From climate-smart agriculture to climate-smart landscapes. *Agriculture & Food Security*, 1, 12.
World Bank. (2011). *Climate-smart agriculture: a call to action*. Washington, DC: World Bank.

Baka community members in Nomedjoh, one of the few indigenous forest peoples with a community forest, ready for a trip into the forest.
Photo credit: Samuel Nnah Ndobe

CHAPTER

23

Institutional dynamics and landscape change – a case study of Southern Cameroon

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Highlights

- Institutions defined as rules and norms are important drivers of change in landscapes
- Both formal and informal institutions driving changes in landscapes are dynamic and are influenced by different actors with varying interests
- Evolution of forest legislation and the formulation of the manual of procedures governing community forests are clear examples of institutional drivers shaping the forest landscape in Cameroon
- Despite evolving institutions governing land and trees in Cameroon, disputes over land and forest rights have grown rather than diminished, leading to changing land use patterns and in some cases increasing land degradation
- Research can provide knowledge of organization and functioning of effective and efficient hybrid institutions built on interactions between customary and formal rules and norms governing the functioning of landscapes

1. Introduction

Landscapes in the literature are defined in different ways. In this chapter, landscapes are defined as socio-ecological spaces hosting a wide array of habitats, land use systems, ecological interactions and people who interact with their environment (van Noordwijk et al., 2013; Robiglio & Yemefack, 2014). Change is an inherent component in a landscape (Bürgi et al., 2004). Research interest in the drivers of change grew amongst different academic disciplines due to the recognition that land use change is one of the important factors affecting global environmental change, which often are the consequences of human interactions with the environment (Turner et al., 1994). Using Cameroon as a case study, this chapter provides an overview of how institutions and institutional dynamics drive changes in the landscape.

Institutions are the rules of the game in a society or the humanly devised constraints that shape human interactions, and are key to economic performance (North, 1990).

Institutions can be both informal and formal; examples of informal institutions are customary or traditional rules and all those that were not created under the formal system whereas formal institutions are their opposite. In the context of landscapes, institutions can be interpreted as rules to limit the impact of undesirable landscape changes (Evans et al., 2008). Conversely, institutions may not be restrictive, but may provide tools that offer incentives for stakeholders to create positive changes in the landscape. Examples of the latter are policy incentives to encourage tree planting, or sustainably manage forests and agricultural landscapes. In many parts of the world, these institutions are not static. They are dynamic arrangements, which are often a result of calculated or spontaneous decisions by communities to respond to changing circumstances (Evans et al., 2008; Greif & Kingston, 2011). According to the theory of induced institutional innovation, new institutions seem to emerge when there are changes in factor endowments, break downs in traditional institutions, modernity, or technical change with marginal costs of factor inputs. These often give rise to new cost benefit relationships to which old institutions may no longer be applicable (Platteau, 1996; Leach et al., 2006).

The goal of this chapter is to exemplify the role of institutions and institutional dynamics in the process of landscape change in Cameroon. Drawing on a review of the literature, field observation and documentation, and personal communication with farmers and experts in this field, the case study presented in this chapter focuses on dominant landscapes in Southern Cameroon amongst which forest and rural agricultural mosaics (e.g., cocoa agroforestry systems and plantations) have multiple sets of institutions governing them. Focusing on forest landscapes, many of the examples are drawn from the community forest concept as it has well-defined rules governing it and the evolution and implementation of these rules have contributed in shaping the landscape in Cameroon (Minang et al., 2007). This chapter reviews the evolution of customary and formal rules governing forest and land tenure arrangements in Cameroon during pre-colonial, colonial and post-colonial periods, and the stakeholders driving such changes, including project interventions to secure community forest and tenure rights to farmers. Landscape changes are then analysed in terms of land cover transition or degradation, which is also referred to as land cover change or land use change (Evans et al., 2008). In this case, we examine the transition from forest land to agricultural, degraded land or degraded forest, in relation to the changes that have occurred within formal and informal rules governing access, ownership, and rights to land and forest resources from the precolonial, to the colonial and post-colonial era in Cameroon.

2. Forest governance and the dynamics of customary institutions in relation to land in Cameroon

Prior to colonization, various groups of people were reported to have migrated to Cameroon from different parts of Africa, resulting in myriad socio-cultural or ethnic groupings. While details of customary rules and norms may vary for the most part, they show similarities in relation to rural land. For instance, under customary regimes, access and use of land is overseen by traditional local leaders or local chiefs who oversee some form of management and community-based control (Fisiy, 1992; ADB, 2009). The chiefs are viewed as the custodians (or customary law administrators) of rural land (Fisiy, 1992). Under such circumstances, land is perceived as community property and in some ways, communities often view the land as sacred where they enjoy inalienable rights (an example is the Bamelike ethnic group in the savannah region of Cameroon). During the precolonial period, it was impossible to talk about single ownership. Instead individual families received use rights or rights of possession to satisfy their food and housing needs. These rights were usually inherited, generally through the male lineage, though in some communities through the female lineage, as with the Kom people of the Northwest Region of Cameroon (ADB, 2009; Oyono, 2009).

The concept of single ownership of land and forest was introduced during the colonial period (ADB, 2009; Oyono, 2009; USAID, 2010). In contemporary Cameroon, most people continue to own land based on diverse customary laws, but some aspects of the traditional rules and norms such as those governing access, acquisition and ownership of land, land use practices and security in Cameroon, are observed to be changing (ADB, 2009). For example, after the introduction of single ownership of land, access and use rights on agricultural and household space are now often acknowledged as rights of ownership. The head of the household or the family can legitimately lease, loan and bequeath the land. In some communities, like within the Bamelike ethnic group in the western highland region of Cameroon, inherited land held under customary law may not be sold to non-indigenous persons but can be sold to members of the family or other indigenous people within the community (Joko, 2006; Fombad, 2009).

With regards to forest and forested lands in the precolonial times, traditional communities regarded the forest as an open access resource in which, people were free to use forest resources without restriction, or as a communal resource in which, use of forested land and resources was subjected to some measures of control by traditional rulers. The latter was common in the western highlands of Cameroon where the concept of sacred forest is widespread. It was needless during this time to talk about private ownership of forests (Oyono, 2009) as forest communities were the 'owners' of the forest. However, individuals in a community could obtain individual rights to forest land by clearing and farming it, and by managing crops on the land during fallow periods. In some areas, forested land up to three kilometres from a village was recognized as property of the village, while beyond three kilometres could be considered as belonging to a number of villages (USAID, 2010). Under customary laws in Cameroon, persons with locally recognized legitimate claims to a parcel of land have property rights to the trees and the resources on the land.

For access to forest resources, under customary laws, it was typical for other community members to gather products such as non-timber forest products (NTFP) from private and communal forest lands without needing the permission of the community leaders. Today, the trends are changing. People have started restricting community members from gathering resources from such lands (Foundjem-Tita, 2013). Initially, NTFP trees were perceived by local communities to grow naturally or to be a gift from God (Brown & Lassoie, 2010). They could thus be considered a common property. Foundjem-Tita (2013) reported that restricted access is mostly practised for those forest resources that are highly commercialized.

3. Evolution of formal institutions governing landscapes

Having gone through three colonial reigns namely, the German, French and English, Cameroon, at the dawn of colonization, disregarded customary or traditional tenure systems and favoured a statutory system, through expropriation of community controlled land and forests and imposition of state ownership (ADB, 2009; USAID, 2010). The most recent laws governing land and forest in Cameroon are the 1974 Land Ordinance governing national lands and the 1994 Forestry Law (Law No. 94/01 of 20 January 1994). The 1994 Forestry Law specifically states that ownership of forest and aquaculture establishments shall be determined by the regulations governing land tenure and state lands and by the 1994 Forestry Law (Government of Cameroon, 1994). This provision expresses the dual nature of forest and land laws in Cameroon. According to the 1994 Forestry Law, the State is responsible for the protection of the country's forests and should reserve a minimum of 30% of the country's land as protected, permanent forest (Government of Cameroon, 1994). In this Forest Law, two types of forest landscapes are recognized: 1) permanent forest estates and 2) the non-permanent forest estates. The permanent forest is further divided into two types (Government of Cameroon, 1994):

a. State forests - including protected areas (national parks, wildlife reserve) and production forest reserves
b. Council forests – managed in a decentralized manner by elected local councils on the basis of management plans approved by the Ministry of Forestry

The non-permanent forest estates consist of forest land which can be converted to non-forest uses. This includes:

a. Private forests belonging to individuals
b. Communal forests managed by a community

Formal laws governing land and forests have undergone several modifications over the years starting from the colonial period stretching to the post-independence periods and to present day Cameroon. For example, Fissy (1992) reports that within a 15-year period (1974 - 1989), there have been 15 amendments to the 1974 Land Ordinance. Current amendments to this law are as recent as December 2005. Similarly, forest legislations in Cameroon have gone through a series of changes over time (Minang et al., 2007). The first forest legislation of the country was enacted by the Germans in 1900, which was followed by successive British and French enactments in the early 20th century. Since independence in 1960, Cameroon has enacted four pieces of legislations between 1968 and 1994 dealing with forest resources, with the most recent being the 1994 Forestry and Wildlife Law (Ngwasiri et al., 2002; ADB, 2009; USAID, 2010). Besides prohibitive laws, the Government of Cameroon passed a number of decrees between 2006 and 2007 that were designed to support further commercial investment in the forestry sector, and to target poverty reduction goals through sustainable management of forest and forest resources. Specifically, these decrees reclassified forest products, allowed for small-scale logging permits, set standards for sports hunting and provided funding for forest monitoring (Cerruti et al., 2008).

Box 23.1

Evolution in the implementation of the concept of community forestry in Cameroon

The concept of community forestry was instituted as a legal instrument delegating responsibility to local communities to shape the forest landscape. However, implementation of the concept was not without major difficulties. One of such difficulty is related to the absence of coherence between the provisions of the Forestry Law and the presidential decree concerning its application, resulting in a lack of clarity about what a community is and how to obtain rights for a community forest. Through a series of workshops and meetings led by the Community Forestry Development project in the Ministry of Forestry in Cameroon, a manual of the procedures for the attribution, and norms for the management of community forests was developed. The manual officially became a legal instrument in Cameroon on the 20th of April 1998 (Djeumo, 2001). The objective of the manual was to boost activities that would lead to the effective allocation of community forests. No single community forest had been allocated three years after the law was passed due to lack of clarity in the procedures and legislation. By 2001, seven community forests had been created and by 2014, out of 404 applications submitted by forest communities, 178 management plans had been approved and 147 management plans signed covering a total surface area of 636,752 ha (MINFOF, 2014).

3.1 Community forestry

With regards to community forests, the 1994 Forestry Law provides opportunities for forest communities to register their community forests rights and enter into agreement with the forest service regarding its management (Government of Cameroon, 1994). As initially mentioned in the introduction, community forestry is considerably cited in this chapter because its policy provisions and regulatory framework and their change over time illustrate dynamics with regards to local communities' forest access rights and the consequent community impact on the landscape (Minang et al., 2007). It should be noted that before 1994, formal institutions did not give any fundamental rights to forest communities with regards to forest management (for details about community forestry see Box 23.1). The new dispensation provided for by the 1994 Forest Law broadened the structure of community rights to forests and forest resources, though these rights are limited to only a small fraction of the forest, i.e., the non-permanent forests (Oyono, 2009). Coupled with that, the rights are not permanent as they are issued for twenty-five year periods and management plans are subject to renewal every five years. The 1994 Forestry Law did not provide the opportunity for forest communities as an entity to own the forest, although such ownership rights remain the strongest set of rights being claimed by local communities (Oyono, 2009). Similarly, for some forest resources such as NTFP, local community rights are limited to usufruct rights. This means that forest communities can collect such products for personal use while economic exploitation is limited by a permit system, which is hard to obtain due to high transaction costs (Foundjem-Tita et al., 2014).

4. Actors shaping institutional changes in agricultural and forest landscapes in Cameroon

Of interest is to understand why there have been so many changes in the statutory and customary institutions governing land and forests in Cameroon, and whose interests have been served by such modifications. Is it the State, citizens, civil servants or those of the forests and other forest resources departments? The birth of the 1994 Forestry Law as described by Ekoko (2000) may help to address some of these issues, clarify the basis of the promulgation of the law and illustrate how stakeholder interests and participation play a role.

According to Ekoko (2000), the formulation of the 1994 Forestry Law was influenced by several groups of actors such as the World Bank, the Government of Cameroon, French politicians as well as logging companies, local politicians and local populations - each of these actors having their own vested interests. The Government of Cameroon, for example, had noticed that the existing 1981 Forestry Law was outdated. Its main inadequacies were that it did not pay sufficient attention to local peoples' income and livelihoods in relation to forest management. It also did not have a clear framework for logging companies. Moreover, the pre-1994 law was characterized by an inefficient taxation system that did not optimize benefits for the state. The World Bank on the other hand, wanted to test its new forest policy guidelines and promote increased government revenues from the forestry sector (Ekoko, 2000; Cerutti & Tacconi, 2006; ADB, 2009; USAID, 2010).

While some members of parliament are recognized to have played a major role in safeguarding the interest of local communities during debates about the law in parliament, others had their personal interests to protect. Some members of parliament were reported to have opposed an auction system because they were directly involved in logging companies either as shareholders or as owners. An auction system would have limited their ability to use their political influence to obtain logging concessions and thus eliminate an important source of their political capital (Ekoko, 2000). The above example supports the rational-choice theory to institutional analysis which argues that institutions are not always crafted in the interest of the 'majority' and that rationally-minded individuals often consider personal gains over societal values and ethics when they make decisions regarding institutional change (Zey, 1998). This is also in line with Greif and Kingston (2011) who posit that many kinds of formal rules are selected through a centralized process of bargaining and political conflict between individuals and organizations who attempt to change the rules for their own benefit.

5. Institutional dynamics and their impacts on landscape management

It is important to assess how and why institutions have evolved in a particular way, and the consequences that new or modified institutions have on landscape change. Robiglio et al. (2003), for example, studied the linkages between tenure and land use change in Cameroon by identifying the social institutions that actively influenced land cover dynamics, specifically the conversion of forest to agricultural land. They found that tenure arrangements, settlement patterns and land appropriation strategies contribute in shaping land use patterns. Another factor that influenced landscape changes in the area they studied is conflict between state and customary institutions. For instance, when local people noticed the expansion of logging activities in what they considered as their land, they accelerated actions which strengthened the customary practice of 'right of first occupancy', by clearing more forest to assert customary control over such forest land for themselves and their descendants.

Although the above changes can also be attributed to population pressure and market forces, one could notice the forces of conflicting institutions (private interests versus community) at play. This corroborates Evans et al., (2008) who argued that even when zoning ordinances are focused on environmental protection, their effectiveness may be limited by weak enforcement and illegality. By instituting in the 1994 Forestry Law that 30% of the state forests has to remain as permanent forests, the government set standards to sustainably manage the forest cover for this proportion of land. However, as reported by Cerutti and Tacconi (2006) the government undermined the sustainable management of the permanent forest estates by allowing forest concessions to log for extended periods without the prescribed and approved management plans. Moreover, the method used to designate permanent and non-permanent forests areas by using satellite imagery and aerial photos led to the inclusion of many areas exploited by local populations for their livelihoods, for example, through hunting, fishing, fallows and agroforestry systems, including cocoa farms (World Rainforest Movement, 2006). Resource extraction within the permanent forest estate is only allowed for personal use which means all such livelihood activities including agroforestry are banned in the permanent forest areas. Consequently, many rural communities found their activities completely restricted by the forest zoning plan. Furthermore, despite existing regulations, farmers continued to encroach into forests to establish cocoa farms. All these helped to strengthen the relationship between unsustainable forest logging and smallholder agriculture expansion on the one hand, and forest degradation and deforestation on the other (Robiglio et al., 2010), both creating changes within the landscape.

The concept of community forestry instituted by the 1994 Forestry Law as a tool to involve local communities to sustainably manage forest and forest resources, cannot be described as a complete success (Djeumo, 2001; Oyono, 2009; Karsenty, 2010). Abusive and illegal timber exploitation sometimes occurs within community forests and many are without appropriate management plans as specified by the law. In some instances, logging companies finance local communities to obtain community forest status assuming the community forest would be another type of a logging permit (Karsenty, 2010). The end result is that the area defined as a community forest ends up having another structure other than what it would have been if it was initiated and managed by the forest communities themselves.

The experiences described above are not exhaustive, but it was quite clear from the examples that despite evolving institutions governing land and trees in Cameroon, land and forest disputes have grown, rather than diminished. Changing land use patterns, increasing land degradation and lack of appropriate institutions or mechanisms to resolve conflicts are some of the causes of these disputes, which in turn, lead to changing patterns in landscapes.

6. Moving towards hybrid institutions for landscape management

Despite the existence and evolution of formal and customary institutions governing landscapes, conflicts persist with often negative consequences for people and the environment. However, evidence also exists that these institutions are evolving towards a mixture of the two, and it may be possible that hybrid institutions work better for landscape management. For example, the traditional forest dwelling communities of the Bakas and Bagyelis (or pygmies) in Cameroon used to be exclusively hunter-gatherers with their activities stretching over large areas of forest land. Many are now settling outside of their original hunting and gathering grounds, which in many cases have become protected forests based on the 1994 Forestry Law. Many of the Bakas and Bagyelis now co-exist with Bantu customary landowners, albeit, often with unequal rights. To integrate the Bakas and Bagyelis into a new way of life conditioned by formal rules, international and national NGOs are working with Bantu villages to explore mechanisms for sharing and/ or transferring appropriate customary ownership rights to the Baka and Bagyeli groups (Nguiffo & Djeukam, 2008). This may help in securing livelihoods and in protecting the environment as original hunting grounds, which have now become protected areas to be better managed for multiple uses.

According to customary bi-laws in most parts of Cameroon, planting a tree is sufficient to get local acknowledgement of some form of ownership and security over a piece of land. Although this customary rule is still observed in most parts of the country, the tendency is now gradually changing towards preferences over statutory provisions. For example, Firmin-Sellers and Sellers (1999) demonstrated that rural farmers in the Western Region of Cameroon have selectively used components of the official titling system, specifically the placement of boundary stones, to enhance their security. According to the same authors, the farmers' actions suggest two things. First, farmers are troubled by insecure tenure, and second, farmers believe state intervention may alleviate their insecurity. Similarly, Foundjem-Tita (2013) reported that 84% of a total of 338 farmers interviewed in both the forest and savannah regions of Cameroon have positive attitudes towards land titles as a proof of ownership and land tenure security. A quotation from one of the interviewed farmers in the study shows a positive attitude toward the land titling system.

"…land titles are preferable because with development and quest for greener pastures, most youths migrate to cities and even abroad whereas the older generation that governs the systems is dying out. You can lease your land to somebody and s/he works there for ages and when your children return to claim their land, there will be nobody to testify that the land is yours'" (pers. Comm. With farmer in the western region of Cameroon).

The farmer's comment suggests that while many still acquire land through the customary system, state or formal institutions are needed to protect local peoples' customary rights against any threat to dispossession. This supposes that much has to be done to study institutional change governing landscapes. An important part of such analysis should consider the most effective and efficient institutions that can result from the interaction between customary and formal rules governing landscapes and landscape resources. As Opper (2008) emphasized, there is need for the interaction effects between formal and informal institutions to be carefully studied, without which, it will be difficult to come up with a theory to explain change such as those happening in a landscape. The concept of community forest can be considered a step in the right direction, that is, government recognition of the capacity of local communities to manage the forest. However as narrated in this chapter, implementation of the concept is marred by high transaction costs, and inappropriate regulations. New institutions designed with the participation of forest communities would inspire a sense of common ownership of the resources and avoid a spirit of competition and conflict which have negative corollaries on the landscape.

7. Conclusion

In summary, the case study has shown that both informal and formal institutions governing landscape and landscape resources in Cameroon are changing, and hybrid forms or institutions that take into consideration local needs, and lie in-between existing customary and formal rules are emerging. At the same time, customary institutions persist in some areas while preference over formal institutions is increasing in many parts of the country. However, formal institutions governing landscapes are often hampered by personal vested interests of the very same actors that created these institutions. In the context of changing institutions characterized by ineffective implementation or inadequacy of formal rules and pre-existing informal institutions, combining statutory tools and customary rules may be optimal when it comes to strengthening claims of ownership rights, giving rise to hybrid approaches. This may have longer-term positive consequences on landscapes, especially if conservation practices are employed on the land, or investments are made for tree planting and other permanent crops once land tenure is secured. The main message in this case study is that institutions (formal, informal or hybrid) are indispensable features in landscapes, and are crucial to landscape management, as they shape the patterns and functions of landscapes. A better understanding of the evolution and dynamics of institutions can help predict the patterns and consequences of landscape change, and in defining subsequent management options. The main limitation of this case study was the lack of attention to specific types of formal, informal and hybrid institutions, and the detailed types of landscape changes that have resulted from their interactions. It is therefore important that subsequent studies provide such robust analysis.

References

ADB (African Development Bank). (2009). *Cameroon, Diagnostic study for the modernisation of land and surveys sector*. Yaounde Cameroon: Country Regional Department Centre.

Brown, H. C., & Lassoie, J. P. (2010). The interaction between market forces and management systems: A case study of non-wood forest products in the humid forest zone of Cameroon, *Forest Trees and Livelihoods*, *12*(1), 12-26.

Bürgi, M., Hersperger, A., & Schneeberger, N. (2004). Driving forces of landscape change — current and new directions, *Landscape Ecology, 19*(8), 857-868.

Cerruti, P. O., Ingram, V., & Sonwa, D. (2008). The forests of Cameroon in 2008. In de Wasseige, C., Devers, D., de Marcken, P., Eba'a Atyi, R., Nasi, R., & Mayaux, P. (Eds.), *The Forests of the Congo Basin: State of the Forests.* Luxembourg: Publications Office of the European Union, Luxembourg, 43-56. Retrieved 19 September 2010 from http://www.observatoire-comifac.net/docs/edf2008 /EN/SOF_02_Cameroon.pdf

Cerutti, P. O., & Tacconi, L. (2006). *Forests, Illegality, and Livelihoods in Cameroon.* Working Paper No. 35. Bogor, Indonesia: Center for International Forestry Research.

Djeumo, A. (2001). The development of community forests in Cameroon: origins, current situation and constraints. *Rural Development Forestry Network*, 25, 1-17.

