Section IV

Supporting multifunctionality through realistic, conditional and voluntary actions to enhance trees as sources of environmental services

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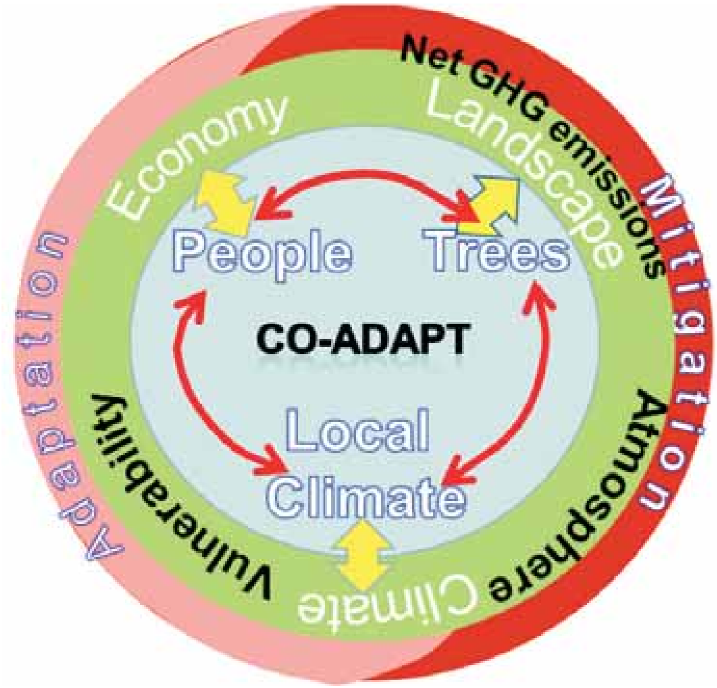


In this final section we will discuss the interrelationships among people, trees and local climate (the inner circle of the diagram), and all the surrounding issues at national and international levels, and then relate our current understanding and knowledge of these interrelations to opportunities for action. We pick up the thread from Chapter D and return to the issue of multifunctionality of landscapes and the way human drivers and institutions that influence the landscape can themselves be modified. This section describes the public debate and the development of new mechanisms to support multifunctionality of landscapes, in four chapters.

G. Supporting multifunctionality: pluralistic approaches to building trust and multilevel institutional reforms.
H. Adopt, evaluate and learn in combining carrots, sticks and sermons.
I. Balancing fairness and efficiency in rewarding environmental service providers.
J. Increasing resilience and sustainagility by support of social and ecological buffers.

Realising win-win solutions and balancing livelihoods and ecological functions will require innovative approaches. These, however, are still in the early stages of learning, although they have been tested in various contexts. Implementation at larger scale will require human and financial resources as well as political will. Solutions will have to transcend current sectoral approaches that distinguish forests from the rest of the landscape and see the forestry, agriculture and processing sectors as separate, with the planning of physical infrastructure such as roads independent of their likely environmental impacts. Effective cross-sectoral institutions that pursue innovative approaches to achieve win-win solutions will build on, review and reform existing institutions. In reversing the trend of current loss and rebuilding multifunctionality as part of climate-change adaptation, the following steps are needed.

1. Create awareness of, and the capacity to do something about, these issues.
2. Explore synergies among various mechanisms and instruments for supporting multifunctionality.
3. Implement innovative incentive schemes.
4. Adopt, evaluate and learn.

It is important at this stage that systems for monitoring, reporting, evaluation and verification (MREV) look at the objectively verifiable impacts on environmental services, as well as on the social and economic processes that have been put in place. Fossilisation of institutions is one risk; constant change and lack of clarity for investors is another. So far, the global institutions for climate change have not provided the stability needed for actors to plan their best course of action. Hopefully, global learning and building consensus will finally match the scale and urgency of the issues at stake.

G. Supporting multifunctionality: pluralistic approaches, trust building and multilevel institutional reforms

The main point of this chapter is to create awareness multifunctionality and increase our capacity to appreciate pluralism. In reversing the trend of current loss and rebuilding multifunctionality as part of climate-change adaptation, such understanding can be supported by new institutional perspectives and reform that is able to achieve several goals.

- Bridge multiple perspectives on the cause-effect relationship in providing environmental services and enhancing livelihoods and the implications for legality and contested rights.
- Build trust among stakeholders as the fundamental effort in sustaining any institutional reforms.
- Understand institutional relationships at different scales and priorities. This relates to the previously discussed LAAMA, NAMA and GAMA in section C.

Figure G.1 shows local livelihoods and their deficits, usually indicated as ‘poverty’, as being positioned between the opportunities and demands of a national economy (itself interacting with international markets) and a local environment that is a source of tradable goods, extracted or produced, and non-tradable services. The outcome generally is that environmental services are squeezed, potentially to the level that they affect local productivity and human welfare. The reduction of natural capital (increase of biodiversity and carbon-stock deficits), that has loss of environmental services as a symptom, can be noticed by ‘downstream’ stakeholders who often see themselves as rights holders. In the resulting dynamic between downstream and upstream actors, trade-offs between local livelihoods and the interests of external environmental services' beneficiaries play a key role. They indicate the degree to which local communities may have to sacrifice opportunities for economic gain in providing environmental services for external beneficiaries. However, there may also be trade-offs among different types of environmental services at various spatial and temporal levels. For example, a monoculture plantation with high wood density might sequester more carbon than a multispecies landscape with high biodiversity value. Environmental services' beneficiaries outside the landscape can try to influence local actors in various ways, using regulatory, incentive and facilitating approaches.

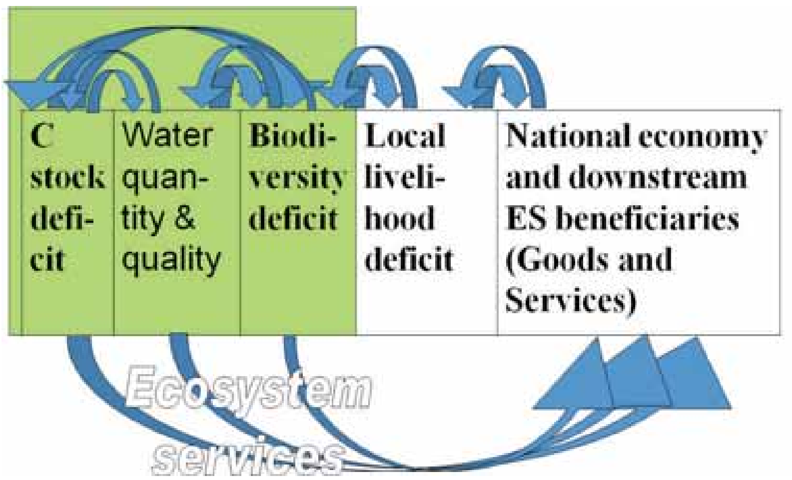


Figure G.1. Schematic representation of local livelihoods, environmental services, external beneficiaries and trade-offs among those elements

Various approaches have all attempted to promote institutional reforms for effective natural resource management, with apparent successes and failures. Any one, or a combination of, these approaches can be more effective in institutionalising reforms in the short term but the most important aspect is making the reform process itself dynamic (agile) and based on evidence, to suit the changing conditions. In this sub-chapter, we present an overview of innovative approaches used in instilling institutional reforms. Approaches have evolved from command-and-control through bottom-up then to an attempt at integration. Different countries are at different stages of institutional review and reforms to mainstream climate adaptation and mitigation. The question we want to answer is how pluralistic, multi-objective and dynamic does institutional review and reform need to be? Herein is a synthesis of some of the innovative approaches.

Beyond the symptoms: dealing with issues at driver level

A major challenge for any systematic approach to addressing governance issues is the gradation of symptoms, agents and underlying causes or 'drivers'. For immediate visual effect it may be sufficient to focus on the symptoms, but the problem may quickly re-emerge in slightly modified form if the agents don't change behaviour. To change the behaviour of all relevant agents, the drivers and underlying causes must be addressed and changed.

In issues of land use and its effect on ecosystem functions, there have been many approaches to attribute measurable land-cover change to agents and drivers, potentially involving intermediate steps and categories. The 'response options' can be grouped into four.

A. The direct consequences of modifying land cover for the benefit of the land user.
B. Land-use planning and the set of rules that clarify which agents are allowed to do what and where in the landscape, usually interacting with varying concepts of ownership and tenurial rights. An important element in this in most countries is the separate treatment for 'forest' categories of land cover.
C. Agent-specific payments or rewards for environmental services that are meant to shift voluntary decisions of land users towards larger benefits for external stakeholders
D. Changes in the rules and incentives for economic activities that apply to all potential land users and that may make socially desirable land-use decisions better aligned with private optimisation of land use. An example can be found in the analysis by Martin et al. (2011): at current prices a shift to inclusion of high-value native timber species on maize farms in the Philippines is just about neutral in terms of farmer benefits but its value for Philippines' society would be twice as high; a change in the tax (farm-grown timber is taxed as if it is a forest product) and subsidy (maize prices and fertiliser are subsidised) could be for the benefit of all and might be sufficient to achieve greater tree planting with multiple additional benefits for society.

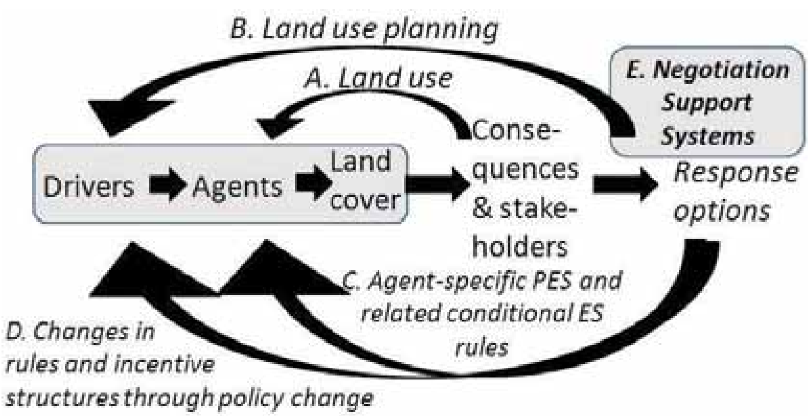


Figure G.2. Feedback loops in the logical chain of drivers, agents, land-cover change and consequences. Source: van Noordwijk et al. 2011a

Pluralistic approaches

The current approach in natural resource management has extended from a single administrative, regulation-based, command-and-control instrument to more pluralistic environmental policies. The need for win-win solutions for complex issues, such as conflicting interests of various stakeholders, drives this process. Participatory approaches, decentralisation of power, recognition of different perceptions and negotiations characterise pluralistic policy instruments. These instruments, practised in developing countries in Asia and Africa, range from creating grass-roots institutions through recognising local by-laws or laws made by a non-sovereign body to applying negotiation support systems.

Negotiation support systems differ from decision support systems in that they recognise that multiple decision-makers interact and need to negotiate (van Noordwijk et al. 2001). To do so, a joint understanding is needed of how a landscape functions and what the consequences are for a range of performance indicators if there are landscape-level changes in land use, creation or closure of channels and/or filters.

Landscape models can only be used for such type of negotiation if they combine three quality criteria (Clark et al. 2011). They need to address the key questions of stakeholders ('salience'), match observed response of the landscape to historical change and extreme events ('credible') and need to be perceived to be free from bias, representing the knowledge of all stakeholders ('legitimacy'). Once such a model has been developed and tested, it can be used for negotiations about land-use change, clarifying the stakes involved for all. The negotiation may well involve intermediaries who establish trust with the various parties before bringing them together in direct negotiation sessions. Intermezzo 13 provides an example.

Further experience with negotiation support systems was obtained by the World Agroforestry Centre in Sahelian and East African countries, where contests over land and tree tenure between communities and the state lead to continued destruction of native tree species. To ensure reform and review of these policies and legislation, policy makers need solid evidence of the impacts that can be expected if local communities obtain legal rights to use and manage natural resources. Pre-implementation studies of the likely impact of new policy and/or legislation are usually needed before policy change will happen. Researchers can only do so effectively if they have earned the trust of the various contestants.

Building trust as the basis

Creating any initiatives to enhance both conservation and livelihoods is challenging in areas where tensions and perception gaps exist between actors, including policy makers and local stakeholders. For example, it is more difficult to engage local stakeholders in coercive military or authoritative states where freedom of expression and choice is inherently absent or restricted compared to a peaceful, democratic condition. Even so, in democratic states, the exercise of freedom of choice can be limited owing to lack of options or presence of threats. The biggest challenge that remains is in educating and building the capacity of local stakeholders, balancing power and removing asymmetric information so that they are able to take their place at the negotiation table without fear of social, political or economic subjugation. Building trust requires the fundamental rights of expression and choice and underlying attributes of participation, representation, transparency and effective communication.

Figure G.3 describes the iterative steps facilitated by an intermediary to remove barriers by overcoming negative power influences. An initial condition mostly starts with unequal power relations with subliminal conflict between poorly organized upland communities and more solid and powerful downstream stakeholders. Better organization of the upland communities can bring the conflicts into the open. When all actors realise that the actual source of conflict is different perceptions of how environmental services are generated and can be protected then it can bring the two sides closer. This condition is conducive for negotiation and trust-building. Further, it has the potential to develop sustainable rewards for environmental services that are based on mutual self-interest and reciprocity.