Ekoko, F. (2000). Balancing Politics, Economics and Conservation: The case of the Cameroon Forestry Law reform, *Development and Change, 31*(1), 131-154.

Evans, T. P., York, A. M., & Ostrom, E. (2008). Institutional dynamics, spatial organization, and landscape change. In Wescoat, J. L. & Johnston, D. M. (Eds.) *Political Economies of Landscape Change*, 111-129. Netherlands: Springer.

Firmin-Sellers, K., & Sellers, P. (1999). Expected failure and unexpected successes of land titling in Africa. *World Development, 27*(7), 1115-1128.

Fisiy, C. F. (1992). *Power and privilege in the administration of law: Land reforms and social differentiation in Cameroon*. Leiden, Netherlands: African Studies Centre.

Fombad, C. M. (2009). Update: researching Cameroonian law. Retrieved 15 June 2010 from http://www.nyulawglobal.org/Globalex /Cameroon1.htm

Foundjem-Tita, D. (2013). A new institutional economic analysis of policies governing non-timber forest products and agroforestry development in Cameroon. PhD thesis, Ghent University.

Foundjem-Tita, D., Speelman, S., D'Haese, M., Degrande, A., van Huylenbroeck, G., van Damme, P., & Tchoundjeu , Z. (2014). A tale of transaction costs and forest law compliance: trade permits for non-timber forest products in Cameroon. *Forest Policy and Economics*, 38, 138-142.

Government of Cameroon (1994). LOI N° 94/01 du 20 janvier 1994 portant régime des forêts, de la faune et de la pêche n Republic of Cameroon. Yaounde, Cameroon: Government of Cameroon.

Greif, A., & Kingston, C. (2011). Institutions as rules or equilibra. In Schofield, N. & Caballero, G. (Eds.), *Political Economy of Institutions, Democracy and Voting*, 1-42. Berlin: Heidelberg, Springer-Verlag.

Joko, M. (2006). *Access to Economic Justice in the Common Law Jurisdiction of Cameroon*. Report for Open Society Institute Africa Governance Monitoring and Advocacy Project.

Karsenty, A. (2010). Le nouveau « grand jeu » économique en Afrique et l'avenir des réformes de la gouvernance du secteur forestier, In German, L. A., Karsenty, A., & Tiani, A. M. (Eds.) *Gouverner les forêts africaines à l'ère de la mondialisation*. Bogor, Indonésie: CIFOR.

Leach, M., Mearns, R., & Scoones, I. (2006). *Environmental entitlements. A Framework for understanding the institutional dynamics of environmental change.* IDS discussion paper, Workshop on political theory and policy analysis. Bloomintgton, USA: Indiana University.

Minang, P. A., Michael, K., & Bressers, H. (2007). Community Capacity for Implementing Clean Development Mechanism Projects Within Community Forests in Cameroon. *Environnemental Management*, 39, 615-630.

MINFOF (Ministrere des Forests et de la Faune). (2014). Situation des forêts communautaires. Retrived from http://www.minfof.cm/index.php?option=com_content&view=article&id=15&Itemid=16

Nguiffo, S., & Djeukam, R. (2008). Using the law as a tool to secure the land rights of indigenous communities in southern Cameroon. n Cotula, L., & Mathieu, P. (Eds.), *Legal Empowerment in Practice: Using Legal Tools to Secure Land Rights in Africa.* London: International Institute for Environment and Development (IIED).

Ngwasiri, C. N., Djeukam, R., & Vabi, M. B. (2002). *Legislative and Institutional Instruments for the Sustainable Management of Non Timber Forest products (NTFPs) in Cameroon. Past present and unresolved Issues*. Yaounde, Cameroon: Ministry of the Environment and Forest (MINEF).

North, D. C. (1990). *Institutions; Institutional Change and Economic Performance.* New York: Cambridge University press.

Opper, S. (2008). New Institutional Economics and Its Application on Transition and Developing Economies. In Brousseau, E., & Jean-Michel, G. (Eds). *New Institutional Economics: A Guidebook*. Cambridge: Cambridge University Press.

Oyono, P. R. (2009). New niches of community rights to forests resources in Cameroon: tenure reform, decentralization category or something else? *International Journal of Social Forestry, 2*(1), 1-23.

Platteau, J. P. (1996). The evolutionary theory of land rights as applied to Sub-Saharan Africa: A critical assessment. *Development and Change, 27*(1), 29-86.

Robiglio, V., Mala, A. W., & Diaw, C. (2003). Mapping landscape: Integrating GIS and social science methods to model human-nature relationship in Southern Cameroon. *Small-scale Forestry Economics, Management and Policy, 2*(2), 171-184.

Robiglio, V., Ngendakumana, S., Gockowski, J., Yemefack, M., Tchienkoua, M., Mbile, P., … Michele, B. (2010). *Reducing Emissions from All Land Uses in Cameroon*. Final National report. Nairobi, Kenya: ASB Partnership for Tropical Forest Margins.

Robiglio, V., & Yemefack, M. (2014). Patterns of change in the landscape. In Minang, P. A., van Noordwijk, M., & Kahurani, E. (Eds.). *Partnership in the tropical forest margins a 20 year journey in search of alternatives to slash and burn*. Nairobi, Kenya: World Agroforestry Centre.

Turner, B. L., Meyer, W. B., & Skole, D. L. (1994), Global Land-use/Land-cover change: towards an integrated study. *Ambio, 23*(1), 91-95.

USAID (United States Agency for International Development). (2010). *Country profile: Property rights and resource governance, Cameroon.* USAID. Retrieved from http://usaidlandtenure.net/sites/default/files/country-profiles/full-reports/USAID_Land_Tenure_Cameroon_Profile.pdf van Noordwijk, M., Lusiana, B., Leimona, B., Dewi, S., & Wulandari, D. (Eds.) (2013). *Negotiation support toolkit for learning landscapes.* Bogor, Indonesia: World Agroforestry Centre, South East Program Office.

World Rainforest Movement. (2006). *Cameroon: A zoning plan that splits apart forests and people.* WRM's bulletin Nº 102. Retrieved from http://www.wrm.org.uy/oldsite/bulletin/102/Cameroon.html

Zey, M. (1998). *Rational choice theory and organizational theory: a critique.* London: SAGE Publications.

A woman holding a grafted cocoa plant grown in her private nursery in the Efoulan area, Cameroon. Photo credit: Lalisa A. Duguma

CHAPTER 24

Pathways for sustainable intensification and diversification of cocoa agroforestry landscapes in Cameroon

Dieudonne Alemagi, Peter A. Minang, Lalisa A. Duguma, Anderson Kehbila and Faith Ngum

Highlights

- Extensification of agriculture, including cocoa expansion, has been linked to deforestation and to the perpetration of poverty in Cameroon
- Sustainable intensification and diversification of coca landscapes could potentially increase productivity, incomes and biodiversity and save forests
- Identifying and assessing sustainable intensification and diversification options/ pathways could help improve efficiency, effectiveness and equity in its contribution to REDD+ and broader green economy efforts
- The government policy supporting full-sun cocoa practices can potentially increase productivity but such practices can also lead to poor risk management, increased vulnerability and decreased biodiversity/environmental functions
- Realizing sustainable intensification and diversification requires policy, institutional, and technical capacity (e.g., incentive mechanisms) changes to come to fruition

1. Introduction

There is increasing recognition that rural landscapes possess a strong potential for Reducing Emissions from Deforestation and forest Degradation (REDD+; van Noordwijk & Minang, 2009). As an agroforestry option, cocoa systems have been widely cited as a potential climate-smart agricultural practice (FAO, 2010). More specifically, it has been suggested that with proper implementation of regulations to control illegal encroachment into the forest, the promotion of increased productivity in cocoa agroforestry landscapes (CALs), through proper intensification pathways, is a strategy for limiting cocoa expansion and agriculture in general (Minang et al., 2014). Within developing countries, agricultural expansion is a leading cause of deforestation (Achard et al., 2002; Robiglio et al., 2010) making such strategies all the more pertinent.

That said, minimal studies have been conducted to analyze sustainable intensification and diversification pathways of CALs in Cameroon. Although the suggestions for promoting intensification and diversification pathways as a strategy for limiting encroachment into the forest and increasing cocoa productivity for farmers are increasing, no detailed account exists on the various pathways that could be used to accomplish this strategy. Focusing on Cameroon as a case study, this chapter critically analyses sustainable intensification and diversification pathways within CALs in Cameroon. Additionally, the feasibility of incentive mechanisms for sustainable intensification and diversification pathways are equally analysed.

2. Setting the stage, field sites and cocoa systems in Cameroon

2.1 Cameroon as a case study

Cameroon offers a credible a *priori* case for examination as 90% of the rural population is estimated to be engaged in small-scale agriculture (Robiglio et al., 2010) including cocoa production, and its government as well as key stakeholders have both proposed pathways to encourage sustainable practices within CALs. This study draws upon relevant literature and field work experience in three study areas, referred to as Efoulan, Ayos, and Muyuka, in the southern part of Cameroon where CALs are predominant.

The Efoulan municipality is located in the Mvila Division of the South Region of Cameroon. An estimated 95% of the municipality's 250,000 people are currently engaged in shifting cultivation for small-scale traditional agriculture with cocoa being the main agricultural product (Feudjio et al., 2012). The municipality of Ayos is situated 123 kilometres from Yaoundé, the national capital of Cameroon. Its surface area is 1250 km^2 with an estimated population of 22,899 inhabitants (INS, 2005). It has been reported that almost the entire population of this municipality depends directly on subsistence farming for their livelihoods with cocoa being one of the principal agricultural products (CANADEL, 2012). The municipality of Muyuka is located in Fako Division of the South West Region of Cameroon. In 2012, its total population was estimated at 86,286 (INS, 2010) the majority of which were engaged in agriculture for income generation and subsistence purposes. Cocoa production is endemic in the municipality of Muyuka and annual production for 2013 was estimated at 14,844 tons (MINADER, 2013).

2.2 Cocoa farming in Cameroon: an overview

Cocoa has long played a vital role in Cameroon's economic development (Armathé et al., 2013), and remains an important source of income for approximately 1.4 million people (KIT Royal Institute, AgroEco/Louis Bolk Institute, & Tradin, 2010). Annual production in Cameroon grew from 120,619 tons in 2000 to 225,000 tons in 2013 (NCCB, 2014), making Cameroon the fourth largest producer of cocoa in the world after Côte d' Ivoire, Ghana, and Indonesia (ICCO, 2014). This makes cocoa farming a major source of foreign currency, accounting for approximately 15% of total annual exports revenue in 2009 (KIT Royal Institute, AgroEco/Louis Bolk Institute, & Tradin, 2010), and 2.1% of Cameroon's Gross National Product (Armathé et al., 2013).

Plantations are often created by cutting down large areas of forest to plant food crops for subsistence purposes and cocoa for cash on the same piece of land (Kimengsi & Tosam, 2013). Cocoa is cultivated on an estimated total surface area of 450,000 hectares by smallholders who usually farm on 1 to 3 hectares of land (ICCO, 2014). It is grown mainly in 7 out of the 10 regions of Cameroon, with the Centre Region producing the most at approximately 90,000 tons per year. This is followed by the South with 48,000 tons, the South West with 46,000 tons, the East with 25,000 tons and the Littoral, West and the North West all contributing approximately 1,000 tons each (NCCB, 2014).

3. Why sustainable intensification of CALs?

Sustainable agricultural intensification has been defined by its goal of "… producing more output from the same area of land while reducing the negative environmental impacts and at the same time increasing contributions to natural capital and the flow of environmental services" (Pretty et al., 2011). Some have also called this it 'ecological intensification' emphasizing the process in reaching sustainable intensification versus the final destination alone (van Noordwijk & Brussaard, 2014). Sustainable intensification pathways can contribute in enhancing multifunctionality of CALs by providing mitigation, adaptation, conservation, and developmental benefits in the following ways:

1. First, it has been established that if intensification of CALs via the use of inputs as well as the integration of timber producing trees in the Guinean rainforest of Central and West Africa (Côte d'Ivoire, Ghana, Nigeria, Cameroon), was done in the late 1960s, an estimated 21,000 km^2 of forests would have been conserved, thereby contributing to a reduction in emissions of about 1.4 billion tons of CO_2 (Gockowski & Sonwa, 2011).
2. Second, the integration of timber and fruit producing trees into cocoa farms, as well as the use of farm inputs in tropical countries including Cameroon, can increase productivity and create multiple income streams for the farmer thus reducing their need to expand their agricultural activities thereby sparing the forests (Minang et al., 2014).
3. Third, intensification of CALs with shade trees can significantly improve soil fertility and supply the soil with organic input through litter as well as wastes from wild animals that use the trees as their habitat (Hartemink, 2005). Such roles improve soil quality and thus enhance cocoa productivity.
4. Fourth, Alemagi et al. (2014) argue that intensification of CALs in Cameroon with diverse tree species can also be an approach for farmers to adapt to or withstand climatic shocks. As an example, they note that if a pandemic wipes out cocoa plants, often the main source of cash income, a farmer with an intensified cocoa farm including timber and fruit producing tree species has alternative economic products to help buffer the cocoa-based income loss.
5. Finally, Eboutou (2009) showed that CALs in Cameroon's forest-dependent communities, which, in general, are intensified with fruit producing trees, are more profitable than less diversified ones. As profitability or income within CALs increases, the demand for land reduces thus leading to a decrease in deforestation and forest degradation.

4. Pathways for sustainable intensification and diversification of CALs in Cameroon

In this section of the chapter, we analyse four possible intensification and diversification pathways or scenarios that can be used to enhance multifunctionality of CALs in Cameroon. These include, full-sun cocoa, tree-diversified cocoa agroforestry, and cocoa enhancement and diversification through vegetative propagation. These were chosen because they either represented current practices on the ground and or are part of government policy (e.g., full-sun cocoa).

4.1 Scenario 1: baseline (dominant current practice)

In the Southern Region of the country, growing fruit and timber producing trees within CALs is normal practice among farmers in the area. It is estimated that 30 tree species per hectare are planted within CALs for home use and/or commercialization (Jagoret et al., 2011). According to Alemagi et al. (2014), priority species include *Dacryodes edulis, Mangifera indica, Irvingia gabonensis*, and *Persea americana*. In the Efoulan municipality located in the Southern Region of the country, reports indicate that CALs in the region can produce about 340 kg of cocoa per hectare and are therefore non- profitable, with a negative Net Present Value (NPV) of ~500 USD (250,000 FCFA)[1] (Eboutou et al., 2010; Gockwoski et al., 2010).

In terms of tree species richness, Bisseleua et al. (2009) note that there are usually 9 tree species in old cocoa forest homegardens while mature intensively managed cocoa forest gardens contain five tree species. With regards to richness in herbaceous species, there are 33 species in old cocoa forest homegardens and 26 species in mature intensively managed cocoa forest gardens. According to Gockowski and Sonwa (2011), the carbon sequestration potentials of these systems is 104 tons (t)/hectare (ha).

4.2 Scenario 2: full-sun cocoa growing

This is a cocoa growing system that is being promoted by the Government of Cameroon where little or no trees are integrated into the cocoa farms. In this method, cocoa production simply involves farmers eliminating the shade canopy in an effort to boost yields. Farmers utilize newer, more resistant hybrids and/or varieties whose vertical trunks are the primary fruit bearing areas of the plant, rather than the horizontal branches (Daniels, 2006). Considering that current productivity is about 340 kg/ha in Cameroon, through this system, the government aims at attaining a productivity of 1000 kg/ha. As Gockowski and Sonwa (2011) note, the carbon sequestration potential of this system is 67.7 t/ha. This scenario is possible under the following conditions:

- The application of 371 kg/ha of 0-18-23 Nitrogen (N) Phosphorous (P) Potassium (K) ratio fertilizer plus micronutrients in full-sun hybrid cocoa plantations (Gockowski & Sonwa, 2011).
- The application of at least two insecticide rounds per year against mirids and four fungicide rounds against black pod (Jagoret et al., 2011).
- Cocoa trees are planted at a distance of 3 x 3 m apart and cocoa tree density is 1,111 cocoa trees per hectare of land (Asare & David, 2011; Gockowski & Sonwa, 2011).
- Structural pruning (removal of branches and stem on a tree to give it the desired shape) is done 2 to 5 years after planting to make sure that the tree has the right shape and height so that field operations (such as harvesting and spraying) can be easily carried out. Thereafter, pruning is carried out every 5 to 7 years towards the end of the dry season to the early parts of the rainy season, before new growth starts.
- Non-cocoa tree canopy should not be more than 25% since this will only serve to starve the tree, causing them to develop fast growing, weakly attached sucker growths, which will increase maintenance costs and break off easily in strong winds (Asare & David, 2011).

Table 24.1 Tradeoffs in sustainable intensification and diversification pathways of CALs in Cameroon. Some values were not available for all practices indicated by '-'.

Key features	Baseline (dominant current practice)	Full-sun cocoa	Tree intensified and diversified cocoa agroforestry systems	Cocoa enhancement and diversification through vegetative propagation
Key practices	• Multi-storey cocoa with mostly fruit and non-timber trees maintained and managed when farm is established after clearing forest • Mostly old > 25 years	• Cocoa is grown with little or no trees integrated into the system • Relatively few recently established medium sized plantations	• Multi-storey cocoa system which is intensified with planted fruit and/or timber tree species • Increased inputs-fertilizers, planting materials, pesticides, etc.	• Renewal of old cocoa plants using vegetative propagation techniques • Integration of grafted cocoa trees and fruit and timber species that are high yielding and more adapted and resilient
Cocoa productivity	340 kg/ha	1000 kg/ha	-	> 400 kg /ha
Non-cocoa composition	30 trees/ha	0 trees/ha (in many instances)	12-15 trees/ha	-
Biodiversity – tree species richness (Bisseleua et al., 2009)	9 species in old cocoa forest home gardens to 5 species in mature intensively managed cocoa forest gardens	1-2 species	11 species	-
Biodiversity - herbaceous species richness (Bisseleua et al., 2009)	33 species in old cocoa forest home gardens to 26 species in mature intensively managed cocoa forest gardens	-	25 species	-
Carbon sequestration	131.3 t/ha (Wade et al., 2010); 104 t/ha (Gockowski & Sonwa, 2011)	67.7 t/ha (Gockowski & Sonwa, 2011)	40-70 t/ha (Wade et al., 2010; Gockowski & Sonwa, 2011))	-

4.3 Scenario 3: tree intensified cocoa agroforestry system

This scenario involves a multi-story cocoa system, which is intensified with fruit and/or timber producing trees. Current CALs all fall into this scenario and as Wade et al. (2010) and Gockowski and Sonwa (2011) suggest, their carbon sequestration potential is 40-70 t/ha. This scenario is possible under the following conditions or assumptions:

- Timber and fruit producing trees, which are preferred by cocoa farmers, are integrated into the cocoa farm. Fruit producing trees include *Persea americana, Dacryodes edulis, Mangifera indica, Irvingia gabonensis, Citrus sinensis,* and *Cola spp* (Alemagi et al., 2014) while potential non-edible/timber species include *Terminalia superba, Triplochiton scleroxilon, Milicia excelsa, Ceiba pentandra,* and *Ficus mucuso* (Sonwa et al., 2014).
- The best possible planting distance between the cocoa and non-cocoa trees is respected. Depending on the tree type, Asare and David (2011) recommend planting timber trees at 12 x 12 m and nitrogen fixing trees at 6 x 6 m triangular spacing.
- Shade management is properly practiced. In order to provide a good and reliable permanent shade which protects the cocoa plants against pests, diseases, and drying out, Asare and David (2011) recommend that timber and fruit trees should be planted a year before the cocoa plants at a distance of 12 x 12 m triangular spacing that could later be thinned to 24 x 24 m if shade is perceived to be too much.
- The fruit and timber producing trees grow normally when integrated into the cocoa farm. Farmers' preference for the tree species to be associated with cocoa is guided by economic importance and compatibility with cocoa. The compatibility with cocoa is assessed by farmers through the shade, rooting, microclimate and soil moisture characteristics (Sonwa et al., 2014).
- There is a market for fruits and timber obtained from these systems. Sonwa et al. (2014) estimated that the net returns to management in cocoa agroforests of *Dacryodes edulis, Ricinodendron heudelotii, Citrus sinensis, Citrus reticulata* (orange) and cocoa stood at 194 USD (96,913 FCFA), 42 USD (20,939 FCFA), 33 USD (16,698 FCFA), 125 USD (62,700 FCFA), and 328 USD (164,000 FCFA)/ha respectively in 2002/2003 in Southern Cameroon.
- Tree tenure is addressed. This is because all naturally growing trees that have not been planted in Cameroon belong to the State as well as those planted on private land without a land title (Foundjem-Tita et al., 2013).
- Insect and pests, which could attack cocoa plants and trees, are well managed. As Asare and David (2011) report, adequate shade, maintaining general farm hygiene by weeding, pruning, and mulching as well as spraying the recommended insecticides at the right time combats insects and pests that attacks trees in CALs.

4.4 Scenario 4: cocoa production enhancement through vegetative propagation

This is a cocoa production system, which emphasizes improving the productivity of the cocoa trees through vegetative propagation techniques. These techniques include seeding, cutting, marcotting, tissue culture (somatic embryogenesis), and grafting. Seeding consists of putting a healthy and physiologically sound seed in conditions that will favour its germination and growth into a full plant. Cutting involves putting pieces of stems, leaves or roots in conditions suitable to induce the regeneration of the missing parts into becoming a full plant. Marcotting is a method aimed at stimulating rooting of a branch on a tree after which the rooted branch is cut from the mother tree, placed in a nursery where it develops leaves and becomes a copy of the mother tree. Somatic embryogenesis is a process by which somatic cells undergo bipolar development to give rise to genetically identical whole plants while grafting is a process in which two plant parts are joined together to form one plant. The technique aims at creating a new plant through the union of a suitable rootstock (which becomes the root system or part of the trunk) and an aerial part of another plant (scion) of the desired variety. All these techniques are possible under the following conditions or assumptions:

- Tree density within the cocoa farm remains constant and cocoa is renewed through vegetative propagation as described above. On average, a plant density of 1,111 cocoa plants per hectare is possible using a planting distance of 3 x 3 m (Asare & David, 2011).
- The strategies, which are put in place for the sourcing of the vegetative materials, are affordable and accessible to farmers. As reported by Asare and David (2011), improved planting materials can be obtained from sources such as farmlands, nurseries of district forest offices, commercial tree seed nurseries, and private tree seed nurseries.
- The appropriate planting distance between the cocoa plants are respected. For instance, Asare and David (2011) recommend a planting distance of 3 x 3 m in Ghanaian context, which, in many cases, has similar features (biophysical, climatic and socioeconomic settings) to that of Cameroon.
- Insects and pests, which could attack cocoa plants, are well managed and the recommendations are the same as the one for the full-sun cocoa growing scenario.
- Other management options (like pruning) within the cocoa farm are respected. Although pruning in mature cocoa farms is done once yearly in the Centre Region in Cameroon (Jagoret et al., 2011), Asare and David (2011) recommend that tree pruning to improve tree health, control growth, and enhance flowering, fruiting, and appearance should be done for the first time 2 to 5 years after planting and thereafter, every 5 to 7 years. Pruning should be carried out towards the end of the dry season to the early parts of the rainy season, before new growth starts while leaving at least 25% of the canopy.