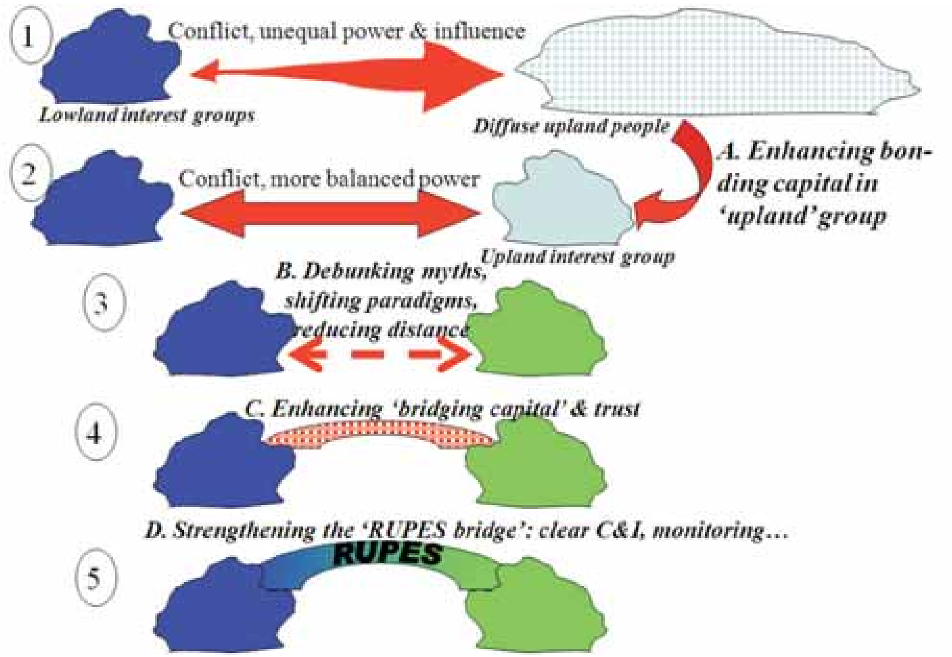


Figure G.3. Schematic description of five stages in the relationship between groups of stakeholders

The proposed iterative steps aim to enhance trust among actors, as described above. However, we caution that merely following the steps will not work; the facilitator must consciously ensure effective participation and representation of all actors, transparency of negotiations and effective communications.

Multiscale links in mitigating and adapting to climate change

Dealing with the vagaries of climate change and increased variability will mainly depend on existing institutional capacity and harmonisation of the implementation of climate-change responses at different scales. Currently, the global response to climate change is polarised at the international level with disconnection between local- and national-level responses. According to Blaikie et al. (1994) and Ribot (1995), adaptation to climate change has to be localised, given that the impacts are inevitably local. But, ultimately, adequate responses at both levels are needed.

Figure G.4 conceptualises the relationships between different policy domains horizontally and vertically and shows how nested climate-change adaptation could be addressed through interactions between action institutions and knowledge systems. This diagram was created for an African context but may be relevant to other developing areas.

As shown by Figure G.4, in the case of institutional analysis of climate-change adaptation, different policy domains, transfers of knowledge, subsequent learning and action across scales are critical. Institutional review and reform across these scales (horizontally and vertically) and policy domains is imperative. At the horizontal level, there are sector-based policy domains (for example, agriculture, forestry, energy, water and wildlife) that relate to climate-change adaptation in different ways. The vertical relationship is limited planning and governance systems pursued by different institutions. These domains operate vertically and lack cross-sectoral coordination yet climate change is a cross-sectoral issue. Scientific knowledge is passed through institutions and policy domains. Factors such as levels of income, property rights, extension services provision, governance, levels of education, state of market infrastructure and proximity to urban centres determine the rate of adoption and expansion of agricultural innovations linked to provision of environmental services.

Institutions at the national level are charged with policy formulation and facilitating implementation. Lower level sub-units are mainly responsible for translating policy provisions into actions with lessons and experiences feeding into national-level policy formulation. In the case of climate change, national-level lessons and experiences feed into regional- and international-level negotiations and decisions. Policies, plans, projects and programs' implementation in different regime structures are often not informed by research undertaken by different organizations. Implementation is affected by complexities associated with multilevel governance systems. Regional-level initiatives influence, and are shaped by, what is happening at national levels. Discussions at the international level on several policy areas and collective learning and action initiatives influence what is happening at the national and country levels. Climate-change adaptation or any other large-scale environmental problems are then nested in different levels of governance providing opportunities of learning lessons across the different levels.

The Rewarding Upland Poor for the Environmental Services they provide (RUPES) project, Pro-poor Rewards for Environmental Services in Africa (PRESA) project and REDD+ schemes are learning opportunities. These learning cycles have shown that the long-term goals are clear but the approaches at different nested levels—local, national and global—will have to evolve on the basis of experiences, some trial and error, and system analysis. Positive feedback loops between international, regional, national and community-level responses to climate change and variability can be possible through institutional review and reform at national levels. Such a learning process can speed up the understanding of all involved and, at the end, actual on-the-ground progress can be reached.

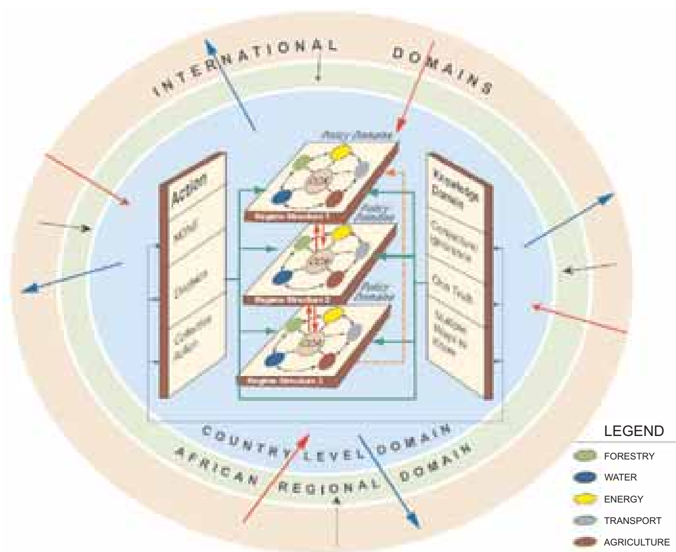


Figure G.4. The concept of various nested policy, knowledge and action domains in climate-change mitigation and adaptation (CAA) in the African context. Source: Yatich et al. 2008

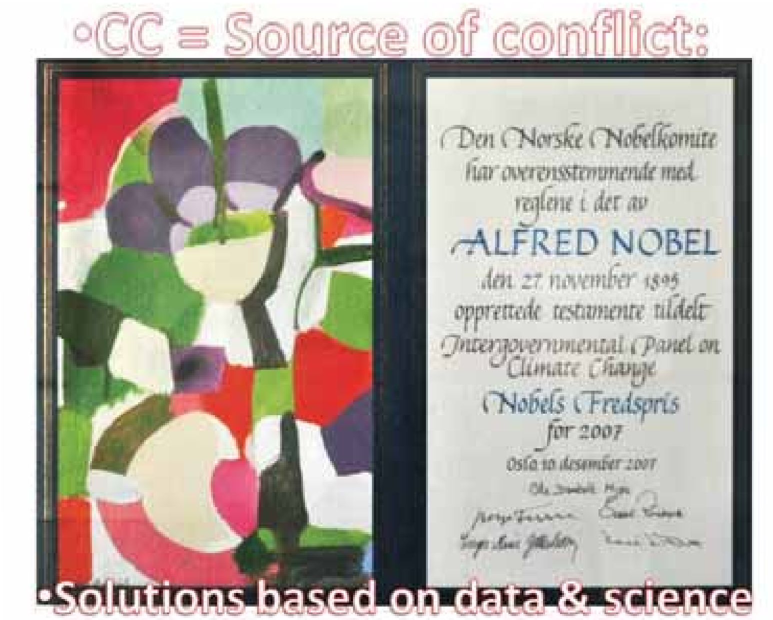


Figure G.5. The 2007 Nobel Peace prize awarded to the Intergovernmental Panel on Climate Change reflects the relationship between climate change and conflict as well as the belief and hope that an evidence-based approach can bring solutions

Intermezzo 13.

The negotiation support system as the basis for forestland stewardship in Indonesia

The negotiation support system helped solved a land tenure conflict between farmers and Government in Indonesia, in the Sumberjaya watershed, Lampung province. In this area, violence flared repeatedly as the Government removed poor, squatter families from State-owned protection forests with the idea that eviction would protect the watershed. However, research conducted by the World Agroforestry Centre showed that multistrata coffee farms provided more livelihoods alternatives for these local people and also controlled erosion similar to natural forest (Verbist et al. 2010). The multistrata system provided a complex canopy that protected the soil surface from heavy raindrops that caused erosion. It also created tree litter that helped weaken the erosive force of the falling water (Hairiah et al. 2006).

At the start of the Centre's involvement, the primary impact pathway was expected to turn a negative downward spiral of conflict, environmental degradation and poverty into a positive, upward spiral of landscape co-management.

By empowering farmers' groups and by bringing science into the negotiations, the district forestry services and farmers' groups reached an agreement on 'conditional land tenure', a unique form of Indonesian community-forestry (Hutan Kemasyarakatan/HKm) permit. The Sumberjaya permit guaranteed conditional land tenure, with more specific performance criteria compared to general HKm permits in other areas of Indonesia: permit holders must a) contribute to watershed health by practising coffee agroforestry, planting a minimum 400 trees in their coffee gardens; and b) protecting the remaining areas of natural forest. The conditional land tenure permits granted land rights to farmers for a five-year trial period, with possible extension of up to 35 years and beyond.

Establishing trust, raising awareness on conservation issues, building capacity, strengthening local institutional capacity and identifying champions among negotiation support system stakeholders are the steps that initiate the NSS process. The process also has to maintain regular dialogues and policy formulation at the district and provincial levels while linking efforts with national negotiation processes. In places where the Government owns major forest tracts, community forestry permits based on conditional land tenure can offer a path to both improved livelihoods and protection of forest services. The Indonesian regulation mentions that this approach applies to both production and protection forests recovering from deforestation.

Monitoring activities

The forestry office of West Lampung has a guideline for monitoring HKm performance. There are several lists of indicators with a scoring system up to 100 points. The scoring system incorporates concerns related to institutional criteria (development of the group to manage the permit area), conservation performance (planting trees and conservation practices in coffee gardens) and overall impact as measured by various social, economic and ecological indicators. An assessment team gives each HKm area a score, which is used to determine whether and for how many years the HKm permit could be extended.

Downward spiral of conflict

Myth perceptions of forests as sole providers of watershed services

- ⇒ Eviction policies for 'squatters' who had developed coffee agroforestry
- ⇒ Short-term management perspectives lead to monoculture coffee as economic optimum
- ⇒ Suboptimal watershed management
- ⇒ Reconfirmation of forest perceptions

Persistence of rural poverty

Upward spiral of co-management

Evidence that well-managed coffee agroforestry can provide essential watershed services

- ⇒ Eviction policies for 'squatters' replaced by negotiated land-use agreements
- ⇒ Long-term management perspectives favour multistrata coffee agroforestry systems as economic optimum
- ⇒ Improved watershed management
- ⇒ Reconfirmation of positive agroforestry perceptions

Reduction in rural poverty

1. 35 permit is revoked
2. 36–45 permit extended for one year and then re-evaluated
3. 46–65 permit extended for five years and then re-evaluated
4. 66 permit is extended for 35 years

Results so far

- In 2005, the criteria and indicators for HKm were approved by the local government. A local policy was issued, outlining the steps for acquiring the 35-year conditional land right.
- In July 2006, 18 farmer groups received community forestry permits for a five-year trial. This increased the area covered from 1367 ha to 11 633 ha (70% of the protection forest now covered by conditional land tenure permits). Nearly 6400 farmers received permits.
- In December 2007, the Ministry of Forestry granted conditional land right permits for 35 years to five farmers' groups in Sumberjaya, covering an area of 1367 ha. These were the first 35-year HKm permits issued to farmers' groups in Indonesia.

Figure G.6. Landscape mosaic in Sumberjaya (Lampung, Indonesia) one of the pilot sites for the RUPES project. Photo: Meine van Noordwijk

Source: http://www.worldagroforestrycentre.org/Sea/Publications/files/leaflet/LE0083-08.PDF

H. Adopt, evaluate and learn in combining carrots, sticks and sermons

There are two main points in this chapter.

- A combination of instruments—administration and regulation, incentive and disincentive, public persuasion—is needed to influence individual decision-making in managing public goods, such as environmental services produced by a multifunctional landscape.
- Environmental services' provision and poverty alleviation are beyond a mere environmental services' market transaction but stem from an interrelationship in the landscape that supports livelihoods' systems and a wide range of actors such as environmental services' providers (mostly local communities) and environmental services' beneficiaries (private companies, their customers and government institutions, including international conventions and green development pathways and conservation).

Instruments to influence individual decision-making in managing public goods

Governance regimes and institutions for collectively managing public goods have three types of instruments to persuade or coerce their members, citizens or subordinates to comply with natural resource management. These three instruments we call 'carrots, sticks and sermons'. Together they define disincentives and incentives for aligning individual decisions with external goals and interests (Figure H.1).

Figure H.1. Cartoon of carrots, sticks and sermons as ways to induce compliance with external goals

Sticks	Regulatory approaches to land use, for example, by enforcing top-down land-use planning. These can often become policy impediments since they provide more benefits for external stakeholders than for the local community.
Carrots	One-off or recurrent incentives to start voluntary environmental conservation. The incentives can refer to any of the 'five livelihoods' framework of sustainable development (Chambers and Conway 1992): 1) natural capital (access to resources); 2) human capital (support for education, health, political career opportunities); 3) social capital (standing within the community, institutional growth); 4) physical

	capital (road access, irrigation infrastructure); or 5) finance (direct payments, microcredit, taxation or tax-deductibles, trust funds).
Sermons	Altruistic behaviour influence that fundamentally exists in any human culture.

A combination of the three types of instruments is usually needed: enforceable rules set the frame within which voluntary actions can be rewarded. Some constraints exist in applying only a single instrument. The regulatory or administrative policy instrument, or 'stick', is often ignored, as we see in the forms of illegal logging and encroachment on protected areas in many countries. Furthermore, the international conventions (international 'stick') might be disconnected from national law. For example, protecting a globally threatened IUCN Red List species does not necessary link to protection of its habitat or home range in the national protection areas. Other cases show that the application of incentive mechanisms without clear regulations can create a chaotic situation that may lead to further environmental degradation.