A number of tradeoffs emerge from the scenarios. The baseline scenario is very poor on productivity, but very high overall in biodiversity and carbon sequestration potential. While the full-sun option, being promoted by the government, can have potentially high cocoa productivity and a moderate carbon sequestration potential, it is very poor on biodiversity, diversity of potential incomes sources and therefore farmers could be exposed to risks when cocoa prices drop, including possible vulnerabilities in case of crop failures/diseases. The tree diversified agroforestry systems scenarios, wherein improved tree planting and improved cocoa is done, show potentially moderate carbon sequestration potential, moderate performance for cocoa productivity, biodiversity, and potential tree product income sources. Farmers will choose these options based on their own individual circumstances on the ground.

5. Feasibility of sustainable intensification and diversification pathway choices: incentives analysis

In order to further understand the potential for growth and/or uptake of the options we review the performance of incentive mechanisms in Southern Cameroon. Incentive mechanisms can be divided into direct and indirect incentives. As Enters (2004) explain, while direct incentives are formulated to have an immediate impact on resource users and to encourage returns to investment in a direct manner, indirect incentives are designed to have an indirect impact on resource users via a change in the overall framework conditions within and outside of a natural resource sector. Some common examples of direct and indirect incentive mechanisms are provided in Table 24.2.

Table 24.2 Examples of different direct and indirect incentive mechanisms (adapted from Enters, 2004).

Direct incentives	Indirect incentives
Grants	Training
Tax relief	Extension services
Subsidized loans	Secured land tenure
Specific provision of local infrastructure	Credit facilities
Goods and materials like seedlings and fertilizers	Farm-to-market roads

The purpose of the discussion that follows is to examine incentives mechanisms that have been designed and implemented by key stakeholders to promote sustainable intensification and diversification pathways within CALs in the three case study communities in Cameroon.

5.1 Credit schemes

Agricultural credit schemes assist farmers to acquire basic agricultural tools (like sprayers), improved planting material, and transport facilities. This was the basis for early credit schemes developed mostly for target farmers in Cameroon (Fonjong, 2004). Indeed, right back from the 1960s, through the 1980s, the government financed agriculture in Cameroon through the farmers' bank, FONADER. FONADER supported small farmers by providing them with credit facilities for increasing agricultural production. The World Bank supported FIMAC (Investment Fund for Agricultural and Communal Micro Projects) scheme was also operational in the 1990s and gave out credit schemes to cocoa farmers operating in the country (Fonjong, 2004). Such incentive mechanisms are very instrumental to facilitate the input-based intensification processes particularly as most of the inputs required are to be purchased from the market either from normal traders or from supplies by the government.

The provision of credit schemes to support and motivate farmers in their quest for engaging in sustainable intensification and diversification pathways within CALs has not been successful in all the three case study areas. Due to financial mismanagement, the operations of the aforementioned financial institutions have all collapsed (Fonjong, 2004). This failure is owed largely to a dearth of understanding of the rural community dynamics in Cameroon, which greatly misguided the provision of these schemes. In the municipality studied, most cocoa farmers relied on the rotatory loan and saving groups ('tontine') which are owned and operated by the communities themselves. Therefore, introducing credit schemes, which are new in such areas, may be problematic to smallholder farmers to manage.

5.2 Training

Training and capacity building for the local communities is a key incentive mechanism for enhancing sustainable intensification and diversification schemes in Cameroon. For instance, if farmers are to be engaged in tree-based intensification and diversification schemes (Scenario 3) as well as vegetative propagation based intensification and diversification schemes (Scenario 4), it is crucial that farmers are educated on how to do it because the local extension workers may not always be there to assist. Experiences from the Efoulan municipality indicate that farmers are very interested to learn about such new dimensions of farm renewal as in the case of vegetative propagation for instance. Hence, providing such training would be a good incentive to make use of to bring lasting changes in the way people manage their cocoa farms.

Sponsored by the U.S. Agency for International Development (USAID), the World Cocoa Foundation, the Global Cocoa Industry, the U.S. Department of Agriculture (USDA), and the Food and Agricultural Organization (FAO), the Sustainable Tree Crops Programme (STCP) implemented (between 2007-2011) by the International Institute for Tropical Agriculture (IITA) provided training to cocoa farmers in Ayos and Owe in the municipality of Muyuka through the participatory farmer field school approach on topics related to integrated cocoa and pest management and the management of cocoa nurseries (IITA, 2012). With regards to the latter, the programme distributed improved planting materials to cocoa farmers, as well as cocoa pods to farmer cooperatives to enable them to develop their own nurseries. However, after providing a series of training meetings, they were abandoned with little or no monitoring. As an agricultural technician in the municipality of Muyuka stated, there was "… no real follow-up in the field after the training".

It is also important that training be based on organized production, innovation, and improved marketing, not on replication alone, as is often the case in local communities with CALs in Cameroon. As Chupezi et al. (2009) explain, training in organized production, processing, and improved marketing of non-timber forest products (NTFPs), like fruits in African communities, can increase the revenue of forest-dependent communities, thus contributing to poverty alleviation.

5.3 Government extension services

Agriculture extension services of the Ministry of Agriculture and Rural Development (MINADER) provides extension workers who disseminate information to rural farmers about proper agricultural practices (like proper soil conservation and seed multiplication techniques), regeneration of old farms, and the importance of agricultural common initiative groups. However, as Fonjong (2004) establishes, the agriculture extension workers that provide extension services to farmers in Cameroon have not only decreased, but the few who are available, work under appalling conditions.

Government and other parastatal continue to overlook cocoa farmers in rural areas of the country and their association with poverty, and what implications this has for sustainable intensification and diversification of CALs. Perhaps nowhere has this been more evident than with the government parastatal SODECAO (Société de Développment du Cacao). In the South Region of Cameroon, SODECAO receives subsidies from the government to produce cocoa seedlings which are distributed to cocoa farmers at reduced prices in the city of Ebolowa situated 32 kilometres from the Efoulan municipality. Between 2012 and 2013, a total of 27,000 cocoa plants were supplied to the municipality of Efoulan. However, because most cocoa farmers in the case study municipality are poor and cannot afford the transport fares to travel to Ebolowa to procure these planting materials, the majority of those who were supplied with these materials were rich and/or average income earners of the public service who are only engaged in cocoa farming on a part-time basis.

5.4 Farm to market roads

If farmers do not have proper access to market for their produces they cannot reap the true potential of their efforts and often they are exposed to selling their products at cheap prices to middle-men (brokers) who take advantage of their efforts. If, for example, farmers chose to adopt vegetative propagation techniques for farm renewal (Scenario 4), their cocoa yield will increase significantly and there is a need for them to access markets to sell their products. This can only happen if there is proper road infrastructure in all three case study sites.

In general, the prevailing state of the roads in the municipality of Ayos, Efoulan, and Muyuka are deplorable. The only tarred road in the municipality of Ayos is a 123 kilometres road that links the municipality to Yaoundé. In Efoulan, all the roads are earth roads with most being seasonal due to poor maintenance. In such poor road conditions it becomes extremely difficult for transporting cocoa to market, which is produced in remote locations. This also discourages fruit tree planting, as products will be largely perishable and susceptible to post-harvest losses. This could, in turn, serve as a disincentive for farmers to intensify their CALs.

6. Summary

The objective of this chapter was to examine options for sustainable intensification and diversification of CALs in Cameroon as a means to reduce deforestation, making cocoa production climate-smart and contributing to Cameroon's green growth ambitions. Three pathways and or options were identified and analyzed (with respect to the current baseline), namely full-sun cocoa, tree intensified and diversified agroforestry cocoa, and cocoa enhancement and diversification through vegetative propagation. Our analysis showed that cocoa farm renewal through vegetative propagation and the integration of trees (timber and fruits) could simultaneously generate moderate increases in cocoa farms productivity as well as moderate biodiversity benefits, carbon sequestration potential, and income from the cocoa plants and diverse tree products. The full-sun cocoa scenario, currently being promoted by government, could lead to moderate carbon sequestration and potentially double cocoa yields, but at the expense of biodiversity, and increased farmer exposure to risks and vulnerability in times of cocoa crop failures or low cocoa prices. Regardless of which pathways farmers choose, sustainable intensification and diversification will only work if it is accompanied by viable policy incentive mechanisms including technical capacity building, improved delivery of extension services, and improvements in market institutions and infrastructure.

Endnote

1 500 CFA Franc (FCFA) is almost equal to 1 USD

References

Achard, F., Eva, H. D., Stibig, H. J., Mayaux, P., Gallego, J., Richards, T., & Malingreau, J. P. (2002). Determination of deforestation rates of the world's humid tropical forests. *Science, 297*(5583), 999-1002.

Alemagi, D., Duguma, L., Minang, P. A., Nkeumoe, F., Feudjio, M., & Tchoundjeu, Z. (2014). Intensification of cocoa agroforestry systems as a REDD+ strategy in Cameroon: hurdles, motivations, and challenges. *International Journal of Agricultural Sustainability*, in press.

Armathé, A. J., Mesmin, T., Unusa, H., & Soleil, B. R. A. (2013). A comparative study of the influence of climatic elements on cocoa production in two agro-systems of bimodal rainfall: Case of Ngomedzap forest zone and the contact area of forest-savanna of Bokito. *Journal of the Cameroon Academy of Sciences, 11*(1).

Asare, R., & David. S. (2011). *Good agricultural practices for sustainable cocoa production: a guide for farmer training.* Manual no. 1: Planting, replanting and tree diversification in cocoa systems, Sustainable tree crops programme. Accra, Ghana: International Institute of Tropical Agriculture.

Bisseleua, D. H. B., Missoup, A. D., & Vidal, S. (2009). Biodiversity conservation, ecosystem functioning, and economic incentives under cocoa agroforestry intensification. *Conservation Biology, 23*(5), 1176-1184.

CANADEL (Centre d'Accompagnement de Nouvelles Alternatives de Développement Local) (2012). *Plan communal de développement de la commune d'Ayos.* Commune D'Ayos, Département du Nyong et Mfoumou.

Chupezi, T. J., Ndoye, O., Tchatat, M., & Chikamai, B. (2009). Processing and marketing of non-wood forest products: Potential impacts and challenges in Africa. *Discovery and Innovation, 21*(1), 60-65.

Daniels, S. (2006). *Developing best practice guidelines for sustainable models of cocoa production to maximize their impacts on biodiversity protection.* Vietnam: World Wildlife Fund.

Eboutou, L. Y., Degrande, A., Jaza, F., & Kamajou, F. (2010). *More than chocolate: Diversifying cocoa agroforests for higher proftability in Cameroon.* Yaoundé, Cameroon: World Agroforestry Centre.

Eboutou, L. Y. (2009). *Rentabilité financière des agroforêts à base de cacao enrichies par des arbres domestiqués dans le bassin de production du centre Cameroun.* Postgraduate Diploma Thesis. Cameroon: Faculty of Agronomy and Agricultural Science, University of Dschang.

Enters, T. (2004). Incentives: Key concepts, typology, and rationale. In Enters, T., & Durst, P. (Eds.). *What does it take? The role of incentives in forest plantation development in Asia and the Pacific*. Regional Office for Asia and the Pacific, Bangkok, Thailand: Food and Agriculture Organization (FAO).

Feudjio, M., Magne, A. N., Alemagi, D., Robiglio, V., Ewane, N., Yemefack, M.,Asaah, E., & Tchienkoua, M. (2012). *Incentives measures for the REED+ mechanism and sustainable development in the Efoulan Municipality of the South Region of Cameroon.* Alternative to Slash and Burn (ASB) Technical Report. Nairobi, Kenya: ASB Partnership for the Tropical Forest Margins.

FAO (Food and Agriculture Organization of the United Nations). (2010). *"Climate Smart" agriculture: Policies, practices, financing for food security, adaptation and mitigation.* Rome: FAO.

Fonjong, L. (2004). Changing fortunes of government policies and its implications on the application of agricultural innovations in Cameroon. *Nordic Journal of African Studies, 13(1), 13*-29.

Foundjem-Tita, D., Tchoundjeu, Z., Speelman, S., D'Haese, M., Degrande, A., Asaah, E.,Van Huylenbroeck, G., Van Damme, P., & Ndoye, O. (2013). Policy and legal frameworks governing trees: incentives or disincentives for smallholder tree planting decisions in Cameroon?. *Small-scale Forestry, 12*(3), 489-505.

Gockowski, J., Tchatat, M., Dondjang, J. P., Hietet, G., & Fouda, T. (2010). An empirical analysis of the biodiversity and economic returns to cocoa agroforests in southern Cameroon. *Journal of Sustainable Forestry, 29*(6-8), 638-670.

Gockowski, J., & Sonwa, D. (2011). Cocoa intensification scenarios and their predicted impact on CO2 emissions, biodiversity conservation, and rural livelihoods in the Guinea rain forest of West Africa. *Environmental Management, 48*(2), 307-321.

Hartemink, A. E. (2005). Nutrient stocks, nutrient cycling, and soil changes in cocoa ecosystems: a review. *Advances in agronomy*, 86, 227-253.

ICCO (International Cocoa Organization). (2014). Cocoa year in Cameroon 2013/2014. *Quarterly Bulletin of Cocoa Statistics, XL*(1).

IITA (International Institute of Tropical Agriculture). (2012). Sustainable Tree Crops Program. Yaoundé, Cameroon: International Institute for Tropical Agriculture.

INS (Institut National de Statistique). (2005). *Recensement général de la population et de l'habitat du Cameroun*. Yaoundé, Cameroun: Institut National de la Statistique.

INS. (2010). *Third general population and housing census of 2005*. Cameroon: Institu Natioanale de Statistique.

Jagoret, P., Michel-Dounias, I., & Malézieux, E. (2011). Long-term dynamics of cocoa agroforests: a case study in central Cameroon. *Agroforestry systems, 81*(3), 267-278.

Kimengsi, J. N., & Tosam, J. N. (2013). Climate Variability and Cocoa Production in Meme Division of Cameroon: Agricultural Development Policy options. *Greener Journal of Agricultural Sciences, 3*(8), 606-617.

KIT Royal Institute, AgroEco/Louis Bolk Institute, & Tradin. (2010). Organic cocoa production in Cameroon and Togo. Amsterdam: KIT Royal Institute, AgroEco/Louis Bolk Institute and Tradin.

Minang, P. A., Duguma, L. A., Bernard, F., Mertz, O., & van Noordwijk, M. (2014). Prospects for agroforestry in REDD+ landscapes in Africa. *Current Opinion in Environmental Sustainability*, 6, 78-82.

MINADER (Ministry of Agriculture and Rural Development). (2013). *Cocoa production figures for Fako Division in 2013*. South West Region, Cameroon: Divisional Delegation of the Ministry of Agriculture and Rural Development, Fako Division.

NCCB (National Cocoa and Coffee Board). (2014). *Cocoa Statistics*. NCCB. Retrieved from www.oncc.com

Pretty, J., Toulmin, C., & Williams, S. (2011). Sustainable intensification in African agriculture. *International journal of agricultural sustainability, 9*(1), 5-24.

Robiglio, V., Ngendakumana, S., Gockowski, J., Yemefack, M., Tchienkoua, M., Tchawa, P., Tchoundjeu, Z., & Bolognesi, M., (2010). *Reducing emissions from all land uses in Cameroon*. Final national report. Nairobi, Kenya: ASB partnership for the tropical forest margins.

Sonwa, D. J., Weise, S. F., Schroth, G., Janssens, M. J., & Shapiro, H. Y. (2014). Plant diversity management in cocoa agroforestry systems in West and Central Africa—effects of markets and household needs. *Agroforestry Systems*, 1-14.

van Noordwijk, M., & Minang, P. A. (2009). *If we cannot define it, we cannot save it*. ASB Policy Brief No. 15. Nairobi, Kenya: ASB Partnership for the Tropical Forest Margins.

van Noordwijk, M., & Brussaard, L. (2014). Minimizing the ecological footprint of food: closing yield and efficiency gaps simultaneously? *Current Opinion in Environmental Sustainability*, 8, 62-70.

Wade, A. S., Asase, A., Hadley, P., Mason, J., Ofori-Frimpong, K., Preece, D., & Norris, K. (2010). Management strategies for maximizing carbon storage and tree species diversity in cocoa-growing landscapes. *Agriculture, ecosystems & environment, 138*(3), 324-334.

Bushmeat, a vital source of household protein in the CARPE landscapes. Photo credit: Kalame Fobissie

CHAPTER 25

Landscape approaches in the Congo Basin: linking the Democratic Republic of Congo's Emission Reduction Program (ERP) and the Central Africa Regional Program for the Environment (CARPE)

Kalame Fobissie

Highlights

- The Central Africa Regional Program for the Environment (CARPE) and the Democratic Republic of Congo (DRC) Emission Reduction Program (ERP) both involve landscape approaches and are increasingly interacting at the local and national levels due to several commonalities that create space for learning across programs
- Participatory land use planning processes can be used to effectively engage multiple stakeholders and provide opportunities to address conservation and development objectives simultaneously
- The structure and performance of landscape governance is closely linked to funding sources, capacity, and the types of stakeholders involved
- The ERP landscape approach, if successfully implemented in the DRC, presents a potential sustainable financial option for achieving conservation and development goals

1. Why adopt a landscape approach in the Congo Basin forests?

The Congo Basin forests form the second largest block of rainforest in the world after the Amazon, covering 300 million hectares of land and spanning six countries: Cameroon, the Central African Republic, the Democratic Republic of Congo (DRC), the Republic of Congo (RoC), Equatorial Guinea, and Gabon. These forests represent a huge carbon sink, and if they remain intact, provide enormous potentials to mitigate the effects of global climate change. The forests are extremely rich in flora and fauna and have the largest number of plant species per unit area in the world with a wide distribution of animal species including approximately 552 mammals, 300 fish, 460 reptiles and 1000 bird species (de Wasseige et al., 2012). Of these, 16 species of birds and 23 species of mammals are considered threatened or endangered (de Wasseige et al., 2012). The Basin is now experiencing a rapidly declining wildlife population due to high human population, hunting intensity, absence of law enforcement, poor governance and proximity to expanding infrastructure (Maisels et al., 2013). The Congo Basin forests also contain diverse natural resources (e.g., timber, minerals, fertile soils, etc.), are home to about 30 million people and support livelihoods for more than 75 million people from over 150 ethnic groups who rely on the forest ecosystems for food, nutritional health, and meeting their livelihood needs (World Bank, 2013).

The use of these resources and ecosystem services for supporting both livelihoods and economic development is putting increasing pressure on the Congo Basin's forests resulting in increasing rates of deforestation and forest degradation. While estimates vary, the net annual deforestation rates of the Congo Basin forests have been estimated to increase from 0.05% to 0.09% between the respective periods of 1990 to 2000 and 2000 to 2005 (de Wasseige et al., 2012). Within the countries constituting the Congo Basin forest, the highest rates of net annual deforestation and forest degradation have been found in the DRC with Gabon experiencing the least. The agents of deforestation in the Congo Basin countries include, but are not limited to, smallholder farmers, state agencies and private companies with the direct and immediate causes of deforestation in the Congo Basin countries revolving around: agricultural expansion (slash and burn, plantations), wood fuel collection (firewood and charcoal), logging (legal and illegal), infrastructural development (roads, dams, settlements), and mining (industrial and artisanal).

One of the consequences of deforestation and forest degradation in the Congo Basin is forest fragmentation between different land units negatively affecting biodiversity (Zhang et al., 2006; Blake et al., 2007) and increasing emissions of greenhouse gases (Achard et al., 2007; World Bank, 2013). In this context, the landscape approach offers opportunities to foster connectivity and promote positive interactions between different land units and species (Linborg & Eriksson, 2004; Tylianakis et al., 2010), increase the species richness and habitat suitability (Bierregaard et al., 1992; Fischer & Lindenmayer, 2007), address some of the drivers of deforestation, and reduce greenhouse gas emissions (DeFries & Rosenzweig, 2010). Within these processes, social and economic dimensions need to be accounted for in addition to ecological ones, to ensure more sustainable outcomes within the landscape (World Bank, 2013). From this view, applying a landscape approach is well suited (Sayer, 2009) to address the conservation and development challenges of the Congo Baisn as it considers ecological, social and economic dimensions and their interactions (Angelstam et al., 2013). Drawing on this framing, this chapter examines and compares two programs which are being implemented at the landscape scale in the Congo Basin, the Central Africa Regional Program for the Environment (CARPE) and the DRC's Emissions Reduction Program (ERP). Focusing mostly on the institutional and governance aspects of these programs, this chapter draws on lessons learned to discuss the potential of further operationalizing landscape approaches in the Congo Basin.