Local norms, or 'sermons', in maintaining landscape multifunctionality often exist as part of local wisdom in conserving nature. There is linguistic evidence for this in that there are many local names for agroforestry systems, such as *tembawang*, *repong*, *pekarangan* (Indonesian local languages), *satoyama* (Japanese) and *taungya* (Philippines). However, economic competition and population pressures shift the value of these 'old rules'. New perspectives to combine local development and negotiation of the 'old rules' need to be found and deployed. In addition, 'sermons' mismatch at the national and global levels: the new global norms, such as gender equality, universal human rights and specific attention to indigenous peoples, have not been part of the formation of many nation states. This situation results in a fluctuation in agreement on how to do justice to the complex issue of environmental conservation and development. However, over time, norms of behaviour with respect to environmental services are expected to shift, so that maintaining landscape multifunctionality will have to be further internalised through effective sermons.

In conclusion, the next step in the development of institutional support for landscape multifunctionality will have to be a combined review of existing incentives (carrots), rights, de facto behaviours (sermons) and regulatory and institutional capacity for change (sticks).

Components enhancing the provision of environmental goods and services

Over the last decade, many 'carrot'-type instruments or incentives have been developed under the banner of 'payments for environmental services' (PES). The language used to describe these mechanisms is largely derived from economics, using market terms such as 'buyers', 'sellers' and 'brokers' to identify key elements of the system. The appeal of free, voluntary engagement between providers and beneficiaries of services is considered more effective than other forms. This 'environmental-services market' concept assumes that without a government bureaucracy imposing rules and with compliance to market mechanisms there will be reduced market failures and less likelihood of regulatory instruments capturing the total value of environmental services. In practice, however, the role of governance in making or breaking such 'free market' mechanisms has been underestimated.

As shown in Figure H.2, there are at least four major components of a system that tries to enhance environmental services, along with the provision of goods, through positive incentives.

Figure H.2. Modified livelihoods' framework that relates the provision of environmental goods and services. Source: van Noordwijk and Leimona 2010

A. The landscape/livelihoods' systems that use the five types of assets to produce both goods and services that are in demand and for which incentives (in any of the five types of asset currencies) exist.
B. Private companies that link supply and demand for commodities and face the expectations of shareholders and customers to have a high-quality product at a low price, without negative feelings of guilt associated with the product.
C. The downstream customers of the goods and services produced in the landscape, who are (or can be made to feel) responsible for the way their 'commodities' are produced.
D. Government institutions at national and sub-national levels that provide basic 'rules of the game'.

In fact, operational payments for environmental services' schemes are usually a combination of the three instruments above: carrots, sticks and sermons. At the local level, the norms influence the community to produce balanced marketable goods and environmental services through the interactions of their livelihoods' capitals (financial, human, social, physical and natural). However, as mentioned above, external pressures and high threats to environmental services can create conditions whereby the local community cannot provide both internal and external benefits without any positive incentives.

Environmental services' beneficiaries, such as the private sector (arrow 1 of Figure H.2), customers of goods and services (arrow 4) produced in this landscape and even global communities all have internal pressures (norms) and external pressures, such as international conventions (sticks), to provide such incentives (carrots) to the environmental services' providers (arrows 2 and 3). As part of any 'green' campaign, the private sector (mostly companies who link supply and demand for commodities) often faces the expectation of high-quality products for a low price, without negative feelings of guilt associated with the product's customers. This drives voluntary internalisation of cost in producing environmental friendly goods or utilising so-called corporate social responsibility activities to offset 'bad' behaviours. Overall, lessons from the RUPES project in Asia and PRESA project in Africa prove that to expand such systems, government institutions at national and sub-national levels have to provide basic ‘rules of the game’ plus generic or specific rules for maintaining environmental services.

REDD+ is a form of PES global mechanism to reduce emissions from deforestation and forest degradation, and encourage forest restoration, with the principle that rich countries can pay for these terrestrial emission reductions in poorer countries, and thus achieve a cost-effective way of reducing the global problem of climate change. In practice, however, the carrots, sticks and sermons of these REDD+ mechanisms have proved to be more complex than originally imagined. With reference to Figure H.2, some points have to be considered.

- In a landscape, rights over resources and land are usually contested within communities, between neighbouring communities, between communities and state-sanctioned operators and between the communities and the state. Concepts of ‘fairness’ clash with those seeking ‘efficiency’.
- For consumers, their degree of flexibility (and use of ‘offsets’ to meet commitments) is unclear and the additionality of greater net emission reduction through the REDD+ mechanism has not been resolved.
- For the private sector, their existing ‘rights to emit’ are challenged, while the rules of the game in offsetting their emissions keep changing. These situations make investment decisions difficult.
- For the governments, the ‘sermon’ of the victim role (that is, developing countries have not enjoyed wealth but currently have to somehow decrease their economic activities, especially forestry business, owing to global commitments to climate-change mitigation), has to be balanced with ‘national sovereignty’ and the advantages of a pro-active role on the world stage.

Intermezzo 14.

RUPES River Care scheme: a contract to reduce river sedimentation

A World Agroforestry Centre team implemented a River Care project in Gunung Sari and Buluh Kapur, Lampung province, Indonesia. River Care is a voluntary collective action for reducing and monitoring sedimentation in a river by constructing simple physical erosion retention devices combined with soil and water conservation in coffee gardens. Payments were categorised: a 5000 watt microhydropower electricity unit for more than 30% sediment reduction and monetary payment for less than 30%.

A contract included agreements on activities to be carried out, rules, monitoring and evaluation, and sanctions. The community decided most of the terms of the contract through negotiation coordinated by the River Care administrator. The contract value allocated USD 1111[17] for operational costs and environmental services' payments were stratified according to sedimentation reduction.

Sedimentation reduction activities at erosion hotspots	▪ Construct and maintain dams to retain sediments from forest, coffee gardens, paddy fields, footpaths ▪ Divert waterways and construct limited ridging and sediment pits on coffee gardens to prevent erosion ▪ Plant grass strips along potential landslide hotspots in coffee gardens ▪ Install water channels and PVC pipes to stabilise water flows
Payment schedule of operational cost	In total, USD 1111: 50% at start; 50% at two months, contingent on performance
Payment as reward for environmental services	Reducing sediment up to: ▪ 30%: in cash: USD 2222 (Gunung Sari) or a microhydropower plant (5000 watt) of similar monetary value to the Gunung Sari payment (Buluh Kapur) ▪ 21 to 29%: USD 833 ▪ 10 to 20%: USD 555 ▪ less than 10%: USD 278
Duration and monitoring	One year with monitoring every three months; termination if 50% contracted activities not completed by midterm monitoring date
▪ Cancellation or non-compliance activities (resulting in ineligibility for second payment) ○ purposively destroying public property ○ friction and conflict among community members ○ corruption	
Force majeure provision in the event of natural disaster	

[17] USD 1 = IDR 9000

At the end of the contract, in Buluh Kapur the hydropower company provided the reward of a microhydropower unit to the local community regardless of their compliance in sedimentation reduction. In this case, the company evaluated performance based on the community's effort and perseverance. This made the River Care scheme even more interesting for researchers. The shifting paradigm from commoditisation of environmental services to shared responsibility in maintaining a healthy ecosystem was very apparent.

Source: Pasha and Leimona 2011

Intermezzo 15.