2. Landscape programs in the Congo Basin

2.1 CARPE landscape conservation approach

CARPE is a 25 year-old Congo Basin regional program of the United States Agency for International Development of the United States Government (USAID), aimed at reducing threats to the Congo Basin forests. "The strategic objective of CARPE is to reduce the rate of forest degradation and loss of biodiversity in the Congo Basin by increasing local, national, and regional natural resource management capacity" (CARPE, 2014). CARPE is divided into three phases. The first phase started in 1995 and ended in 2002 and included four countries. The focus was to gather baseline information on the Central African forest ecosystems and building human and institutional capacities in the Central Africa region. The second phase started in 2003 and ended in 2012. The focus was on supporting sustainable natural resource management practices on the ground, improving environmental governance, and strengthening natural resource monitoring capacity at the Congo Basin regional level. During the second phase, CARPE worked in 12 priority landscapes (see Box 25.1 for one landscape case study example) and covered nine central African (six Congo Basin plus three additional) countries namely: the Central African Republic, Equatorial Guinea, Gabon, RoC, Burundi, Cameroon, DRC, Rwanda, and Sao Tome & Principe (Figure 25.1). The third phase started in 2013 and will run up till 2020. This last phase of CARPE is limited to the DRC, the RoC and Rwanda and builds on the lessons from the two previous phases to protect and manage forests and wildlife in the selected landscapes. The specific focus according to Central Africa Forest Ecosystems Conservation (CAFEC, 2013) will be to i) conserve wildlife that are threatened by illegal and unsustainable exploitation for local and international markets, and ii) reduce deforestation and forest degradation by implementing Reducing Emissions from Deforestation and Forest Degradation (REDD+) activities that align with national REDD+ strategies and actions.

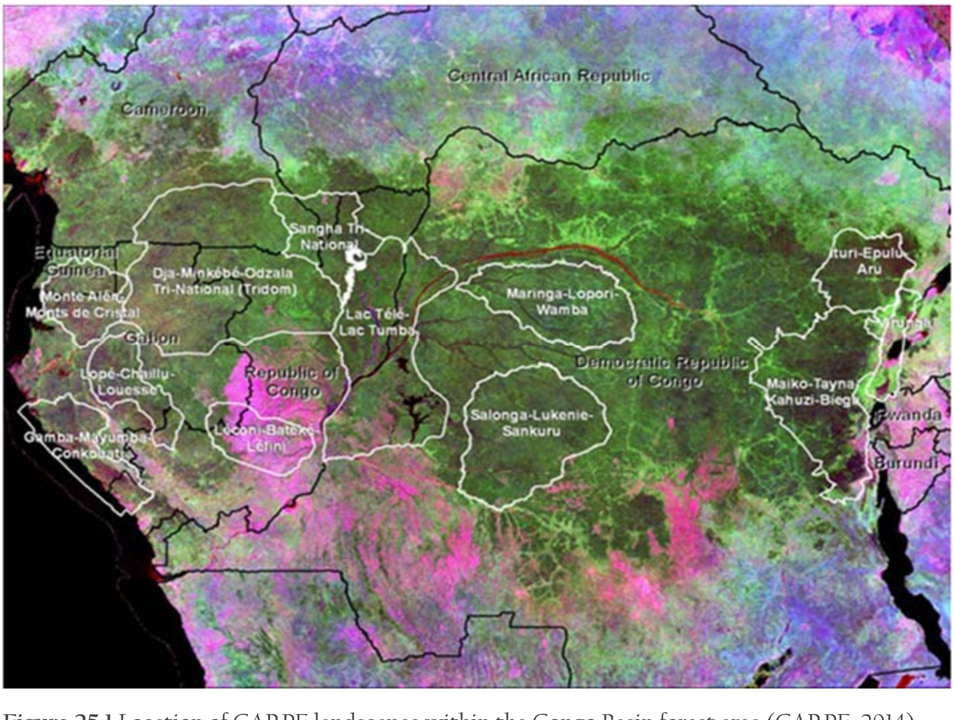

Figure 25.1 Location of CARPE landscapes within the Congo Basin forest area (CARPE, 2014).

Box 25.1

Activities of Salonga-Lukenie-Sankuru (SLS) CARPE landscape program

(Steel & Yoko, 2010; Yanggen et al., 2010; Pope et al., 2013; de Marcken, 2014; GoDRC, 2014)

The operationalization and management of all CARPE activities in the Salonga-Lukenie-Sankuru (SLS) landscape is led by the World Wide Fund for Nature (WWF) in collaboration with local village management committees and a group of more than fifteen consortium and collaborating partners located in five town and village locations within the SLS landscape in DRC: Mimia, Oshwe, Mundja, Monkoto and Etate. These partners include, but are not limited to, Private Agencies Collaborating Together (PACT), Wildlife Conservation Society (WCS), International Conservation and Education Fund (INCEF), Zoological Society of Milwaukee (ZSM), World Resources Institute (WRI), Network of Central African Protected Areas (RAPAC), La Société de Développement Forestière (SODEFOR), Institut Congolaise pour la Conservation de la Nature (ICCN), Max Planck, Action d'Aide Sanitaire et de Développement-DRC NGO (AASD), Institut Africain pour le Développement Economique et Social (INADES), World Fish Center, Smithsonian Institute, RARE and Global Action Coalition-DRC NGO (GAC). The vision of the SLS CARPE landscape program is to maintain large intact forests within the landscape and ensure the conservation of biodiversity while also promoting human well-being (Pope et al., 2013).

The SLS landscape has a total area of about 10.4 million ha, of which, about 96% is covered in forest. The landscape is rich in forest and water resources and is home to threatened species such as the bonobo (*Pan paniscus*), chimpanzee (*Pan troglodytes*), elephant (*Loxodonta africana cyclotis*), buffalo (*Syncerus caffer*), hippopotamus (*Hippopotamus amphibious*) and leopard (*Panthera pardus*). Threats to wildlife within the landscape are partly due to conservation objectives being at odds with the livelihoods needs of the population and the activities of industrial logging companies like SODEFOR. To overcome these conflicting conservation, livelihood and development priorities, the SLS CARPE landscape program engages in cross-cutting enabling activities, including environmental education, capacity building workshops and trainings and land use planning activities for local communities, civil society organizations and the DRC's government conservation agency (ICCN).

The land use planning process macro-zones the entire SLS landscape into protected areas (PAs), community-based natural resource management (CBNRM) areas, and extractive resource zones. Common steps and activities used for the land use planning include: setting up a planning team and defining their roles, gathering of basic information about the landscape, creation of a public participation strategy, and the development of a landscape plan linked to the desired landscape conditions and site specific objectives. Some of the sectoral activities carried out in the SLS landscape target livelihood needs and include, for example, sustainable fishing practices, rearing of pigs and chickens, and sustainable farming practices that both reduce deforestation and increases production of groundnuts, cowpea, rice, beans and maize. To enable the uptake of these activities, CARPE provides small grants to civil society organizations to promote and implement them. The aim is that by improving livelihoods it will reduce illegal activities such as poaching and bushmeat hunting as well as reduce the overall human pressure on the SLS landscape's forests and wildlife. Other activities directly targeting conservation objectives include, for example, the monitoring of biodiversity and the maintenance of the 5,581 km2 Monkoto biological corridor to allow the movement of wildlife and genetic exchange between the two blocks of the Salonga National Park. On the industry side, CARPE is also promoting environmentally friendly industrial logging activities by technically supporting SODEFOR's effort to engage in forest certification and other good forest governance and sustainable forest management practices.

So far, the SLS CARPE landscape program is in the right direction in meeting conservation, livelihood and development objectives through well-defined priorities and activities for different stakeholders. Moving forward will entail increased capacity in implementation, improved data for planning, continuous engagement of multiple stakeholders and the mobilization of additional funds for landscape activities.

2.2 The Congo Basin's Emission Reduction Programs (ERP)

The ERP is a World Bank coordinated program under the Forest Carbon Partnership Facility (FCPF)'s Carbon Fund (CF) aimed at providing payments for verified emission reductions from REDD+ programs in different countries. So far, Costa Rica, Ghana, Nepal, Mexico and the DRC have their Emission Reduction Program Idea Note (ER-PIN) accepted into the CF's pipeline. After the selection of their ER-PIN, REDD+ countries move on to signing a letter of intent with the World Bank after which they engage in designing a full ERP at the landscape level. Upon review and validation of the program document by the CF participants, the World Bank and REDD+ countries enter into negotiations, eventually signing an emission reduction purchasing agreement (ERPA). At this stage, the ERP is implemented, verified and payments are made to the REDD+ countries following the CF monitoring and reporting procedure.

In the Congo Basin, the DRC and the RoC are taking the leadership in developing ER-PINs at the landscape level. While the RoC's 12.2 million ha ER-PIN (GoRoC, 2014) remains eligible and will be considered for selection in subsequent CF meetings, the 12.3 million ha ER-PIN of the DRC (GoDRC, 2014) has been approved to move to the next stage of designing a full ERP. The DRC's ERP is a 36-year landscape program (2014 to 2050) to be implemented within the jurisdictional boundaries of the Plateau and Maï Ndombe Districts, together encompassing a population of approximately 1.8 million people. The DRC's ERP involves a multi-stakeholder process which includes the participation and contributions of more than 100 actors from the government, indigenous peoples groups, local communities, civil society, the private sector and technical and financial institutions. The ERP aims to design and implement enabling and emission reducing activities that can address and reduce the increasing deforestation and forest degradation trends that are driven by slash and burn agriculture, forest fires, firewood and charcoal production, legal and illegal logging and mining and cattle ranching activities. Based upon its overarching aim, the ERP is aligning its activities with existing pilot REDD+ projects and related activities within the same landscape. On the ground the DRC ERP (GoDRC, 2014) learns, adapts and builds on the Forest Investment Program (FIP) Integrated REDD+ Sub-Project in the Plateau District (PIREDD), the WWF REDD+ for People and Nature (R-PAN) project, the Wildlife Works Carbon (WWC) Conservation Concession REDD+ project, the CARPE Lac Tumba and Salonga landscapes programs, the Nouvelle Société d'Agriculture et Elevage (NOVACEL) south Kwamouth REDD+ agroforestry project, and cattle ranching concessions in the Plateauand Maï Ndombe districts.

3. Commonalities and differences between CARPE and the DRC's ERP

Although CARPE and the DRC's ERP landscape programs have some differences as highlighted in Table 25.1, the two programs are increasingly moving together with many underlying commonalities linked to key operational landscape attributes. Both programs for example, are engaged in participatory, multi-stakeholder processes with diverse participants from local communities, government agencies, conservation organizations, the private sector and civil society organizations. They both operate at the local landscape levels and within the national policy arena. Both also pay attention to interactions between ecological and social processes to achieve multiple outcomes. Both of the programs' main ecological outcomes are linked to biodiversity protection and long-term carbon storage in the landscape while socio-economic development outcomes are linked to improved livelihoods, resource access and rights, and good local governance of natural resources. To realize both ecological- and socio-economic-based outcomes within the DRC's ERP and the CARPE's DRC landscapes, the landscapes are mapped and macro-zoned into multiple components with different land use activities. Many factors are influencing the convergence of the two programs with the DRC's ERP increasingly capitalizing on the experiences of CARPE.

First, both programs are receiving funding from the same donors who promote similar objectives within each program. This includes funding from both USAID and Norway's International Climate and Forest Initiative (NICFI). Second, the location of the current ERP overlaps with two of CARPE's landscapes, the Lac Tumba and Salonga landscapes. This presents an opportunity for integration between both programs' activities (GoDRC, 2014). Third, before REDD+ as an idea was born in 2005, CARPE had already been

Table 25.1 Some of the differences between CARPE and the ERPs, focusing mainly on the DRC context.

Theme	CARPE	ERP
Starting point	Biodiversity conservation	Reduction of carbon emissions
Scope	Central Africa region and countries	Global with focus on tropical countries
Landscape niche	Cuts across administrative boundaries	Limited to administrative boundaries
Landscape lead	Conservation organizations e.g., Conservation International (CI), WCS	The DRC government
Funds mobilized	At least 246 million USD in 25 years for 12 landscapes	262 million USD expected in the next 5 to 10 years for 1 ERP landscape in the DRC
Political support	Moderate government support	Very strong government support
Performance	Not rewarded with financial payments	Rewarded with financial payments
Monitoring	Less strict monitoring and verification	Strict monitoring and verification process

operating for 10 years generating a large wealth of knowledge and experience from which the DRC REDD+ process can learn from. On this basis CARPE has actively contributed to the development of REDD+ under the DRC ERP, mostly drawing from their past experiences and lessons learned (GoDRC, 2012). In this process, CARPE has aligned one of its objectives, to reduce emissions from deforestation and forest degradation, with the DRC ERP (GoDRC, 2013). As such, it contributes to both the DRC ERP landscape program and the national REDD+ strategic framework (CAFEC, 2013). CARPE's specific contributions include: assisting with development of forestry zoning standards and steps for land-use planning, development of a national MRV system for the assessment of land use and forest governance, and the conservation of forest carbon stocks in protected areas where rare, endangered and symbolic biodiversity such as Bonobos and Okapis are found. At the international level, CARPE has partnered with the DRC government to organize a side event during the United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties (COP) 17 in Durban, South Africa in 2011, to present and showcase DRC's ERP landscape approach concept as part of the national policy and political commitment to move REDD+ forward.

4. Lessons learned from CARPE

This section focuses on three focal areas of the CARPE landscape approach: land use planning, policies and governance, and monitoring. The lessons presented here are mainly a synthesis drawn from the CARPE publication: "Landscape-scale conservation in the Congo Basin: Lessons learned from CARPE" (Yanggen et al., 2010). Such lessons are then further analyzed to better understand landscape attributes, principles and concepts related to the CARPE landscape conservation approach.

4.1 Land use planning (LUP)

CARPE's Landscape LUP process uses a participatory multi-stakeholder approach that involves diverse actors. This participatory approach is highly solicited for planning, implementing and resolving conflicting and diverse interests within a landscape approach framework (Reed, 2008; Bernard et al., 2013). These processes include explicit efforts to manage potential tradeoffs and synergies between both conservation and livelihood-development objectives instead of conservation alone. In this process, CARPE supports and funds community micro-projects providing alternative livelihoods options for the communities. In doing so, local communities are provided with incentives to uptake more sustainable agricultural practices and other interventions within conservation areas, mapped as part of the LUP process. The timing of the new micro-projects should, however, be thoroughly discussed and carefully planned as some scholars (Kareiva et al., 2007) caution that potential tradeoffs involved in the uptake of the micro-projects may create problems if the changes in activities occur abruptly. To avoid such pitfalls and make the interventions work, the CARPE landscape approach engages communities and other stakeholders at the initial planning stage of the LUP process to discuss their interests and values. In this process, the implementation of the CARPE landscape approach has learned that management, implementation and monitoring are much easier and less complex when a LUP is within one government district, department, region or province. By implication, these administrative boundaries represent boundaries for reporting units. The reporting units in the case of CARPE are often large in size, which in turn avoids fragmentation (Wu, 2004) and maintains connectivity and interactions between species (Moser et al., 2007).

4.2 Policy, governance and monitoring

Although the CARPE landscape conservation approach, as a program of USAID, is an externally driven process, its successful implementation on the ground is partially due to the efforts dedicated to strengthening the multiple local and national governance and policy arenas within the different Congo Basin countries. Despite these governance and policy arenas being weak in many of the countries having low capacity to effectively support the CARPE landscape approach, the CARPE program has taken a 'muddling through' (see Sayer et al., 2009) approach, helping to strengthen the various governance and policy frameworks within their landscape approach process. They have done this by providing trainings and the building capacity of civil society organizations (CSO) to participate in policy process, advocacy, and the implementation of activities on the ground. In this process, the CSOs are learning, building their skills, becoming more empowered, promoting the rule of law and strengthening their voices. As a result, on the whole, they are becoming more respected by the government. This promoted learning process provides new knowledge and a basis for adaptive collaborative management of natural resources (Sayer et al., 2013). Active and continual learning in the CARPE landscape approach is further highlighted through the adoption of participatory, dynamic learning by adopting a monitoring and evaluation approach that facilitates project planning and objective setting in partnership with project implementing partners. The learning process gives opportunities to stakeholders and project partners to set standards and baselines upon which progress and achievements are measured.

5. Implications for implementing DRC's ERP

5.1 Implementation of conservation and development activities

The nature of the proposed activities under the DRC's ERP intends to address multiple conservation and development objectives and functions. In line with this, the ERP landscape approach in the DRC outlines five conservation and development objectives and benefits linked to carbon and biodiversity ecosystem services long-term livelihood security and well-being, statutory and customary rights to resources, and finance and good governance. In this context, the DRC ERP can adapt some of CARPE's landscape activities in its approach.

Looking at the objectives, expected benefits and the implications of CARPE, there is a dichotomy between socio-economic development (livelihoods and rights) and conservation (biodiversity and carbon) priorities that need to be carefully managed as they may involve tradeoffs; a focus on environmental benefits may undermine social and economic benefits and vice versa. Local activities and practices linked to poaching, fire, land clearing and forest encroachment, although motivated usually to meet livelihood needs, are also threats to biodiversity conservation and drivers of deforestation creating a points of conflict. Environmental education and awareness, and livelihood alternatives and improvements is a crucial first step in bridging the different conservation and development priorities. LUP activities further provide opportunities to identify and map clear boundaries for addressing different conservation and development activities, and clarify and strengthen the rights of indigenous peoples and local communities over natural resource management and utilization.

5.2 Governance and funding model

The government of the DRC is not directly included in CARPE's agreements with conservation organizations such as WWF, WCS, Conservation International (CI), etc. However, the CARPE landscape program works on the ground with the government agency, ICCN, in charge of the conservation of nature. This indirect way of working with the government of the DRC is a compromise between ensuring their inclusion within the process without relying on their direct support as their governance system is still weak and lacking capacity (Transparency International, 2010). Therefore, the governments of the DRC and other Congo Basin countries arguably have no direct ownership of the CARPE process and outcome – even if CARPE is partly supporting the DRC's ERP. This approach is the contrary of the ERPs where the State is the leading institution and has a clear and formal role in steering the whole process. To maximize legitimacy and effectiveness of the governance of DRC's ERP at the landscape level, Aquino and Guay (2013) propose a dynamic hybrid national governance structure that consists of an independent national REDD+ fund and a regulatory process made up of command and control policy and market elements that involve public, private and civil society organizations. This is different from the current practices of CARPE. The CARPE approach gets funds mainly from the governments of USA and Norway and gives the funds to conservation organizations that channel a small part to civil society and community-based organizations to implement targeted activities on the ground.

6. Conclusion and recommendations

The ERPs' and CARPE's landscape approaches are important and promising programs to address the multiple, diverse and conflicting conservation and development activities in the Congo Basin forests. While they are increasingly converging in many ways, the newly introduced ERP landscape approach in the DRC is learning from past and ongoing activities of the CARPE landscape conservation approach. Even though the CARPE program is just one of the many partner institutions involved in the DRC's ERP, it has however a clearly defined niche for contribution linked to biodiversity issues, land use planning, and outreach activities that can influence the conservation and development outcomes of the ERP landscape approach. The ERPs' and CARPE's landscape approaches have different entry points and governance structures, but they all lead to similar destinations in terms of conservation and development objectives, activities and outcomes.

This chapter recommends that contributions from the CARPE landscape approach are inevitable for the successful implementation of the DRC's ERP landscape approach. Before the end of the third and final phase in 2020, the CARPE landscape approach should continue to generate new knowledge and contribute in capacity building especially within the civil society organizations from the local to the national levels. In this way, the government and the people of the DRC should be in charge of fully implementing their ERP landscape approach to create conservation and development benefits through the program's activities.

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Disclaimer

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References

Achard, F., DeFries, R., Eva, H., Hansen, M., Mayaux, P., & Stibig, H. J. (2007) Pan-tropical monitoring of deforestation. *Environmental Research Letters*, 2, 045022.

Angelstam, P., Grodzynskyi, M., Andersson, K., Axelsson, R., Elbakidze, M., Khoroshev, A., … Naumov, V. (2013). Measurement, collaborative learning and Research for sustainable use of ecosystem services: landscape concepts and Europe as laboratory. *AMBIO*, 42, 129 -145.

Aquino, A., & Guay, N. (2013). Implementing REDD+ in the Democratic Republic of Congo: An analysis of the emerging national REDD+ governance structure. *Forest Policy & Economics*, 36, 71-79.

Bernard, F., Minang, P. A., van Noordwijk, M., Freeman, O. E., & Duguma, L. A. (Eds) (2013). *Towards a landscape approach for reducing emissions: Substantive report of Reducing Emissions from All Land Uses (REALU) project*. Nairobi, Kenya: World Agroforestry Centre (ICRAF).

Bierregaard, R. O. J., Lovejoy, T. E., Kapos, V., Santos, A. A. D., & Hutchings, R. W. (1992). The biological dynamics of tropical rainforest fragments: a prospective comparison of fragments and continuous forest. *BioScience*, 42, 859–866.

Blake, S., Strindberg, S., Boudjan, P., Makombo, C., Bila-Isia, I., Ilambu, O. … Maisels, F. (2007). Forest elephant crisis in the Congo Basin. *PLoS Biol*, *5*(4), e111. doi:10.1371/journal.pbio.0050111

CAFEC (Central Africa Forest Ecosystems Conservation). (2013). *Request for application (RFA) number RFA-660-13-000001: Central Africa Forest Ecosystems Conservation (CAFEC).* Kinshasa, Democratic Republic of Congo: USAID.

CARPE (Central Africa Regional Program for the Environment). (2014). About CARPE. Retrieved from http://carpe.umd.edu/about/index.php

DeFries, R., & Rosenzweig, C. (2010). Towards a whole-landscape approach for sustainable land use in the humid tropics. *Proceedings of the National Academy of Sciences, 107*(46), 19627-19632.

de Marcken, P. (2014). *CARPE II and III: WWF landscape programs.* Washington, DC: Presentation during CARPE partners meeting, January 27-28, 2014.

de Wasseige, C., de Marcken, P., Bayol, N., Hiol, F. H., Mayaux, P., Desclee, B., … Atyi, R. E. (2012). *The Forests of the Congo Basin—State of the Forest 2010*. Luxembourg: Publications Office of the European Union.

Fischer, J., & Lindenmayer, D. B. (2007). Landscape modification and habitat fragmentation: a synthesis. *Global Ecology and Biogeography*, 16, 265–280.

GoDRC (Government of the Democratic Republic of Congo). (2012). *Readiness Plan for REDD 2010-212 (R-PP)*. Kinshasa, DRC: Government of the Democratic Republic of Congo.

GoDRC. (2013). *Stratégie-cadre nationale REDD de la République Démocratique du Congo.* Kinshasa, DRC: Government of the Democratic Republic of Congo.

GoDRC. (2014). *Mai Ndombe REDD+ Emission Reductions Program Idea Note (ER-PIN)*. Kinshasa DRC: Government of the Democratic Republic of Congo.

GoRoC. (2014). Republic of Congo Emission Reductions Program Idea Note (ER-PIN). Brazzaville: RoC: Government of the Republic of Congo.