Green tea and clean water: Incentive for environmentally and socially responsible tea-farm management in Kenya

The Kapingazi River is one of the tributaries of the Tana River. It originates from the eastern slopes of Mount Kenya. Downstream of Kapingazi, on the Tana, are located a series of reservoirs for hydropower generation responsible for nearly 70% of the electricity produced in Kenya. The Kapingazi supplies 20% of the water consumed in the town of Embu. It also supplies six community projects for domestic and irrigation water, institutions and factories (mainly coffee and tea).

Following the drought of 2000, the river dried up completely. During the rainy season, the river becomes heavily polluted with sediment from farms, roads, footpaths, river banks and bare areas. Soil erosion leads to decline in farming yields. Sediment transported downstream into the reservoirs reduces their capacity and raises the maintenance costs of the turbines. Rural poverty results from low yields and poor access to markets. Domestic water users in Embu and other users relying on the water from the river were also concerned about the water quality and sustainability of flows, especially during the dry season.

Initiatives in solving the problems by involving local communities in this area came from various institutions and funding agencies, including the Government of Kenya, International Fund for Agricultural Development, Global Environmental Facility and the Pro-poor Rewards for Environmental Services in Africa (PRESA) project of the World Agroforestry Centre. Livelihoods' enhancement initiatives included promoting more effective use of natural resources, improving access to water and introducing more sustainable farming and water management. These initiatives linked to the development of 'rewards for environmental services' schemes and the existing ecocertification scheme in the catchment. The potential buyers of the environmental services included the Kenya Electricity Generation Company and irrigation projects on the lower Tana River. To set up the system, the PRESA project is working in the Kapingazi watershed to facilitate fair and effective agreements between stewards and beneficiaries of environmental services. The major challenge is to combine the various initiatives in the area, including the rewards scheme for watershed conservation and already existing ecocertification.

Eco-labelled tea produced in Kapingazi catchment, Kenya, promises farmers a price that is three-to-four times higher than ordinary tea, if farmers comply with the conditions for 'good agricultural practices' monitored and certified by the Rainforest Alliance under its Agriculture Certification scheme[18]. The Rainforest Alliance follows the Sustainable Agriculture Network (SAN) standards[19] in awarding their Rainforest Alliance Certified™ seal of approval. This certification assures the production of socially and environmentally benign branded tea as demanded by its consumers. The general compliance of the SAN system is that farms must comply with at least 80% of all applicable criteria and 50% of each principle's criteria to obtain and maintain certification. The SAN's ten principles are:

[18] http://www.rainforest-alliance.org/agriculture.cfm?id=tea

[19] http://www.rainforest-alliance.org/agriculture.cfm?id=standards

1. Social and environmental management system
2. Ecosystem conservation
3. Wildlife protection
4. Water conservation
5. Fair treatment and good working conditions for workers
6. Occupational health and safety
7. Community relations
8. Integrated crop management
9. Soil management and conservation
10. Integrated waste management

The requirements emphasise a system (agroforestry) performance or Level 2 conditionality that must be accomplished by the environmental services' providers. Some articles under this principle are general, such as Article 2.1: 'The farm must maintain the integrity of aquatic or terrestrial ecosystems inside and outside of the farm and must not permit their destruction or alteration as a result of management or production activities on the farm'. This criterion only states a general objective in ecosystem integrity that must be achieved by the project. An eco-labelling scheme can be interpreted as benefit-risk sharing. The failure of a project to fulfil its certification causes lower prices with the risks borne by farmers while the buyers suffer from limited supply for production.

Source: Firmian et al. 2011

I. Balancing fairness and efficiency in rewarding environmental services' providers

The main point of this chapter is to discuss lessons from the implementations of action research sites in Asia and Africa that reinforce the need to balance both fairness and efficiency in environmental services' rewards schemes. There are four principles of fair and efficient schemes (van Noordwijk and Leimona 2010).

1. Realistic: based on shared understanding of the relationship between land-use practices and the provision of environmental services, at the level required and with similar expectations.
2. Conditional: the incentives and rewards must be outcome-based to the degree possible, rather than prescribing a strict definition of PES.
3. Voluntary: within the constraints of collective action, evolving norms of behaviour and existing regulation.
4. Pro-poor: in the design, access, decision making and outcomes; and recognise the need to be inclusive of social and gender stratifications; both for reasons of 'fairness' (achievement of moral equity objectives) and 'efficiency' (working against global norms simply can raise transaction costs in the long run).

In the next section, we will discuss the methods that have so far emerged to deal operationally with these four principles through emerging experiences of creating efficient and fair incentives for enhancement of environmental services in Asian and African countries (Leimona 2011).

Part of the literature on the topic uses a ‘3E framework’ (Table I.1), emphasising effectiveness, efficiency and equity as the three primary characteristics in establishing a sustainable scheme. The framing in terms of ‘fairness and efficiency’ may, however, be more comprehensive than this, as the ‘fairness’ concept extends beyond objectively measurable equity and ‘efficient’ is a precondition for effectiveness (Table I.1).

Table I.1. Defining efficiency and fairness versus effectiveness, efficiency and equity

	Effectiveness	Efficiency	Equity
Efficiency	Efficiency equals	Effectiveness per unit investment	
Fairness			Fairness implies an objectively measurable 'equity' concept ***plus*** a subjective perception of proportionality

Table I.2 extends the fairness and efficiency concepts to the four principle of a RES scheme: realistic, conditional, voluntary and pro-poor principles. Each cell in this table highlights implication of the fairness and efficiency when they are connected to each principle. For example, the realistic principle mostly enhances the efficiency of the scheme. However, the fairness element can also be added by giving attention to multiple knowledge systems and the need to shared understanding about 'real' environmental services performance and the conservation costs. In the case of the pro-poor principle, a purely efficient PES scheme mostly excludes this principle since it can reduce the efficiency. However, since this principle is avoidable for any implementation of PES in developing countries, a fair PES under the pro-poor principle should minimally remove any policy instruments that make the poor worse off. The next section will discuss this aspect in more in detail.

Table I.2. The terms ‘fairness’ and ‘efficiency’ reach across the four realistic-conditional-voluntary-pro-poor characteristics

	R = Realistic	C = Conditional	V = Voluntary	P= Pro-poor
Efficiency	Focus on 'real' environmental services, clear performance standards, appraisal of opportunity, implementation and transaction costs	Investment linked to achievement of performance standards	Compliance likely to be higher, monitoring costs lower where agreements are genuinely agreed	Ignoring poor and disadvantaged groups cannot be efficient in the longer run
Fairness	Attention to multiple knowledge systems and needs for shared understanding	Negotiated performance standards	Contracts that meet free and prior informed consent standards for all stakeholders	'Do no harm' as minimum standard; self-determination and focus on process as well as results and outcomes

Multiple knowledge systems under a 'realistic' principle

In a genuine PES scheme, where PES is treated as a commoditisation of environmental services, the principle of a realistic scheme is defined as strong links between land-use practice and provision of tangible and measureable environmental services. This principle is considered as one of the elements for enhancing the effectiveness of such schemes. However, in reality, perspectives on 'realistic' relations between land-use practices and provision of environmental services differ between stakeholders. For example, the popular perception that only forests can provide watershed functions has been challenged by scientific studies indicating that mosaics of forest patches, agroforests and other agricultural uses can also provide a regular flow of water of low sediment load, depending on rainfall regime.

There are at least three major stakeholders whose ecological knowledge[20] and perceptions are important: 1) local people; 2) general public represented by the policy makers; and 3) the scientific community. In order to connect the stakeholders and their ecological knowledge, we must recognise the three main ecological knowledge systems: local, public/policy and scientific modellers' (LEK, PEK and MEK, respectively).

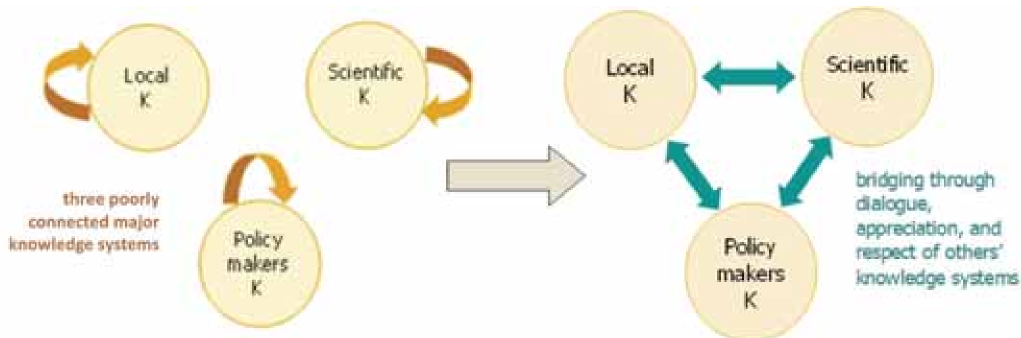


Figure I.1. Major knowledge systems require 'reconciliation' to achieve realistic and successful rewards' mechanisms for improved environmental services

Fair and efficient environmental services' rewards schemes articulate all ecological knowledge systems to address the 'realistic' principle. We also can consider how PES is a follow-on from the negotiation support system discussed earlier. Realistic expectations of agreed quantitative indicators for an historical baseline, the current situation and plausible future scenarios may help in the negotiation process leading to an environmental services' contract. Shorter negotiation time and less conflict reduces transactions costs. Tomich et al. (2010) emphasised that the framing and language of 'ecosystem' or 'environmental services' is not value-free and that alternative perspectives need to be at least acknowledged (Tomich et al. 2010, Ash et al. 2010).

Further, the acknowledgement of the three ecological knowledge systems should consider analysing the severity of issues, their presumed causes and options to deal with them (including constraints to any solutions). Science-based understanding of the landscape and issues can build on, complement and contrast with local and public/policy knowledge and usually provide more quantification of risks and likely impacts. In relation to climate-change adaptation, the variability of rainfall and the way landscapes provide buffering of water flows are key issues open to quantitative analysis. As a last step in the assessment, the different perspectives can be used to

[20] Joshi et al. (2003) defined 'ecological knowledge' as the understanding of the components and processes within the ecosystem and the interrelationship between them.

define what the best common ground for action is, at what spatial and temporal scales and which issues need further clarification before action will be broadly supported and understood.

Local and public ecological knowledge

Local people's ecological knowledge (LEK) is normally embedded in their social and ecological environments. Rural people living in areas that are of environmental importance generally depend on natural resources for their livelihoods. LEK is often descriptive and usually stems from local people's observations, active experimentation and external sources (Joshi et al. 2003). The long-term sustainable use of resources, along with the associated ecosystem functions, depends on their LEK, activities and ability to maintain and utilise the resources. The LEK shapes their decisions and actions, which in turn influence the potential for environmental services from their system. Local people's decisions and actions may also be influenced by their cultural perceptions and values as well as their resource endowments (Joshi et al. 2003).

Public ecological knowledge (PEK) is the common understanding of the general public of how the ecosystem functions. The policy makers, representing the public, often make policies that may influence the access and use of natural resources by local and external people. Their knowledge is often categorical and influenced by their educational background and the public media.

Generally LEK and PEK surveys can be conducted along with spatial and landscape studies. Existing LEK about natural resource management (such as soils, water, forests, agroforests) among local communities can be explored using tools commonly used in Rapid Rural Appraisal and Participatory Rural Appraisal methods. The aim of a LEK survey is to explore and articulate local people's understanding (whether correct or incorrect) of the major issues, problems, their causes and effect, experience and perceptions related to the environmental services under consideration. Local people are the primary source of knowledge. Direct observations, individual and group interviews with a preset checklist are the key methods for knowledge acquisition for LEK. Key informants are the main source of knowledge and information. For PEK, key policy makers are selected for interview. The checklist can be structured using 'digging' questions such as 'what, why, how, by whom and when' (see Box I.1). The steps recommended in the exploration of LEK are detailed in Jeanes et al. (2006).

Box I.1

Key questions during exploration of LEK and PEK

1. Is there a real and important problem?
2. What is the problem and since when did it manifest?
3. What is causing the problem?
4. Who is causing the problem?
5. Who is affected?
6. How bad is it for those affected?
7. What can be done to stop or reduce the problem?
8. How do we know that this will work?
9. What effort and cost does this solution require from whom?
10. Why hasn't this solution been implemented yet?
11. Why do we think it will work this time?
12. Who will have to contribute to the cost?

For policy makers, the degree of synergy across ecosystem services is an important point of consideration (Box I.2).

Box I.2

Can carbon stocks be a proxy for all ecosystem services?

Figure G.1 showed carbon stocks (C), watershed functions (W) and biodiversity (B) as three parallel parts of the ecosystem services complex. To the degree that these functions respond in parallel to degradation impacts and restoration efforts, any of the three can be used as a 'proxy' for the other, and managing for of the three services will have positive 'co-benefits' for the others. The degree of coupling among B, C and W, however, is relatively low. Watershed functions depend on strategically placed tree cover rather than forests across the watershed; biodiversity depends on conservation of natural vegetation; carbon stocks may be maximised in plantations of high-value timber that have low B and W functionality (Xu 2011).

At international level, the issue of emission reduction has received more attention and potential funding streams than biodiversity conservation. There is a risk of 'carbonisation' of landscape management, where maximising carbon stocks leads to reductions of B and W functionality. In this regard, the choice of emission reduction schemes has an interesting set of consequences for the 'co-benefit' debate (Table I.4).

Table I.4. Consequences for biodiversity values and watershed functions of the choice of accounting base for rewarding reduction of land-based emissions. Modified from van Noordwijk et al. 2009

Emission reduction scheme	Consequences for biodiversity value	Consequences for watershed functions
RED = Reducing emissions from deforestation	Untouched natural forest generally has high biodiversity value, but there also are low carbon stock, high biodiversity habitats that require conservation	Natural forest is generally a source of clean water with buffered flows, but is not in itself a guarantee for downstream watershed functions
REDD = the same, plus emissions from forest degradation (loss of forest carbon stock)	Logging if done in accordance with the rules can reduce carbon stock with little impact on biodiversity, until thresholds are reached	Logging roads can have a disproportionately negative effect on water quality by affecting riparian buffers
REDD+ = the same, plus carbon capture in restored/increased forest carbon stock	Plantation forestry generally has low biodiversity value and 'forest improvement' on 'degraded lands' from a tree production perspective can have negative impacts on biodiversity	Plantation forestry can have negative effects on water yield
REDD++ = REALU = reducing emissions from all land uses, independent of operational forest definition	Managing biodiversity at landscape scale and from a long-term ecological perspective may require ecological corridors between protected areas; this can synergise with watershed functions rather than carbon optimisation	Additional focus on dispersed trees and maintaining soil organic matter in agriculture can synergise with infiltration, buffers and maintenance of watershed functions

Modellers' ecological knowledge

The ecological knowledge of the scientific community develops through a more formal research process of replicated experimentation and analysis. The researchers' ecological knowledge develops into generic 'models' of understanding and application. Hence, the modellers' ecological knowledge (MEK) is also descriptive and process-based, similar to LEK.