Kareiva, P., Watts, S., McDonald, R., & Boucher, T. (2007). Domesticated nature: shaping landscapes and ecosystems for human welfare. *Science*, 316, 1866–1869.

Linborg, R., & Eriksson, O. (2004). Historical landscape connectivity affects present plant species diversity. *Ecology, 85*(7), 1840–1845.

Maisels, F., Strindberg, S., Blake, S., Wittemyer, G., Hart, J., Williamson, E. A., … Warren, Y. (2013). Devastating decline of forest elephants in Central Africa. *PLoS ONE, 8*(3), e59469. doi: 10.1371/journal.pone.0059469

Moser, B., Jaeger, J. A. G., Tappeiner, U., Tasser, E., & Eiselt, B. (2007). Modification of the effective mesh size for measuring landscape fragmentation to solve the boundary problem. *Landscape Ecology*, 22, 447–459.

Nayar, A. (2009). Model predicts future deforestation. Projections could help Central African nations in Copenhagen climate talks. *Nature*, doi: 10.1038/news.2009.1100

Pope, C., Yoko, A., Ekutsu, E., Molouba, Y., Erikisson, J., & Lumingu, C. (2013). *Salonga-Lukenie-Sankuru landscape*. Power point presentation during WWF CARPE III planning workshop, 25 June 2013, Kinshasa, DRC.

Reed, M. S. (2008). Stakeholder participation for environmental management: A literature review. *Biological Conservation, 141*(10), 2417–2431.

Sayer, J. (2009). Reconciling conservation and development: Are landscapes the answer? *Biotropica, 41*(6), 649–652.

Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J., Sheil, D., … Buck, L.E. (2013). Ten principles for a landscape approach to reconciling agriculture, conservation and other competing land uses. *Proceedings of the National Academy of Sciences, 110*(21), 8349-8356.

Steel, L., & Yoko, A. (2010). Community-based natural resource management land use planning: Lessons learned from the Monkoto Corridor CBNRM Zone. In Yanggen, D., Angu, K. & Tchamou, N. (Eds.), *Landscape-scale conservation in the Congo Basin: Lessons learned from CARPE.* Gland, Switzerland: IUCN.

Transparency International. (2010). *Global corruption report: Climate change.* Berlin, Germany: Transparency International.

Tylianakis, M. J, Laliberté, E., Nielsenc, A., & Bascompte, J. (2010). Conservation of species interaction networks. *Biological Conservation, 143*(10), 2270–2279.

World Bank, (2013). *Deforestation trends in the Congo Basin. Reconciling economic growth and forest protection.* Washington, D.C.: World Bank.

Wu, J. (2004). Effects of changing scale on landscape pattern analysis: scaling relations. *Landscape Ecology*, 19, 125–138.

Yanggen, D., Angu, K., & Tchamou, N. (Eds.) (2010). *Landscape-scale conservation in the Congo Basin: Lessons learned from CARPE.* Gland, Switzerland: IUCN.

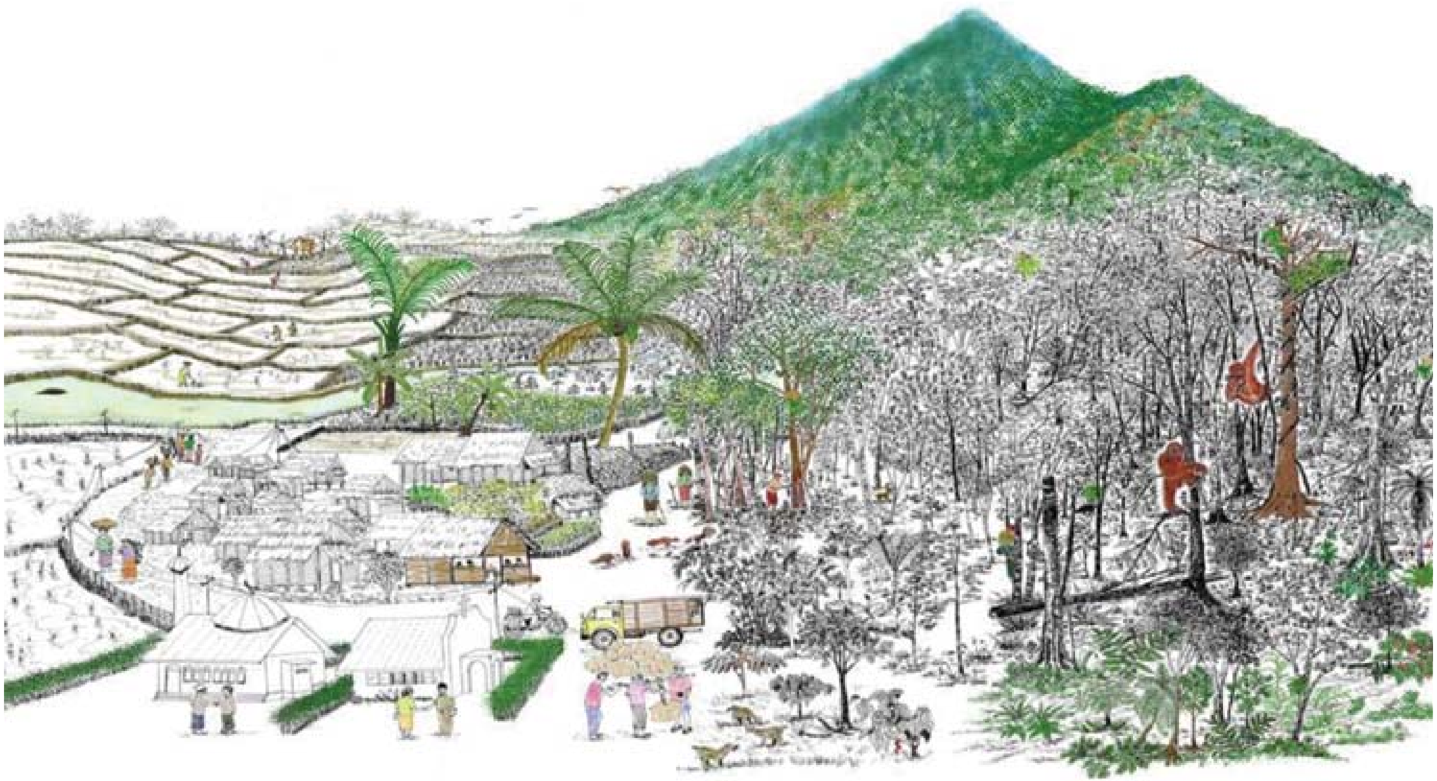
Zhang, Q., Justice, C. O., Jiang, M., Brunner, J., & Wilkie, D. S. (2006). A GIS-based assessment on the vulnerability and future extent of the tropical forests of the Congo Basin. *Environmental Monitoring and Assessment,* 114, 107–121.

PART

6

Synthesis and Conclusions

Landscape as a gradient from rice fields to village, agroforest and remaining natural forest in North Sumatra; the drawing was developed jointly with villagers to emphasize conservation options other than eviction of villages and creating a national park. See further information in Clark et al. (2011). Artist: Wiyono



CHAPTER

26

The future of landscape approaches: interacting theories of place and change

Meine van Noordwijk, Peter A. Minang, Olivia E. Freeman, Cheikh Mbow and Jan de Leeuw

Highlights

- Theories of (desirable) change, driving (co)investment in the trajectories landscapes will take, will need to be firmly rooted in a theory of place to reduce the chance of failure and increase the likelihood of success at scale
- Common theories of place include the way all major asset types (natural, human, social, built-up and financial capitals) interact in major similarity domains
- Specific theories of change at the landscape scale can best be constructed ('co-produced') together with all stakeholders after an initial assessment and awareness phase
- Generic theories of change need to reconcile three knowledge value chains: 1) relating process- and system-level understanding to urgency and feasibility of action; 2) linking on-the-ground action and supportive policy reform to understanding as framed in multiple knowledge systems; and 3) reassessment of preferred solutions and early diagnosis of next-generation issues that emerge during implementation at scale

1. Introduction

In this chapter we come back to the full set of propositions introduced in Chapter 1 of this book. Through the preceding chapters we learned of the need to consider the full cross-scale complexity of Figure 26.1, with global change drivers interacting (generally with strong effect from the global to local scale and weak feedback from the local to global), through their national translation in development policy and its implementation, to the set of feasible landscapes, as well as the factors that determine the appropriateness of the current landscape within this range of feasible solutions.

All preceding chapters dealt, for different contexts and place, with the contrast between change as currently happening in the various landscapes in business-as-usual scenarios and patterns of change that are deemed desirable. Place is more than a geographic location and the measurable properties that are associated with it. It includes a 'sense of place' and a 'sense of identity' of the people living there, and those that trace their historical family roots there and still want to engage in its future. Landscapes contextualize farms and

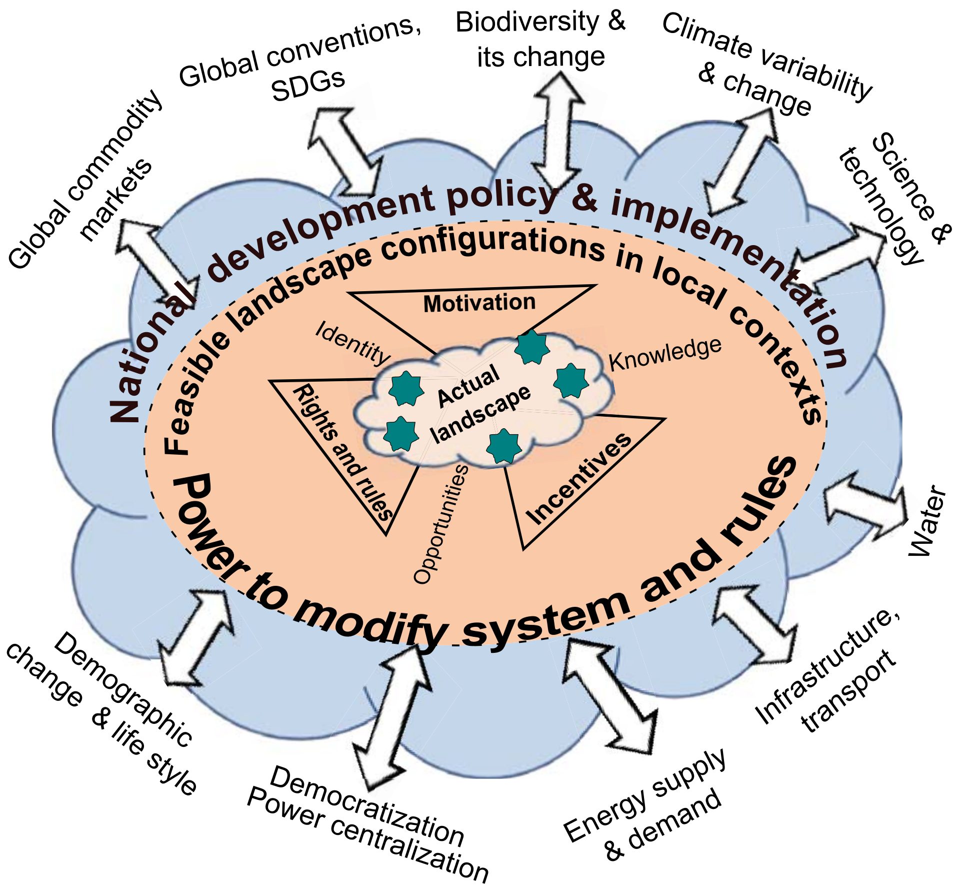


Figure 26.1 Combination of Figures 1.2 and 1.3, showing the overall complexity of the way landscapes as socio-ecological systems interact with a wider national and global system scales, as well as with households and (gender and wealth differentiated) individual livelihood strategies.

livelihood options of the people living in an area, as part of multi-dimensional change, socio-ecological resilience and adaptation to past pressures and expected future change (van Noordwijk et al., 2011; de Leeuw et al., 2013). They influence the biophysical aspects (potential land productivity, microclimate) of plots and farms, especially where lateral flows such as water, nutrients, biota or fire are involved. They also shape the portfolio of activities that provide year-round opportunities for rewarding the use of labour.

In this concluding chapter we will reflect on the way 'theories of place' (ToP) and 'theories of change' (ToC) can be reconciled on the long and winding way towards the 'sustainable development goals' (SDGs). Landscapes have been recognized as an important scale in the Convention on Biological Diversity (CBD)[1], the World Heritage Convention[2] and the European Landscape Convention[3]. Landscape approaches are now accepted to be part of the agenda for international agricultural research (see Box 26.1) and within the development agenda (see Mbow et al., Chapter 8 of this book on the SDGs). This means that beyond advocacy to get them accepted, we now need to deal with all the obstacles to make them fully functional.

The many case studies and context-based information on the practicability of climate-smart landscapes that has emerged so far is the building materials for harnessing a generic 'ToC' that aligns with current 'ToP' as a way of contextualizing sustainability. We will first discuss what has so far emerged as ToP, before relating this to ToC (see Box 26.2 for formal definitions).

Box 26.1

New directions for international agricultural research

In the October 2014 version of the proposed Strategic Results Framework for the CGIAR it is proposed that this consortium of fifteen international research centres focuses its research on three broad domains:

1. Addressing commodities within agri-food value chains
2. Managing agro-ecosystems and landscapes
3. Enhancing voice and participation of low- and middle-income countries on global issues

In doing so specific attention will be given to three cross-cutting topics of global importance:

A. Women and youth
B. Nutrition and health
C. Climate change

Box 26.2

Working definitions for theories of place and change

Theory of place (ToP): Framework for articulating, describing and analyzing the spatial and contextual aspects of current livelihoods, the business-as-usual projection of ongoing change, and the identity and sense of belonging associated with these.

Theory of change (ToC): Implementable, rational pathways aligned with documented experience, to achieve change that is deemed desirable by funders and acceptable by gatekeepers.

2. Diversity of landscapes and theory of place (ToP) (Proposition A)

The preceding chapters have provided many elements of a ToP, although this may have been largely implicit in many cases. The basic questions of physical and human geography provide a basis for any discussion of landscapes:

Who are the people making a living, influencing and associating with the place,

What are the major land use practices, and

Where are activities located (what is the spatial pattern of land use, remaining forests/wilderness, urban and trade centres) and what is the temporal pattern of change and projections of a business as usual scenario.

Beyond taking the *status quo* for granted, the actual landscape configuration is a member, and likely a suboptimal one, of the set of feasible options for local circumstances (Box 26.3 summarizes what we learned regarding proposition A).

Box 26.3

Proposition A: Current landscapes are a suboptimal member of a set of locally feasible landscape configurations

What we know well enough to act on:

A1. (see Chapters 2, 6, 9, 11, 17 and 22) Landscapes are shaped by human interactions, rather than having an absolute scale requirement. At the landscape scale, bottom-up collective action interacts with top-down governance systems. These systems typically rely on hierarchy, sectoral divisions (e.g., forest versus agriculture) and a strong jurisdictional approach to legality. Bypassing this jurisdictional level offers only short-term gains with long-term costs. Expecting jurisdictions to initiate actions will equally fail.

A2. (see Chapters 2, 4, 7, 13, 14, 15, 17, 18, 20 and 23) Perspectives on sub-optimality are likely to diverge among stakeholders. A negotiation process is essential to move outside the business as usual trajectory. Existing assessment methods relying on participatory methods can function well, but need time and resources. Suggested short-cuts don't work well.

A3. (see Chapters 2, 3, 4, 6, 7, 8, 12, 13, 20, 21 and 24). Improvements towards multifunctionality require retention of what functions well and restoration of what got lost. Current efforts are likely constrained by 1) incomplete diagnosis, 2) insufficient appreciation of consequences, 3) limited capacity to explore the full set of alternative options and interventions, and 4) ineffective shaping of coalitions for change. Therefore, an integrated process is needed to support all links in this chain.

Critical uncertainties to be resolved:

A*1. (see Chapters 3, 4, 6, 8, 9, 11, 14, 15, 20, 21 and 23) We need to better understand the politics of legal pluralism, with the local histories of place and people interacting with generic concepts such as 'indigenous people', constitution, national laws and international agreements. This cascaded interaction shapes and affects the emergence of new types of collective action that are needed for the landscape as a whole to become 'climate-smart'.

A*2. (see Chapters 13, 16, 17, 20 and 22) We need technical appraisal of multifunctionality of the full set of feasible landscapes within local constraints, and better ways to use remotely sensed characteristics in dynamic models of socio-ecological systems, with multiple feedback loops.

A*3. (see Chapters 3, 8, 10, 12, 13 and 20) We need operational metrics for monitoring the current degree of multifunctionality, matching the knowledge systems (local, public and scientific ones) and expectations of the various stakeholders, as these are still limited and in need of testing for robustness. Recent distinctions (Byerlee et al., 2014) between 'technology-based' versus 'market-based' intensification need to be further tested.

Many chapters referred to ToP that includes the way all major asset types (natural, human, social, built-up and financial capitals) currently interact. But beyond describing the current state of these assets, few considered how landscapes can be grouped in major similarity domains. Yet, a typology of similarities is important to achieve wider applications of elements and approaches that appear to work in specific examples. The similarities can be structural/compositional (ecologies) or functional depending to the way land is managed and resources used (livelihood). Both aspects are very context dependent and are usually influenced by past and current policy circumstances and institutional setups.

The 'Landcare' chapter (11) discussed a ToP in which farmed landscapes are responsible for environmental degradation in the absence of collective action for tree-based restoration of functions, but also provided a ToC of how 'Landcare' as platform for collective action can turn the situation around. The 'water-focused' chapter (13) highlighted the flows of water as an important dimension of a ToP, with proposed metrics for integrity of flow buffering, and the need for multistakeholder negotiations to overcome inconsistencies in existing sectoral policies that determine what land uses are allowed where. The 'charcoal production' chapter (14) described a ToP of where and when the use of woodfuel crosses thresholds of sustainable use, and which actions might reduce demand and/or increase supply to restore the balance. The 'gender' chapter (15) explored how gender-specific perception of space and land-use effects on ecosystem services shapes current reality, as a ToP. It also articulated that gender-specific preferences and levels of empowerment in decision-making at household and collective scales can reduce undesirable inequalities. The 'negotiation support tools' chapter (17) used a ToP in which multiple layers of geographic information systems reflect current conditions and ongoing change. It used this as a basis for a ToC in which multi-stakeholder negotiation process around visualized and quantified scenarios, as *ex ante* impact studies, assist in achieving free and prior informed consent for planned change.

3. A landscape approach as a theory of change (ToC) (Proposition B)

We here use 'ToC' in two ways: a) as a description of likely 'business as usual' change in a non-linear dynamic socio-ecological system, and b) as a backdrop for additional interventions to modify local trajectories. In a project-centric world, the b-type theories of change predominate, but are unlikely to succeed unless they are realistic about the a-type, location-specific ToC.

Success of any landscape approach intervention will usually depend on the actors/ stakeholders within the landscape, their interests and level of engagement with the approach itself. To assist in the understanding of both ToP and ToC examining the following questions, beyond the who, what and where, within the context of the specific landscape can prove constructive (see Figure 26.2):

Why the drivers of current patterns, with a special interest in leverage points for nudging trajectories away from 'business as usual',

So what of the consequences of current landscape configuration and land use patterns on ecosystem services, including the provisioning services enhanced in agriculture and forest management, and

Who cares, i.e., the 'stakeholders of externalities', those affected by decisions but without direct influence on these decisions.

The dynamic landscape leaning loop (Figure 26.2) can move to a next iteration if those who care can effectively engage with the primary land users, actors and agencies involved in the 'business as usual' trajectory. Theories of (desirable) change, driving (co) investment in the trajectories landscapes will take, will need to be firmly embedded in a ToP to reduce the chance of failure and increase the likelihood of replication of successes. The relative roles of actors inside and outside the landscape of focus vary between the

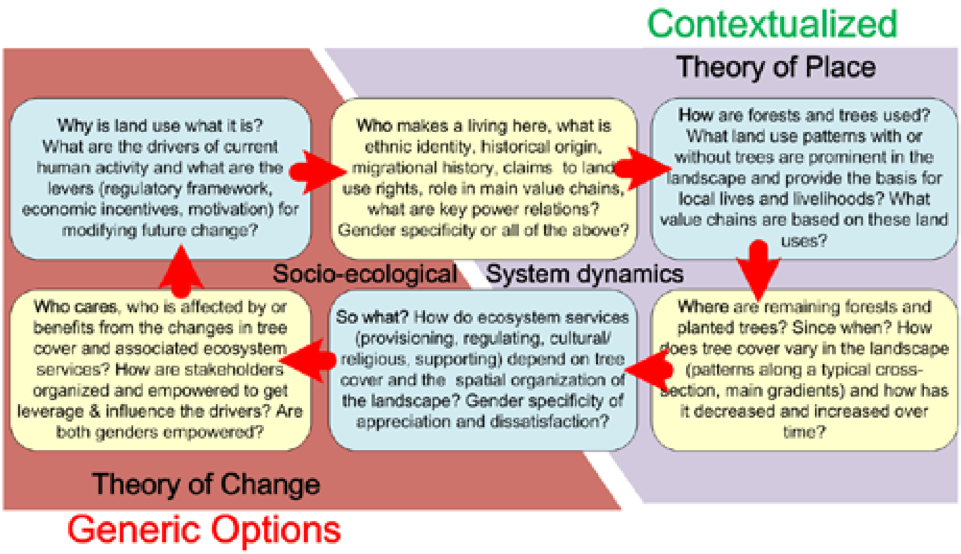


Figure 26.2 The relationship between ToP and ToC at the landscape scale are reflected through the answers to six main groups of questions (van Noordwijk et al., 2013).

cases discussed in preceding chapters. Where existing internal and external actors are associated with *status quo* and business-as-usual trajectories, the seeds for change can come from individuals or small groups inside or from those concerned about undesirable conditions and trends outside. In most cases both are needed to make a difference and form a coalition that can make a difference. Articulation of the set of SDGs (Chapter 8) can help to safeguard against hijacking the agenda of a place for an external priority; the goals formulate supposedly acceptable minimum standards for a wide range of aspects related to development and the welfare of people and the environment, globally.

At the generic level we may find a common pattern in the way issues arise from one or more knowledge systems (science, local or public) and lead to a sense of urgency, feasible targets and suggested entry points for change. Many issues may not get beyond this point of being a concern to a specific group of stakeholders, but some get wider attention and lead to the articulation of a 'specific ToC', if a broader group becomes convinced that it is important. The generic ToC can indicate what the following steps may be (Figure 26.3).

In this context, six roles can be identified for agents of change, knowledge brokers and/or scientists:

1. Basic science of discovery, recognizing patterns, understanding system connections
2. Translating basic science to actionable knowledge on issues that appear to have urgency
3. Bringing different knowledge systems and stakeholders together in joint production of a specific theory of change
4. Piloting (e.g., in 'learning landscapes') ways to achieve desirable change, and identifying issues that deserve further attention for roles 1 and 2, and/or providing a basis for
5. Wider capacity development to broaden the basis for action
6. Supporting a broad-based political platform for change

Within the generic ToC, three knowledge value chains can be identified (van Noordwijk et al., 2014*a*): the steps from basic science to actionable knowledge, the way knowledge is linked to policy action and increased ability to act, and the broader learning loop that connects the current to future issues (see Figure 26.3).

Within this generic scheme, specific ToC's sketch a logical chain of events that can lead to desirable change, but they have to consider the many ways in which unintended private use of new opportunities distracts from the publicly stated goals. A comprehensive framework of human decision-making that includes behavioural (pico) economics, meso-scale environmental economics of financial incentive systems as well as planetary-boundary ecological (giga) economics is needed to underpin credible theories of change (van Noordwijk et al., 2012). Many chapters refer to the micro- and meso-scale, a few include the pico- and macro-scales, but the giga-scale of planetary boundaries is still heavily contested where it imposes restrictions on the sum total of anthropogenic change to the planet. Box 26.4 summarizes the experience in this book, mostly process-based, on how specific ToC, that are described as 'landscape approaches', can function.

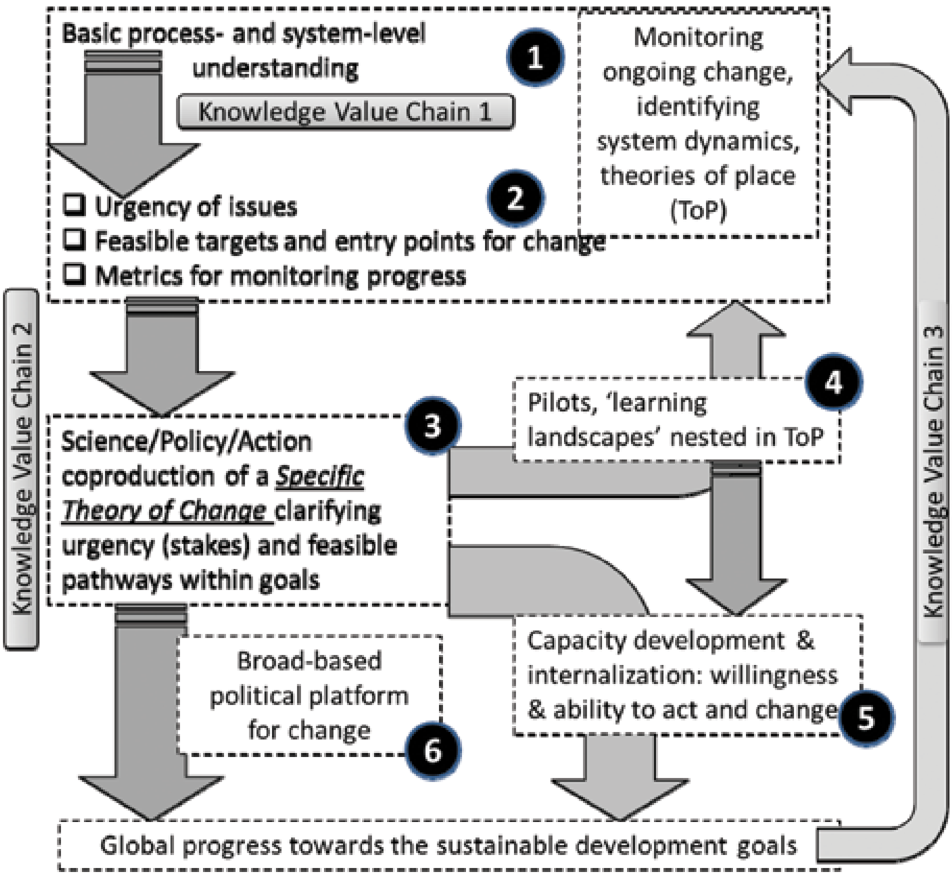


Figure 26.3 Generic ToC for global progress towards the SDGs, by combining six roles for agents of change (see text) and three knowledge value chains: 1) from generic to specific understanding, 2) from knowledge to action, and 3) from action to next-generation challenges.

Box 26.4

Proposition B:
Actors and interactions can nudge landscapes towards better managed tradeoffs within the set of feasible configurations, through engagement, investment and interventions

What we know well enough to act on:

B1. (see Chapters 2, 6, 7, 9, 19 and 23) External stakeholders who engage and invest in landscapes to influence ongoing change, need to ensure moral as well as jurisdictional legitimacy, by attention for perceived fairness, empathy with local agenda's and awareness of political subtexts.

B2. (see Chapters 6, 7, 10, 11, 13, 19 and 24) When designing and implementing an incentive system for better landscape management, 'co-investment in stewardship' may be more effective than a language of payments. Balancing the basic governance instruments of rights, incentives and suasion requires full understanding of their interactions in the local context.

B3. (see Chapters 7, 8, 9, 11, 17, 20, 21, 23 and 24) The governance paradigms used at the landscape scale in balancing rights, incentives and suasion can differ from those used at national and international scales. A multi-paradigmatic approach to polycentric governance has consequences for accountability and transparency that requires specific attention.

Critical uncertainties to be resolved:

B*1. (see Chapter 5, 6, 17, 21 and 23) We need to find new ways to ensure that commitments to 'free and prior informed consent' apply to all external interventions that increase resource extraction and environmental degradation, and not only to those that support environmental services (such as Reducing Emissions from Deforestation and forest Degradation (REDD+)), as the current asymmetry favours degradation over restoration.

B*2. (see Chapters 7, 9, 15 and 18) We need to further assess individual (and often gender-specific) and collective motivation and behaviour that shapes the landscape through land-use decisions and how landscape governance instruments interact with intrinsic motivation and collective action.

B*3. (see Chapters 4, 5, 6, 7, 9, 11, 16, 19, 20 and 25) We need better tested integral planning tools, with transparency at scale transitions if a multi-paradigmatic approach is used, that relates payments at the national scale to investments at the local scale.

4. Climate-smart landscapes? (Proposition C)

As has become clear throughout this book, the current interest in 'climate-smart' landscapes cannot operate in a vacuum. While climate change provides a specific policy entry point for landscape engagement, climate is only one of the many boundary conditions for actual landscapes, and climate change one of the many driving forces that modifies the set of feasible landscape configurations. While the primary relationship between a landscape's land cover and climate at any location on earth is expected to come through greenhouse gas emissions, the more local micro- and meso-effects are gaining in recognition (Moore et al., 2012; Chapter 13). Box 26.5 summarizes the findings of the book chapters on Proposition C.

A specific ToP that has been attractive to much of the literature on climate-smart landscapes is the forest transition or tree-cover transition theory. The basic idea of non-linear dynamics of forest cover at national or landscape scales has been around for more than 20 years (Rudel, 1998; Mather & Needle, 1998), with the empirical evidence reviewed by Meyfroidt and Lambin (2011). Byerlee et al. (2014) recently suggested that 'technology-based' intensification tends to have a land sparing effect helping to conserve forests, while 'market-based' intensification can at least locally have an opposite effect. This could be an interesting element of 'ToP' to test further, supposing that the two types of intensification can indeed be separated in practice. Meyfroidt et al. (2014) analysed the multiple pathways of commodity expansion in tropical forest landscapes and found that patterns indeed differed between commodities, urging for more empirical specificity of current generic theories.

The 'forest transition theory' has been presented as both a ToP and a ToC, depending on the spatial or temporal dimension used as its x-axis. It has proven to be a powerful rallying point for structured thinking about the wide diversity of settings global development agenda deals with, but it remains to be seen that it is a sufficiently precise framework for dealing with the specific challenges and opportunities of any place. A recent exploration of the way forest transition 'configurations' influence the way food security is achieved,

Box 26.5

Proposition C: Climate is one of many boundary conditions for landscape functioning

What we know well enough to act on:

C1. (see Chapters 3, 6, 8, 16, 18 and 25) Operational synergy is feasible at the landscape scale between climate change adaptation and mitigation (reduction of net greenhouse gas emissions). The forces that urge to keep separate adaptation and mitigation agenda's and funding streams at higher policy levels need to be challenged on the basis of track record and efficiency in reaching both goals.

C2. (see Chapters 8, 10, 12, 18 and 24) Current trends toward landscape simplification reduces landscape multifunctionality and leads to increasing vulnerability of local communities' livelihoods. These trends may need to be reversed as priority action to secure climate-smart outcomes.

C3. (see Chapters 12 and 13) Relative to current focus on changes in carbon stocks and its links to global climate change, land use effects at micro- and meso-scales on water flows, including terrestrial influences on rainfall, deserve more attention in landscape approaches.

Critical uncertainties to be resolved:

C*1. (see Chapters 3, 7, 8 and 10) We need a deeper understanding of conditions for real synergy and policy coherence and the opportunity for an integral SDG agenda to transcend the silo's that current conventions and implementation modes are building and protecting.

C*2. (see Chapters 19, 20 and 21) We need metrics that assess loss and gain of buffering of livelihoods, to be used in guiding public-private partnerships, including those that are deemed to be climate-specific.

C*3. (see Chapters 10 and 13) New ways are needed to relate landscape-scale water management to higher scale influences on rainfall and its variability, including the site-specific teleconnections.

challenged and perceived (van Noordwijk et al., 2014*b*) gives some indication that it can be used productively. Yield gap analysis can show where more efficient use of agricultural land can spare land for other functions, but more comprehensive efficiency gap analysis suggests that conventional ways to close yield gaps create other problems of resource use inefficiency (van Noordwijk & Brussaard, 2014).

Duguma et al. (2014*a*; *b*) explored how the currently segregated agendas on climate change adaptation and mitigation can move towards real synergy, but such change that seems perfectly logical on the ground at the landscape scale, faces major roadblocks at the international level. The past decade of discussions on getting 'forests' on the climate change agenda have shown that it is politically convenient to use a vaguely defined concept as a rallying point for stakeholders with multiple, and potentially conflicting interests. But to become policy-relevant, rather than politically convenient, sharp definitions and delineations are needed. The 'forest' agenda doesn't have the required definitional clarity and can only hope to be addressed as part of a wider 'landscape' approach (Matthews et al., 2014). We need to make sure that the landscape agenda does not meet a similar fate of attracting attention but not translating it to action. To make it operational those defining the modalities probably need to bite the bullet and firmly link the landscape approach to jurisdictional entities of local government, if we want it to lead to action. Despite substantial investment in 'readiness' for REDD+ implementation, there still are major gaps in connecting the links to become a functioning chain (Minang et al., 2014).

5. Discussion and way forward (Proposition D)

Drawing on a range of experience, theories, tools and methods, this book, on the whole, has argued for integrated approaches to address complex social-ecological challenges (such as climate change) within landscapes. By understanding ToP within specific landscapes an appropriate ToC can be developed to facilitate desirable multifunctional landscapes. While such processes may not always be so straight forward requiring them to be iterative and adaptive, they can still be very constructive in finding innovative and integrated solutions as demonstrated through the numerous case studies presented throughout this book.

While there is no specific formula for applying an integrated climate-smart landscape approach, there are many tools and methods which can used to assist in this process, the specifics of which will be largely context dependent (see van Noordwijk et al., 2013 for a compilation of 49 such methods and Catacutan et al., 2014 for tools with a gender focus). Box 26.6 summarizes lessons learned in the various chapters of the book regarding Proposition D, specific to the way ToP and ToC interact.

The generic ToC of Figure 26.3 provides some guidance on the complementary roles of scientists and knowledge brokers that can jointly support change – while any of the roles if weakly performed can lead to stalled processes and lack of timely actions. As the roles have rather different requirements and individuals as well the institutions that host them tend to specialize, a broad coalition of partners is needed to make progress. While some resource competition can be expected to drive perspectives that any of the six roles is more important than others and more deserving of public funding, it is only in synergy that the wicked character of the development agenda can be transformed into manageable challenges.

Box 26.6

Proposition D:
Theories of change must be built within theories of place for effective location-specific engagement

What we know well enough to act on:

D1. (see Chapters 4, 7, 9, 11, 13, 22 and 23) The best way to ensure that ToP, including issues of identity and rights, inform ToC is to have early and strong involvement of local voices in any change process that is seen as externally desirable.

D2. (see Chapters 17 and 25) The tree cover (or forest) transition relationship with demography provides a useful typology of domains of landscape and livelihood similarity within broad climatic zones. It can primarily apply at subnational rather than national scales.

D3. (see Chapters 7, 8, 16, 21 and 23) Outcomes of socio-ecological system change at the process-level, e.g., through changes in human capacity and motivation, are likely to be more profound and sustainable than modified values for state variables, such as carbon stocks. Current 'results-based management' focus on what can be quantified may distract from what matters most.

Critical uncertainties to be resolved:

D*1. (see Chapters 8, 15 and 18) Building on ongoing analyses of gender specificity of landscape appreciation and preferences, further ways are needed to ensure women, youth and underprivileged groups can more effectively influence decision processes.

D*2. (see Chapters 4, 6, 7, 11, 18 and 25) New ways are needed to deal with the boundary between forest-institutional and agrarian perspectives on land and its tree cover, and to use this as a typology and framing for government resource allocations and development planning.

D*3. (see Chapters 6, 18, 19 and 21) With accountability for research and development interventions currently focused on measurable 'impact', ways to record impact on the higher-leverage aspects of dynamic systems are needed beyond the concrete metrics of state variables.

Endnotes

1 http://www.cbd.int/convention/
2 http://whc.unesco.org/en/conventiontext/
3 http://www.coe.int/t/dg4/cultureheritage/heritage/Landscape/default_en.asp

References

Byerlee, D., Stevenson, J., & Villoria, N. (2014). Does intensification slow crop land expansion or encourage deforestation? *Global Food Security*, 3, 92–98.

Catacutan, D., McGaw, E., & Llanza, M. A. (2014). *In Equal Measure: A User Guide to Gender Analysis in Agroforestry*. los Banos: World Agroforestry Centre.

Clark, W.C., Tomich, T. P., van Noordwijk, M., Guston, D., Catacutan, D., Dickson, N. M., & McNie, E. (2011). Boundary work for sustainable development: natural resource management at the Consultative Group on International Agricultural Research (CGIAR). *Proceedings of the National Academy of Sciences*. doi:10.1073/pnas.0900231108

de Leeuw, J., Njenga, M., Wagner, B., & Iiyama, M. (Eds.) (2013). *Treesilience: an assessment of the resilience provided by trees in the drylands of Eastern Africa*. Nairobi, Kenya: World Agroforestry Centre (ICRAF).

Duguma, L. A., Wambugu, S. W., Minang, P. A., & van Noordwijk, M. (2014*a*). A systematic analysis of enabling conditions for synergy between climate change mitigation and adaptation measures in developing countries. *Environmental Science & Policy*, 42, 138-148.

Duguma, L., Minang, P. A., & van Noordwijk, M. (2014*b*). Climate change mitigation and adaptation in the land use sector: from complementarity to synergy. *Environmental Management, 54*(3), 420-432.
Mather, A. S., & Needle, C. L. (1998). The forest transition: a theoretical basis. Area, 30(2), 117-124.
Matthews, R. B., van Noordwijk, M., Lambin, E., Meyfroidt, P., Gupta, J., Verchot, L., ... Veldkamp, E. (2014). Implementing REDD+ (Reducing Emissions from Deforestation and Degradation): evidence on governance, evaluation and impacts from the REDD-ALERT project. *Mitigation and Adaptation Strategies for Global Change, 19*(6), 907-925.
Meyfroidt, P., & Lambin, E. F. (2011). Global forest transition: prospects for an end to deforestation. *Annual Review of Environment and Resources*, 36, 343-371.
Meyfroidt, P., Carlson, K. M., Fagan, M. E., Gutiérrez-Vélez, V. H., Macedo, M. N., Curran, L. M., ... Robiglio, V. (2014). Multiple pathways of commodity crop expansion in tropical forest landscapes. *Environmental Research Letters, 9*(7), 074012.
Minang, P. A., van Noordwijk, M., Duguma, L. A., Alemagi, D., Do, T. H., Bernard, F., ... Leimona, B. (2014). REDD+ Readiness progress across countries: time for reconsideration. *Climate Policy*, (ahead-of-print), 1-24. doi: 10.1080/14693062.2014.905822
Moore, N., Alagarswamy, G., Pijanowski, B., Thornton, P., Lofgren, B., Olson, J., ... Qi, J. (2012). East African food security as influenced by future climate change and land use change at local to regional scales. *Climatic change,110*(3-4), 823-844.
Rudel, T. K. (1998). Is there a forest transition? Deforestation, reforestation, and development. *Rural sociology, 63*(4), 533-552.
van Noordwijk, M., & Brussaard, L. (2014). Minimizing the ecological footprint of food: closing yield and efficiency gaps simultaneously? *Current Opinions on environmental Sustainability*, 8, 62–70.
van Noordwijk, M., Hoang, M. H., Neufeldt, H., Öborn, I., & Yatich, T. (Eds.)(2011). How trees and people can co-adapt to climate change: reducing vulnerability through multifunctional agroforestry landscapes. Nairobi, Kenya: World Agroforestry Centre (ICRAF).
van Noordwijk, M., Leimona, B., Jindal, R., Villamor, G. B., Vardhan, M., Namirembe, S., … Tomich, T. P. (2012). Payments for Environmental Services: evolution towards efficient and fair incentives for multifunctional landscapes. *Annual Review of Environment and Resources,* 37, 389-420.
van Noordwijk, M., Lusiana, B., Leimona, B., Dewi, S., & Wulandari, D. (Eds). (2013). Negotiation-support toolkit for learning landscapes. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.
van Noordwijk, M., Matthews, R. B., Agus, F., Farmer, J., Verchot, L., Hergoualc'h, K., … Dewi, S. (2014*a*). Mud, muddle and models in the knowledge value- chain to action on tropical peatland issues. *Mitigation and Adaptation Strategies for Global Change, 19*(6), 887-906.
van Noordwijk, M., Bizard, V., Wangkapattanawong, P., Tata, H. L., Villamor, G. B., & Leimona, B. (2014*b*). Tree cover transitions and food security in Southeast Asia. *Global Food Security,* dx.doi.org/10.1016/j.gfs.2014.10.005i

Landscape democracy in action; community consultations in Vietnam. Photo credit: Pham Duc Thanh

CHAPTER 27

Enhancing multifunctionality through system improvement and landscape democracy processes: a synthesis

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Highlights

- Landscapes are complex socio-ecological systems with competing land uses and a range of stakeholders with multiple, diverse, and sometimes conflicting objectives
- Multiple tools' processes, often combined in ways that can capture and manage complexity, embrace uncertainty and enable tradeoffs and synergies, are required
- Deliberate attention to process design, implementation and performance can help enhance overall success in implementing a landscape approach
- Democratic/good governance principles, criteria and indicators can help guide and monitor process performance in a landscape approach

1. Introduction

The landscape approach has been increasingly featured in the literature as a viable and reliable approach to reconciling agriculture, conservation, development, climate change and other competing land uses and objectives in the context of sustainability (DeFries & Rosenweig, 2010; Scherr et al., 2012; Sayer et al., 2013). At the same time there is growing recognition that landscapes are complex socio-ecological systems with a mosaic of land uses, multiple stakeholders, with diverse and sometimes conflicting objectives and perspectives. Therefore managing landscapes requires an equally sophisticated approach that can work within the complexity involved. However, such sophistication must not stand in the way of sufficiently pragmatic simplicity required to ensure successful implementation. Hence, the question has arisen on how to best facilitate a landscape approach to enable effectiveness, efficiency and equity in practice. This chapter synthesizes cross-cutting process elements from the chapters in this book and proposes a process-based approach to facilitate sustainable multifunctional landscapes in practice. It also draws on the chapters and some of the examples within, as well as broader literature to highlight and demonstrate the relevance and usefulness of process in a landscape approach.

2. Processes in landscapes: adaptive management as a guide

Landscapes are place-based systems that result from interactions between people, land, institutions (laws, rules and regulations) and values. They are made up of a mosaic of different land uses with landscape patterns and processes being defined by the interactions occurring between social, ecological and social-ecological systems. A landscape approach can then be defined as a set of concepts, incentives and tools for planning and managing land in order to achieve multiple economic, social and environmental objectives. In the definitions above and in several others, there is less emphasis on a well-defined end product and much more emphasis on interactions, actions, tools, methods and incentives, suggesting that 'process' or 'processes' are perhaps what largely defines a landscape and a landscape approach (see Minang et al., Chapter 1, this book for a more rich description of landscapes and landscape approaches).

As such, major attempts at providing guidelines and principles for landscape approaches have all stressed the importance of process. Several of the ten principles for a landscape approach by Sayer et al. (2013) relate to processes. These include: continual learning and adaptive management, negotiated and transparent logic, participatory and user friendly monitoring, and clarification of rights and responsibilities. Frost et al., (2006) also cite several processes in their guidelines for implementing integrated landscape approaches including: multi-scale analysis and intervention, develop partnerships and engage in action research, facilitate rather than dictate, promote visioning and development of scenarios, and foster social learning and adaptive management. Table 27.1 summarizes how the various chapters in this book address processes in the context of landscape approaches.

One specific concept, which is often directly or indirectly referred to in the process of taking a landscape approach, is adaptive management. Applying an adaptive management framework, or taking an iterative approach, provides the flexibility to adapt management approaches to complex evolving social-ecological systems in the management process itself, to better achieve sustainable outcomes. Adaptive management has been defined as a systematic approach for improving management by learning from system outcomes. It recognizes that resource management in landscapes is dynamic, uncertain and complex, hence continued learning, reflection and adjustments are essential elements for success (Holling, 1978; Lee, 1999). The process typically involves, assessing the problems, considering alternatives, predicting outcomes based on current knowledge, implementing alternatives, gaining new knowledge and using the new knowledge to adjust objectives and options (see Figure 27.1). More broadly, adaptive management is used to refer to processes that allow for learning-by-doing (Plummer 2009). It can also be considered a decision-making process that allows for accountability, transparency and experimentation.

Adaptive management has evolved into adaptive collaborative management (co-management in short; ACM). The co-management dimension captures the idea that rights and responsibilities should be shared among actors that claim any sort of stake in a given resource in the landscape (Plummer, 2009). Hence, ACM can be seen as a multi-stakeholder governance system. One that does not only focus on learning and improvement, but also addresses conflicting interests, values, and actions among multiple actors, and equity. It can therefore be seen to have several similarities with the emerging concept of landscape democracy elucidated in Box 27.1.

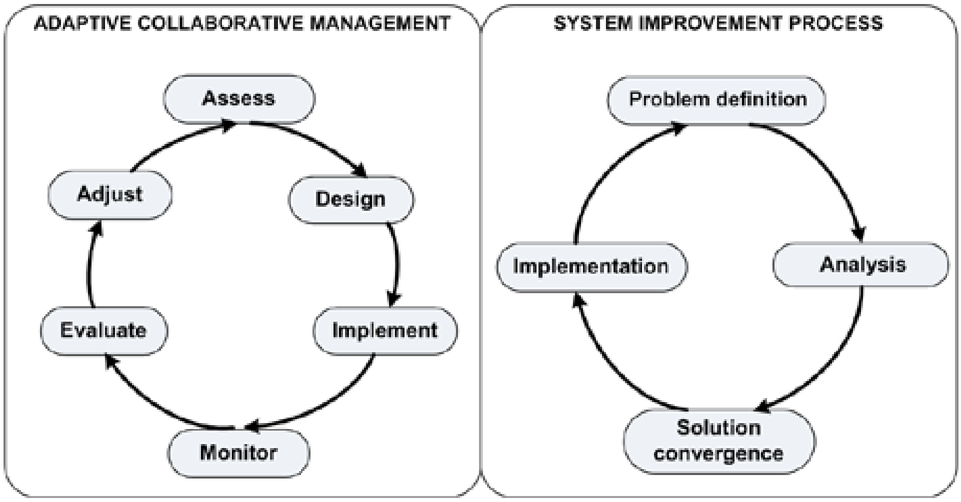

Figure 27.1 An illustration showing both adaptive collaborative management (ACM) and system improvement process (SIP).

Plummer (2009) identifies key determinants of outcomes in ACM. Among the endogenous factors are: properties of networks (i.e., connectivity, centrality), assets employed by agencies, institutions and individuals (i.e., human, social, physical, financial and natural capitals), and key features of individuals and attributes of organizations (e.g., leadership, emotions, capacity, knowledge systems, power, culture, etc.). Among exogenous factors are: social and political contexts, meso-scale drivers of change, and ecosystem changes and resource alterations that perpetuate crisis.

While ACM has been well developed theoretically, implementation has been more challenging, often simplified into a learning-by-doing scenario and less structured to sufficiently handle complexity, uncertainty and feedbacks. Below is a summary of some of the challenges that are encountered in practice:

1. **Transition from process to results:** Adaptive management usually involves long-time frames, implying long waits for results (Jones, 2009). Jiggins and Röling (2002) raised this concern in the context of applying adaptive management to forest management.
2. **Cross-scale problems:** In adaptive management, it is often difficult to prove if the desired changes at the micro-level could actually lead to changes at the macro-level (Jiggins & Röling, 2002; Walters, 1997).
3. **Boundary problems:** Adaptive management is only possible within a defined system boundary. However, there is no objective way of delineating boundaries for social-ecological systems.
4. **High costs of monitoring** (Walters, 1997; Lee, 1999; Jones, 2009)**:** Adaptive management involves monitoring changes over a long period of time (Lee, 1999) and over a large-scale area involving very complex processes and usually significant financial commitments.
5. **Vulnerability to institutional changes:** Institutions are often changing and the long-term nature in adaptive management renders the process vulnerable to such changes (Jones, 2009).

The challenges above can be summarized into two main issues. Firstly, the lack of sufficient understanding and deployment of structured analysis across both spatial and temporal scales (see Minang et al., Chapter 9, this book); and secondly, challenges with facilitating collaborative processes. In the remainder of the chapter, we focus on options for addressing these two challenges in a bid to improve ACM processes within landscapes.

3. A systems improvement process approach

Regarding the first challenge on structuring analysis in landscapes, several potential approaches exist. In looking for one that brings in fundamental change, we identified among others, the Systems Improvement Process (SIP). SIP is a comprehensive analytical framework for solving difficult large-scale social system problems such as sustainability (Harich & Bangerter, 2014). The process centres on root cause analysis, and uses problem decomposition and feedback loop modelling to find and resolve the root causes. This is justified by the fact that the problems addressed in landscapes are 'wicked' and therefore need to be properly analysed and tackled from the roots. Decomposition potentially helps improve understanding of complex issues while modelling helps learning about potential solutions (Checkland, 2000). SIP consists of five main steps: problem definition, analysis, solution convergence, implementation and continuous improvement. Each step has further sub-sets of steps. Figure 27.1 shows the details of each of the steps, but more significantly it shows that the difference between SIP and ACM is the emphasis on analysis of the problem and solutions. SIP suggests that 80% of the time spent in sorting out complex socio-ecological challenges should be spent on problem analysis in a participatory mode in order to identify and build solutions to root causes.

Finding root causes of a problem and looking extensively at high leverage points in the feedback loops should be dominant in resolving the problem (see Duguma & Minang, Chapter 10, this book for details on leveraging systems). At the solution convergence stage, the options are narrowed down to solutions that can work around 'high leverage points', which are then tested. Bringing such structured problem analysis and solution identification into ACM processes could potentially improve sustainable landscape management processes.

4. A process structure

Figure 27.2 summarizes a process framework (referred to as the 'Landscape Process Wheel') that borrows from adaptive management, enhanced with landscape democracy/ governance (Arler, 2011; Colfer & Pfund, 2011) and SIP. It consists of five main components, namely: planning; actions and practices; policies, institutions and capacity; monitoring, evaluation and audit; and participation and negotiations. Beyond the generic adaptive management process cycle of plan, act, monitor, evaluate, and plan, specific emphasis has been put here on practices, policies, institutions, capacity and participation and negotiations because they have emerged in recent years as challenges in successful sustainable landscape management (Fisher et al., 2007; Plummer, 2009). Suffices to mention that in reality the process components mentioned herein above are interlinked and are scarcely linear. We present them here in components for purposes of understanding. The sub-components in the framework are intended as guidance and not by any means exhaustive.

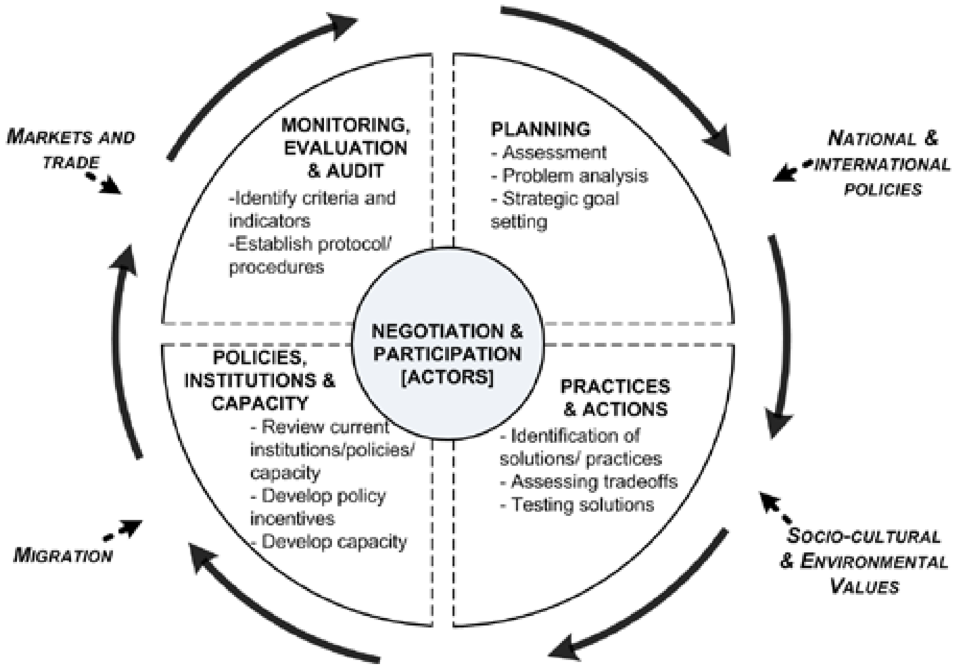

Figure 27.2 The Landscape Process Wheel showing main landscape processes. Text in italics with broken arrows represents the landscape context and external driving forces.

Table 27.1 summarizes how the chapters in this volume address each of these processes. By positioning negotiation and participation as core elements in an ACM process enhanced by SIP, it is our hope that this could potentially address the problem structuring and facilitation challenges of classic ACM identified earlier on in this chapter.

4.1 Planning

Planning processes in landscapes are well documented in the literature (Dalal-Clayton et al., 2003). In generic terms, these processes involve setting out desired goals and a course of action to develop the landscape. Typically such a process will involve identifying the main problems/challenges, analyzing the challenges, identifying solutions and charting course for implementation. The aspect of disaggregated problem (root cause) analysis as a means of improvement through process improvement (Harich & Bangerter, 2014) and leveraging systems in landscapes (as discussed in Duguma & Minang, Chapter 10) can be key parts of this process. Chapters 15 (Villamor et al.), 16 (Suyanto et al.) and 17 (Dewi et al.) of this book offer models for planning across multiple sectors within the context of climate change, and providing tools to identify options within and across different sectors in the landscape (e.g., agriculture, forestry, etc.). Villamor et al. (Chapter 15) specifically looks at the benefits and advantages of using tools for gender-specific spatial analysis while Suyanto et al. (Chapter 16) and Dewi et al. (Chapter 17) focus on identifying low-emission development pathways across sectors. Alternatively, Bernard (Chapters 4) and Louman et al. (Chapter 6) draw on other specific landscape approach planning and management processes looking to experiences of the '*gestion de terroirs*' concept applied in Francophone West Africa, and 'Climate Smart Territories' in Central America, respectively.

Table 27.1 Summary of how chapters in this book address various dimensions of landscape processes.

Process component/sub-component	Book chapter and contribution
Planning • Assessment • Problem analysis • Strategic goal setting	Chapter 2: Defing and understanding the landscape Chapter 9: Scale considerations in landscape analysis Chapter 10: Leveraging systems as an approach to seeking solutions in landscapes Chapter 13: Dealing with multiple knowledge systems Chapter 15: Gender analysis tools/scenario analysis Chapters 16 and 17: Tools for analyzing options Chapters 4, 6, 22: Examples or case studies of planning
Actions and practice • Identifying appropriate solutions/ practices • Assessing tradeoffs and synergies between practices/solutions • Testing solutions	Chapter 3: Seeking multifunctionality through synergies and reducing tradeoffs Chapter 5: Socio-ecological systems approach to analyzing and addressing landscape restoration Chapters 13 and 14: Specific actions for charcoal and water Chapters 16 and 17: Tools for analyzing options Chapters 12 and 23: Scenario analysis of options Chapter 22: An assessment tool to identify needs and opportunities for climate-smart agriculture within the landscape
Institutions/policies/knowledge • Review institutions/policies and capacity (knowledge, skills and attitudes) • Develop policy incentives • Develop capacity	Chapter 13: Multiple governance instruments Chapter 18: Identify and discuss a set of key elements for institutional arrangements for climate-smart landscapes Chapter 23: Shows how institutional change pathways and processes directly impact community forest landscapes in Cameroon Chapters 19, 20, 21: Identify opportunities for the private sector as an institution to invest in landscapes and adopt landscape approaches
Monitoring, evaluation and audit • Identify criteria and indicators • Establish protocol/ procedures • Verification and audit	Chapter 5: Socio-ecological systems indicators Chapter 8: Link to the Sustainable Development Goals (SDGs) and the associated monitoring framework that will be set up Chapter 13: Proposed buffering indicator Chapter 15: Gender analysis tools/scenario analysis Chapters 16 and 17: Tools for analyzing options

Negotiation and participation	Chapter 9: Scale considerations in the facilitation of landscape processes Chapter 13: Introduces a set of tools for evidence-based negotiation support in landscapes approaches Chapter 17: Elaborates on a set of tools for negotiating multiple issues in ecosystem services and emission reductions and provides case studies Chapters 4, 6, 7, 11, 13, 17, 18, 24, 25: All give examples of participatory landscape processes involving negotiations

4.2 Actions and practices

Ensuring that actions taken are effective and efficient is an important element of successful sustainable landscapes. This begins with identification and selection of appropriate practices in the specific landscape context. Sutherland et al. (2011) propose an interesting solution scanning approach for selection management intervention applicable to landscapes. Several multi-criteria tools exist for evaluating and selecting land management practices (Coe et al., 2014). In this book a number of chapters present tools and examples for enhancing actions in landscapes. Focusing on intensification, the socio-ecological systems approach for analyzing and addressing landscape restoration (Duguma et al., Chapter 5) and scenarios for assessing options for sustainable intensification in landscapes (Öborn et al., Chapter 12; Alemagi et al., Chapter 24) provide some insights on how to sustainably apply this at the landscape scale.

Analysing tradeoffs and synergies between actions is extremely important at the landscape level (Freeman, Chapter 3). Therefore, understanding tradeoffs and forging synergy for landscape actions are key processes in taking a landscape approach. Testing options and adapting practices is an important part of the process, in order to discern what works in a given landscape. This requires the participation of a range of different knowledgeable actors within in the landscape.

4.3 Policies, institutions and capacity

Inadequacies in institutions, capacity development and policies are often cited as factors responsible for either the failure or success of landscape initiatives (Martson, 2000). We therefore consider these as important determining elements in landscape processes. Institutions and policies provide the set of values, rules and regulations for engagement and management of landscapes, and hence, are crucial for landscape management. Capacity includes knowledge, skills and resources needed for effective and efficient management of landscapes. A key ingredient here relates to the identification and deployment of traditional and local knowledge alongside scientific knowledge in the context of adaptive management (Berkes et al., 2000).

Wambugu et al. (Chapter 18) identify and discuss a set of key elements for institutional arrangements for climate-smart landscapes. Focusing on community forest landscapes in Cameroon, Foundjem-Tita et al. (Chapter 23) shows how institutional change pathways and processes directly impact the outcome of such community-based initiatives providing some lessons learned. Kissinger et al. (Chapter 19), Gyau et al. (Chapter 20) and Namirembe and Bernard (Chapter 21), specifically focus on the role of the private sector - as one kind of institution - in landscape approaches and opportunities for their engagement.

4.4 Monitoring, evaluation and audit

Monitoring, evaluation and audit are essential processes that provide the basis for reflective learning in landscapes. It is meant to provide observations on progress towards the agreed objectives and actions in the landscape. Clear, agreed and practical indicators for measuring progress are needed, and roles and responsibilities in measuring, analyzing, verifying and recording are crucial. Several authors have emphasized the role of participatory monitoring and evaluation processes that may be as effective and efficient as scientific monitoring (Zahabu, 2006; Brofeldt et al., 2014), but having the advantage of local ownership, added legitimacy and potentially a better chance to use the results to change behaviour in landscapes (Alcorn, 2000). van Noordwijk et al. (Chapter 13) discusses the concept of buffering indicators in landscapes.

4.5 Negotiation and participation

Negotiation is extremely important in arriving at common goals, objectives and sustainable solutions in landscapes. It is one way through which the important element of trust can be generated in multi-stakeholder landscapes. A negotiation process that can bring about trust among actors has to be transparent, fair, equitable and accountable (Caddy & Vergez, 2001). The participation of all stakeholders in decision-making is a necessary pre-condition for such a transparent and accountable process (Arnstein, 1969).

Dewi et al. (Chapter 17) elaborates on a set of tools for negotiating multiple objectives related to ecosystem services and emission reductions and provides case studies of how they are applied in Indonesia. Table 13.2, in Chapter 13 (van Noordwijk et al.), introduces a set of tools for evidence-based negotiation support in landscapes approaches.

Legitimacy demands the participation of all stakeholders in all processes and decision-making, executed in a fair and equitable manner. Sufficient attention has to be paid to women, youth, minorities and disadvantaged groups in the landscape community. Participation can be defined by various types and intensities from lowest to highest: manipulative and passive (information flows between local people and outsiders); consultation and functional participation (facilitators refer focused and specific issues to local people and interpret their responses into a pre-prepared frame); interactive involvement in decision-making by actors in most stages; and initiating actions 'from' and 'owned' by local people (see ladders of participation by Arnstein, 1969; Catley, 1999; Carver, 2003). Chapters 4 (Bernard), 6 (Louman et al.), 11 (Catacutan et al.), 15 (Villamor et al.,) and 18 (Wambugu et al.) all emphasize and provide examples of participatory processes.

This component of processes in a landscape approach is the hub around which the success of all other processes depend. Elements of participation and negotiation are needed for decision-making in all process components.

5. Landscape democracy: a platform for improving processes

We have established in the preceding sections that successful landscape approaches are best facilitated as multi-stakeholder processes, in which ACM is enhanced through systems improvement. Striving to maintain a quality process therefore requires guiding principles and frameworks for monitoring. Democratic or good governance principles,

Box 27.1

Landscape Democracy

Landscape democracy can be defined as the operationalization of democratic and good governance principles (such as transparency, accountability, participation, legitimacy and coordination) in multi-stakeholder processes at the landscape level. Landscapes are multi-stakeholder spaces, often characterized by diverse perspectives, interests and goals. More often than not these interests and goals are conflicting, requiring participatory and highly interactive decision-making processes to bring about sustainable landscapes. This raises questions as to who should make decisions in landscapes and how and why those decisions should be made - hence, the link between democracy and landscapes and the term 'landscape democracy'. Landscape governance can thus be seen as a set of measures of the relationships between the 'governed', i.e., civil society and the public, and the 'governing', i.e., government, its institutions and private sector interests (UNDP, 1997; Caddy & Vergez, 2001).

The European Landscape Convention sees landscape development "… as the concern of all and lends itself to democratic treatment, particularly at the local and regional levels. Landscape democracy has also been seen as an extension of Aldo's Land Ethic (Matrazzo, 2013). Aldo's Land Ethic enlarges the 'community' to include soils, waters, plants and animals or collectively 'the land'. This implies that restoration of sustainable landscapes and the connection between rights and responsibilities and 'land' must be established.

Arler (2011), identifies and discusses relevant values that landscape democracy could build: self-determination (autonomy in decision-making); co-determination and participation (ensuring common good); impartiality and respect for arguments (ensuring deliberation and that well considered decisions are made); and procedures and multi-order impartiality (rules for deliberation that ensure respect and equity). The extent to which these values prevail in landscapes would depend on degrees of centralization, decentralization, and devolution in the country. The principle of subsidiarity in the European Union is a good example on which the concept of landscape democracy has been based. Levels at which decisions can be made in each country can influence sustainable development in landscapes (Colfer et al., 2011). Nonetheless, these values remain important determinants of successful landscape processes.

criteria and indicators have been deployed in participatory process quality assessment and monitoring in natural resource management (Alcorn, 2000; McCall & Minang, 2005). In a critical review of ACM, Prabhu et al. (2007) identify three anchors for success namely, communication and creation of a vision, social learning and joint collective. These anchors dovetail with democratic principles, hence suggesting that landscape democracy is a potential pathway for improving effectiveness and efficiency in landscapes. Box 27.1 introduces the concept of landscape democracy.

We introduce a set of good governance and landscape democracy-based dimensions, criteria and indicators for monitoring and designing landscapes to ensure effectiveness, efficiency and equity. Key dimensions include legitimacy and participation, empowerment, ownership of knowledge and process, respect for local people and indigenous local knowledge, equity and effectiveness and competence. These dimensions are further broken down into criteria and specific indicators for tracking landscape processes (see Figure 27.3 for details). The suggested criteria and indicators set in Figure 27.3 are not intended to be exhaustive, but a guide that is modifiable in different contexts. We

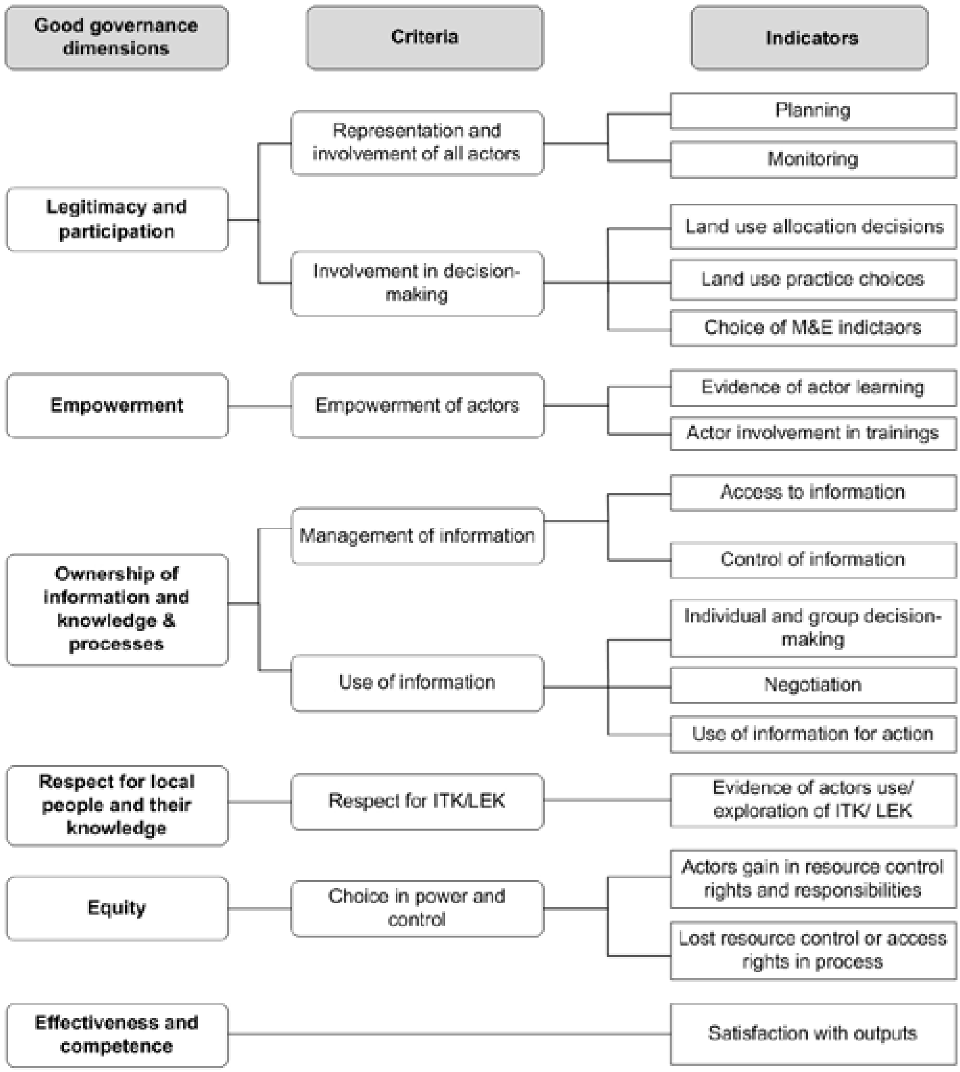

Figure 27.3 A suggested good governance framework for assessing landscape negotiation processes. ITK denotes Indigenous Technical Knowledge, while LEK represents Local Ecological Knowledge. Source: adapted from McCall and Minang (2005).

briefly elucidate on the dimensions in the ensuing text. The legitimacy and participation dimension has already been discussed in the preceding section.

Empowerment: Empowerment is largely derived from the purpose of the agency facilitating the process. This can be seen as a continuum. At one end is 'facilitation'- when participation is used to introduce or endorse an outside agenda - while the other end is 'empowerment' - wherein participation is intended to enhance local decision-making, reinforce responsibilities and amplify the voice of local people (McCall & Minang, 2005). At any point in-between is 'mediation', where the aim is to enable tradeoffs between multiple interests and objectives. These purposes of participation, facilitation, mediation and empowerment (McCall, 2003) are important to keep in mind and look out for in any landscape approach.

Ownership of knowledge and process: Who owns? Who manages? And who has access to what information is an important power variable in participatory decision-making processes. Similarly who controls the process is also important. Having a transparent and open process and giving a voice to each actor is important. These are critical variables of trust not only in terms of decision-making processes but also for eventual implementation.

Respect for local people and indigenous/local knowledge: Local knowledge (both technical and general) is important for two reasons. It can be a measure of community capability to make a difference in landscapes, and is complementary to scientific knowledge. Berkes et al. (2000) found that traditional ecological knowledge constituted in many cases a wealth of knowledge that allowed interpretation and responding to feedback to guide resource management with similarities to adaptive management in terms of feedback learning, and the treatment of uncertainty/unpredictability. Making this part of the analytical, implementation and learning processes in landscapes would be beneficial.

Equity: Landscape processes can impact stakeholders negatively and positively. Being sensitive to stakeholder needs and vulnerabilities and to the power relations between actors in a landscape is extremely useful in landscape processes. As we saw in the facilitating, mediating and/or empowerment dimensions of participation, it is important to monitor the impact and/or potential impacts on actor perceptions, and interests. Gender has emerged as an important dimension to watch in landscape processes (Villamor et al., 2014). It is also important to address the merging specificities of the private sector and any other group needing attention.

Effectiveness and competence: Participatory processes can be quite demanding in terms of time, resources and technical know-how. While accepting uncertainty and risks is expected in an adaptive management process, managing both is not quite easy. These technical and logistical challenges of collaborative stakeholder processes need to be managed in the process as best possible if the expected outcome is to be reached. One way of doing this is to check satisfaction with intermediary outputs and outcomes in the process. Satisfaction with the process and outputs will be the ultimate measure of success.

6. Reflections and way forward

We set out in this book to review experiences and present a set of concepts, tools, methods and incentives that can help professionals, researchers and policymakers better understand and improve landscape approaches. In our journey we have examined four propositions. Firstly, that the current configuration of landscapes is usually far from the potential (Proposition A), that landscape approaches can aim for broader perspectives on multifunctionality than is reflected in the business-as-usual trajectory (Proposition B), that climate change is a small (but important) part of a wider set of necessary landscape functions (Proposition C), and that theories of change need to build on theories of place, for context specific blending of fairness and efficiency.

This chapter sought to explore opportunities for improving multi-stakeholder processes, based on learning from the 25 chapters in this book (Parts 1-5). We found ACM, SIP and landscape democracy as potential building blocks for such an improvement process going forward. However, some salient points for reflection remain. We frame them under two practical implementation perspectives: landscape analysis and understanding and facilitation of actions in landscapes.

6.1 On landscape analysis

Landscapes are complex multi-level systems with multiple components and multiple interactions. As dynamic systems, landscapes are also uncertain and unpredictable therefore embracing uncertainty and capturing complexity in a dynamic way remains an important challenge for working in landscapes. A number of points need to be kept in mind as we take the journey into landscape approaches.

Between 'sophistication' and 'practicality':

This book has assembled and introduced several concepts, tools, methods and incentives for analysing and inducing change in landscapes. There are choice challenges as multiple tools should be combined in ways sophisticated enough to capture and manage complexity, embrace uncertainty and enables tradeoffs and synergies. At the same time such sophistication must not stand in the way of sufficiently pragmatic simplicity required to ensure successful implementation. This dilemma needs further guidance and attention. Clearly tradeoffs exist between increased accuracy and possibilities for local participation, local involvement and local knowledge; integration guidance is needed with respect to tools, methods, and options selection by context (Coe et al., 2014), but also skills and knowledge requirements in the use of the tools.

Between 'precision' and 'accuracy':

How much precision (reproducibility of results under the same conditions) is required? For whom? and for what purposes? are important questions for consideration in landscapes. The implications of sampling size and data requirements for improved accuracy (closeness to real value) and the associated costs represent serious considerations in landscape analysis. For outside certification processes, it might be unnecessary to invest so much when returns on investment may not be as high. This is critical for carbon projects. At current carbon prices of between 2-5 USD per ton in developing countries conservative estimates may be reasonable unless in exceptional circumstances. Spatially aggregating to a 1 km^2 assessment size may reduce uncertainty to an acceptable level with low-cost assessment methods (Lusiana et al., 2014). The main consideration here should be the purpose(s) of the landscape action, and a match of scales for monitoring and action.

Principles of scale:

Scale is a key determinant in understanding, planning and managing landscapes. Stakeholders in a landscape may perceive the landscape and its functioning differently, given their specific interests. Therefore, in seeking to answer the question, what is/are the appropriate scale(s) for analyzing a phenomenon, three pre-requisite considerations might be important. These include: i) *'hierarchy in scale'*- the extent to which phenomena manifest at multiple scales and/or are hierarchical in structure; ii) *'scale effects'*- what changes in patterns and processes can be observed when the scale of analysis changes; and iii) *'scaling'*- what theories, methods and models can be used in extrapolating/translating information across scales? The scale of analysis can be determined by the observer using appropriate criteria and analytical methods (Turner et al., 1989). While several studies exist, there is no consensus on characteristic scales and hierarchical levels for several phenomena (Wu & Qi, 2000). Hence, specific attention and justification is needed for any robust analysis of multifunctional landscapes. Combining the technical understanding of scale with the multiple knowledge systems provides a further challenge.

Metrics for function and process:

One of the most challenging aspects of landscape approaches is the question of metrics for determining multifunctionality or sustainability and metrics for effective, efficient and equitable landscape processes. In this chapter, we have attempted to provide a set of good governance criteria and indicators for process performance assessment, but these are largely qualitative, though quantifiable. Some work is needed to further quantify these dimensions.

There have been attempts at metrics for sustainability in landscapes (Cassatello & Peano, 2011) in a European context and several attempts at sustainable forest landscapes and land management in developing countries (Dumanski, 1997; Sheil et al., 2004) but attempts at metrics that capture systems dimensions of landscapes and are cost effective are still elusive (Torquebieau et al., 2013). Bernard et al. (2014) argued that unsustainability issues are easier to identify than a firm statement of sustainability. Landscapes may represent the appropriate and practical scale at which national and global objectives related to a green economy, the SDGs and/or natural capital accounting can be monitored (See Mbow et al., Chapter 8, on opportunities for linking SDGs with landscapes). This represents an important area of research in the immediate and medium term.

6.2 On facilitating and enabling action

Several chapters in this volume have highlighted the importance of participatory processes in bringing about change in landscapes (Chapters 4, 6, 7, 11, 13, 17 and 18). One major opportunity in landscapes approaches is the potential for harmonising often divergent sectoral policies and activities at the landscape scale through participatory processes especially between agriculture, forestry, environment, mining, livestock, fisheries and others. Still a number of critical issues stand out from these chapters and in the literature.

Synergy and tradeoffs:

Every landscape approach will have multiple actors, with diverse and often conflicting objectives (e.g., conservation versus competing agriculture, emission reductions, biofuel production and many more; see Torquebiau, Chapter 2). It is therefore important to understand the tradeoffs in reconciling these objectives in landscape implementation processes (see Freeman, Chapter 3). Recognizing the interests and actors and how they might negotiate is important. However, understanding potential synergies between objectives and interests can be more helpful. Further development of evidence-based negotiations and planning landscapes (including the methods and capacity for implementation) will remain a crucial area of work in developing countries.

Understanding opportunity costs of various land use options and the ecological productivity thresholds for various options and their impacts are good examples of tradeoff considerations needed for decision-making or negotiations. One way forward identified and needing further research for synergy in climate-smart landscapes is a ‘land use practice portfolio approach to synergy’ (Harvey et al., 2013; Duguma et al. 2014) as one way of bringing together climate change mitigation and adaptation strategies and the multiple mechanisms involved (e.g., Clean Development Mechanism, REDD+, Nationally Appropriate Mitigation Actions (NAMAs) and others) at the landscape level.

Business case for landscapes:

The exploratory analysis of public-private interactions in the context of landscapes in Part 4 of this book (Kissinger et al., Gyau et al., Namirembe and Bernard, Chapters 19, 20, 21) reveals a number of key issues such as lack of necessary policy conditions, frameworks and capacity to engage the private sector on the part of communities. A leading factor in the later category is the absence of a business case approach to landscapes, hence insufficient investments in landscapes. So far market infrastructure for carbon and water services have remained very poorly developed and other services such as biodiversity are lacking clear mechanisms through which public and private actors can co-invest (van Noordwijk et al., 2012). Such a co-investment framework is necessary for any successful and viable multifunctional landscape approach in the future hence substantial research investments are needed.

Nested landscapes:

In most of the landscapes presented in this book and elsewhere, multifunctionality or sustainability has been sought within landscapes. Increasingly, with concepts such as reduced emissions in the case of REDD+ or NAMAs wherein accountability is at the national level, there is a need to nest landscapes to national level policies and actions such as towards a green economy or the SDGs (Minang & van Noordwijk, 2013). Given that drivers of landscapes are largely from outside landscapes, e.g., markets, migration etc. (see Figure 27.2), landscapes may need to work with adjacent landscapes if problems of leakage (displacement of activities due to local actions) are to be handled. More so, there are questions as to the degree to which landscapes can specialize in given functions as long as they can 'outsource' other functions to adjacent, distant or associated landscapes. To what degree should a landscape develop cash crops (e.g., rubber, cocoa, oil palm) as long as they can import food from another landscape? Maybe this is possible if there is some jurisdictional planning at a level where several landscapes interact. These sorts of nesting related questions need to be answered if landscape approaches are to contribute meaningfully to sustainable development.

In summary, for current landscapes to move towards the full potential of multifunctionality, fully involving all interested parties in defining an agreed vision for change, and taking into account climate change among multiple boundary conditions, tremendous attention needs to be given to improving processes in term of analysis (especially in terms of structuring wicked problems) and decision-making. This book has made some contributions by exploring concepts, tools, incentives and experiences, but much more is needed going forward. Some of the concepts highlighted such as landscape democracy, systems improvement, nesting landscapes and others need further testing within climate-smart landscapes and multifunctional landscapes in general.

References

Alcorn, J. B. (2000). *Borders, Rules and Governance: Mapping to catalyse changes in policy and management (No. 91)*. London: International Institute for Environment and Development.

Arler, F. (2011). Landscape Democracy in a Globalizing World: The Case of Tange Lake. *Landscape Research, 36*(4), 487-507.

Arnstein, S. R. (1969). A ladder of citizen participation. *Journal of the American Institute of planners, 35*(4), 216-224.

Berkes, F., Colding, J., & Folke, C. (2000). Rediscovery of traditional ecological knowledge as adaptive management. *Ecological applications, 10*(5), 1251-1262.

Bernard, F., van Noordwijk, M., Luedeling, E., Villamor, G. B., Sileshi, G. W., & Namirembe, S. (2014). Social actors and unsustainability of agriculture. *Current Opinion in Environmental Sustainability*, 6, 155-161.

Brofeldt, S., Theilade, I., Burgess, N. D., Danielsen, F., Poulsen, M. K., Adrian, T., ... Widayati, A. (2014). Community monitoring of carbon stocks for REDD+: does accuracy and cost change over time?. *Forests, 5*(8), 1834-1854.

Caddy, J., & Vergez, C. (2001). *Citizens as partners: Information, consultation and public participation in policy-making.* OECD Online Bookshop. Paris: Organization of Economic Cooperation and Development (OECD). Retrieved 20 Nov 2004 from http://www1.oecd.org/publications/e-book/4201131E.PDF

Carver, S. (2003). The future of participatory approaches using geographic information: Developing a research agenda for the 21st century. URISA Journal, 15(1), 61-71.

Cassatella, C., & Peano, A. (Eds.) (2011). *Landscape Indicators Assessing and Monitoring Landscape Quality.* Netherland: Springer

Catley, A. (1999). *Participatory approaches to veterinary epidemiology.* London: IIED, Sustainable Agriculture & Rural Livelihoods.

Catley, A., & Mariner, J. (2002). Where there is no data: *Participatory approaches to veterinary epidemiology in pastoral areas of the Horn of Africa.* International institute for environment and development (IIED). Drylands programme.

Checkland, P. (2000). Soft systems methodology: a thirty year retrospective. *Systems Research and Behavioral Science,* 17, S11-S58.

Coe, R., Sinclair, F., & Barrios, E. (2014). Scaling up agroforestry requires research 'in' rather than 'for' development. *Current Opinion in Environmental Sustainability, 6,* 73-77.

Colfer, C. J. P., & Pfund, J. L. (Eds.). (2011). *Collaborative governance of tropical landscapes.* Gateshead, UK: Earthscan

Dalal-Clayton, B., Dent, D., & Dubois, O. (2003). *Rural planning in developing countries: supporting natural resource management and sustainable livelihoods.* Earthscan, London.

DeFries, R., & Rosenzweig, C. (2010.) Towards a whole-landscape approach for sustainable land use in the humid tropics. *Proceedings of the National Academy of Sciences,* 107, 19627- 19632.

Duguma, L. A., Minang, P. A., & van Noordwijk, M. (2014). Climate Change Mitigation and Adaptation in the Land Use Sector: From Complementarity to Synergy. *Environmental management, 54*(3), 420-432.

Dumanski, J. (1997). Criteria and indicators for land quality and sustainable land management. *ITC journal, 3*(4), 216-222.

Fisher, R., Prabhu, R., & McDougall, C. (2007). *Adaptive collaborative management of community forests in Asia.* Bogor, Indonesia: Center for International Forestry Reserach.

Frost, P., Campbell, B., Medina, G., & Usongo, L. (2006). Landscape-scale approaches for integrated natural resource management in tropical forest landscapes. *Ecology and Society, 11(2)*, 30. Retrieved from http://www.ecologyandsociety.org/vol11/iss2/art30/

Harich, J., & Bangerter, P. (2014) Building a foundational framework for sustainability science with root cause analysis and the system improvement process. Retrieved Aug 2014 from www.thwink.org

Harvey, C. A., Chacón, M., Donatti, C. I., Garen, E., Hannah, L., Andrade, A., ... Wollenberg, E. (2013). Climate-Smart Landscapes: Opportunities and Challenges for Integrating Adaptation and Mitigation in Tropical Agriculture. *Conservation Letters, 7(2)*, 77-90.

Holling, C. S. (Ed.). (1978). *Adaptive Environmental Assessment and Management.* New York: John Wiley & Sons.
Jiggins, J., & Roling, N. (2002). Adaptive management: potential and limitations for ecological governance of forests in a context of normative pluriformity. *Adaptive management: From theory to practice,* 93-104.
Jones, G. (2009). The Adaptive Management System for the Tasmanian Wilderness World Heritage Area—Linking Management Planning with Effectiveness Evaluation. In *Adaptive Environmental Management,* 227-258. Netherlands: Springer.
Lee, K. N. (1999). Appraising adaptive management. *Conservation ecology, 3*(2), 3.
Lusiana, B., van Noordwijk, M., Johana, F., Galudra, G., Suyanto, S., & Cadisch, G. (2014). Implications of uncertainty and scale in carbon emission estimates on locally appropriate designs to reduce emissions from deforestation and degradation (REDD+). *Mitigation and Adaptation Strategies for Global Change, 9*(6), 757-772.
Marston, S. A. (2000). The social construction of scale. *Progress in human geography, 24*(2), 219-242.
Matrazzo, S. L. (2013). The Democratic Landscape: Envisioning Democracy Through Aldo Leopold's Land Ethic. Masters of Liberal Studies Theses. Paper 45. Rollins College, Hamilton Holt School, Winter Pak, Florida, USA
McCall, M. K. (2003). Seeking good governance in participatory-GIS: a review of processes and governance dimensions in applying GIS to participatory spatial planning. *Habitat International*, 27, 549-573.
McCall, M. K., & Minang, P. A. (2005). Assessing participatory GIS for community-based NRM: claiming community forests in Cameroon. *The Geographical Journal*, 171, 340-356.
Minang, P. A., & van Noordwijk, M. (2013). Design challenges for achieving reduced emissions from deforestation and forest degradation through conservation: leveraging multiple paradigms at the tropical forest margins. *Land Use Policy*, 31, 61-70.
Plummer, R. (2009). The adaptive co-management process: An initial synthesis of representative models and influential variables. *Ecology and Society, 14*(2), 24.
Prabhu, R., McDougall, C., & Fisher, R. (2007). Adaptive collaborative management: A conceptual model. Adaptive Collaborative Management of Community Forests in Asia. In Fisher, R., Prabhu, R., & McDougall, C. (Eds.) *Adaptive collaborative management in community forests in Asia: Experiences from Nepal, Indonesia and the Philippines,* 16 – 48. Bogor Indonesia: CIFOR.
Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J. L., Sheil, D., Meijaard, E., ... Buck, L. E. (2013). Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. *Proceedings of the National Academy of Sciences, 110*(21), 8349-8356.
Scherr, S., Shames, S., & Friedman, R. (2012). From climate-smart agriculture to climate smart landscapes. *Agriculture and Food Security*, 1, 12.
Sheil, D., Nasi, R., & Johnson, B. (2004). Ecological criteria and indicators for tropical forest landscapes: challenges in the search for progress. *Ecology and Society, 9*(1), 7.
Sutherland, W. J., Gardner, T., Bogich, T. L., Bradbury, R. B., Clothier, B., Jonsson, M., ... Dicks, L. V. (2011). Solution scanning as a key policy tool: identifying management interventions to help maintain and enhance regulating ecosystem services. *Ecology and Society, 19*(2), 3.
Torquebiau, E., Cholet, N., Ferguson, W., & Letourmy, P. (2013). Designing an Index to Reveal the Potential of Multipurpose Landscapes in Southern Africa. *Land, 2*(4), 705-725.
Turner, M. G., Dale, V. H., & Gardner, R. H. (1989). Predicting across scales: theory development and testing. *Landscape Ecology, 3*(3-4), 245-252.
UNDP (United Nations Development Programme). (1997). Defining core characteristics of good governance. New York: United Nations Development Programme, Management Development and Governance Division. Retrieved 20 Nov 2004 from http://magnet.undp.org/policy/
van Noordwijk, M., Leimona, B., Jindal, R., Villamor, G. B., Vardhan, M., Namirembe, S., ... Tomich, T. P. (2012). Payments for environmental services: evolution toward efficient and fair incentives for multifunctional landscapes. *Annual Review of Environment and Resources,* 37, 389-420.
Villamor, G. B., van Noordwijk, M., Djanibekov, U., Chiong-Javier, M. E., & Catacutan, D. (2014). Gender differences in land-use decisions: shaping multifunctional landscapes?. *Current Opinion in Environmental Sustainability, 6,* 128-133.

Walters, C. (1997). Challenges in adaptive management of riparian and coastal ecosystems. *Conservation ecology, 1*(2), 1.
Wu, J., & Qi, Y. (2000). Dealing with scale in landscape analysis: an overview. *Geographic Information Sciences, 6*(1), 1-5.
Zahabu, E. (2006). Kitulangalo forest area, Tanzania. In Murdiyarso, D., & Skutsch, M. (Eds.) *Community forest management as a carbon management option: case studies.* Bogor: Center for International Forestry Research.

"*Climate-Smart Landscapes: Multifunctionality in Practice* provides leadership on the landscape approach scientific discourse. It is a practical guide with case studies and suggested methods of application. I find the insights on how to create synergy between the different UNFCCC mechanisms - NAMA, REDD+, LULUCF - at the landscape level to be particularly beneficial for the UNFCCC negotiation process as we build consensus towards a new agreement in Paris, 2015."

Prof. Dr. Kuntoro Mangksubroto*, Professor, School of Management, Institute of Technology, Bandung, formerly Head of National REDD+ Task Force, Republic of Indonesia and Head of President's Delivery Unit, Republic of Indonesia*

"If we could choose to change one thing it would unlikely be our climate, but sadly we are faced with this inevitability. With respect to agriculture, forestry and the environment the global negotiations have earnestly highlighted the 'why', the 'what' and the 'where' but have given us little guidance on the 'how'. This book speaks in an enabling way to policymakers, civil society, scientists and land managers to address 'how' to integrate perspectives and outcomes in managing nested biophysical and human landscapes. The framing propositions also speak to some of the bigger practical aspects for implementation such as the inadequacy of current metrics. If you change your understanding and actions after reading one book this year, you will not find a better volume than this one to do so."

Prof. Tony Simons*, Director General, World Agroforestry Centre (ICRAF) and Honorary Professor of Tropical Forestry, Faculty of Science, University of Copenhagen*

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