The predictive ability of models under MEK is an important aspect that can be used as a management tool. Models try to answer 'what if?' questions. For models to be used correctly, the scientific modeller needs to understand the biophysical system being studied and how the model operates. Models require scientific understanding of the dynamics of environmental services, both in their development and use, especially during the parameterisation, calibration and validation phases of using the model.

The value of a model for non-technical users may be quite different from the statistical validity evaluated by modellers (Lusiana et al. 2011). As models tend to (over)simplify, they are particularly challenged in dealing with diversity (Villamor et al. 2011). Participatory modelling (Johnson 2009) can link MEK with LEK and/or PEK. Participants selected across the different stakeholder groups should be involved in the problem definition, model selection (or development), application and output evaluation. The model should be friendly to non-modellers and it is also important to ensure that stakeholder participation is continuous, transparent and representative. Gathering of data and inputting to the model may take some time. The modeller should be aware that such delays may make the participants lose interest, hence, this should be handled carefully. The participants' views, values and knowledge should be incorporated in the modelling process. This can be achieved, for example, through simulation runs of scenarios that would reflect a proposed change in the watershed and together evaluate the model outputs. At the end of the participatory modelling process, the model results should influence watershed management decisions.

Baseline study

A baseline study is the analysis of the current situation to identify the starting point for a project: in this case, a PES mechanism. The baseline survey is a benchmark for monitoring and evaluation. It helps to assess a PES project. It should focus mostly on the environmental services in question and anything that would affect the ecosystem in providing the services. This would require collecting relevant data from various sources for the study. Some of the relevant data sources could be, for example, satellite imagery, aerial photos and water quality assessment data. External parameters that may also affect the reward mechanism, such as climate variability, would also be an important component of baseline surveys. Global patterns of land-cover change (Figure I.2) suggest a dramatic increase of pasture and a continuous increase of cropland, more at the cost of 'other land' categories than forest, but the baselines at national and eco-regional scales can be quite different.

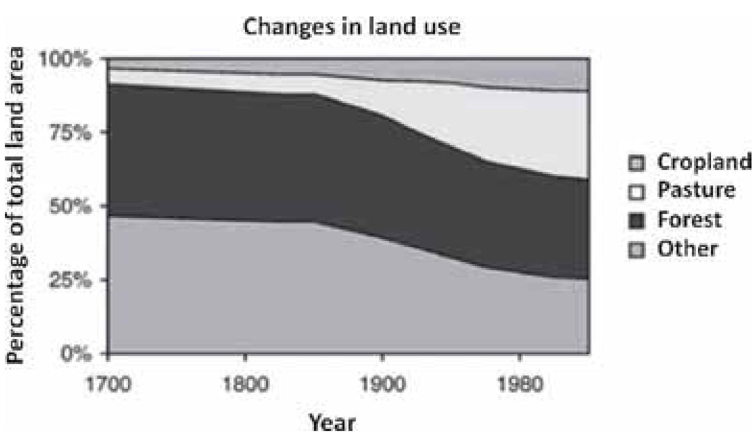


Figure I.2 Historical estimation of global land-use changes. Source: Goldewijk and Battjes 1997, Lambin et al. 2001

Tools for spatially explicit assessment of ecosystem services

In addition to scenario development and prediction of trends of ecosystem services through models on the basis of accumulated information (for example through LEK, MEK, PEK), for effective and realistic policies and mechanisms, such as PES, an assessment of the existing and potential states of ecosystem services needs to be done spatially. Trees, for instance, are generally large and long-lived vegetative components within any landscape; they have profound and multiple spatial environmental impacts on water flow and quality, soil erosion, carbon storage and biodiversity conservation as well as productivity, welfare of domestic animals and landscape aesthetics. The impact of tree cover on ecosystem services is influenced by the location of the trees. This requires planning in a spatially explicit context, so that trees may be strategically located for greater ecosystem benefits. Hence, within a PES framework, farmers enhancing and maintaining tree cover at critical ecosystem points should receive higher rewards than others. In this context, GIS tools like Polyscape (Box I.3) can be applied to explore spatially explicit trade-offs amongst ecosystem services inherent in tree placement within landscapes. Such tools are crucial for engaging stakeholders, fostering participatory approaches to landscape management, negotiating land-use changes and implementing policies and practices across sectors at a landscape scale (Sinclair et al. 2009).

Box I.3

Polyscape for negotiations

A key problem with using any geographic information system (GIS) tools and techniques in developing countries is that major information such as soil maps and land-use data often exist at a very low resolution (or out of date, inaccurate or non-existent). To partly overcome this, the Polyscape GIS toolbox was designed to incorporate local stakeholders' (or experts') ecological knowledge into the tool's output. This provides two key benefits: first, the data is improved cheaply and efficiently; and second, consultation with local people generally increases their participation in the intervention, which is often critical to success.

Figure I.3. Toolbar of Polyscape toolbox

Polyscape runs in ESRITM ArcMap™ 9.2 (or 9.3) with Spatial Analyst™ extension. Polyscape currently comes with six tools (Figure I.3). The first four tools use simple rules to explore where opportunities exist to modify land use to increase a particular ecosystem service and where the existing land use is already providing important benefits to the landscape. The ecosystem services currently treated are agricultural productivity (tractor icon), flood mitigation (raindrop icon), erosion and sediment transfer to streams (dirt/water icon), and habitat connectivity (ladybug icon). The fifth tool provides algorithms to explore where mutual opportunities and/or trade-offs exist. The sixth tool provides a facility for allowing stakeholders to correct erroneous land-use and/or soil data, create scenarios of land-use change and add in their own specifications as to what land they consider valuable/not valuable and/or non-negotiable (Jackson et al. 2009). The requirements of data for application of Polyscape vary according to the ecosystem services under consideration.

Polyscape produces spatially explicit outputs in the form of maps showing areas where different ecosystem services either show a trade-off or have synergies at landscape scale. Figure I.4 shows a typical trade-off layer derived from the application of Polyscape in Sasumua watershed (one of PRESA's research sites) in upland Kenya. The trade-offs shown explore two separate ecosystem services (flood mitigation and farm productivity). The research interest here was to explore where best to place trees in the landscape. There are small areas where tree planting meets all criteria (shown as light green); areas where a single ecosystem service is good and other ecosystem services are neutral (shown as dark green). The areas coloured red or maroon show where new trees are either not desirable or would require large incentives to promote. Large areas are dominated by trade-offs amongst these environmental services or low impact (shown as orange).

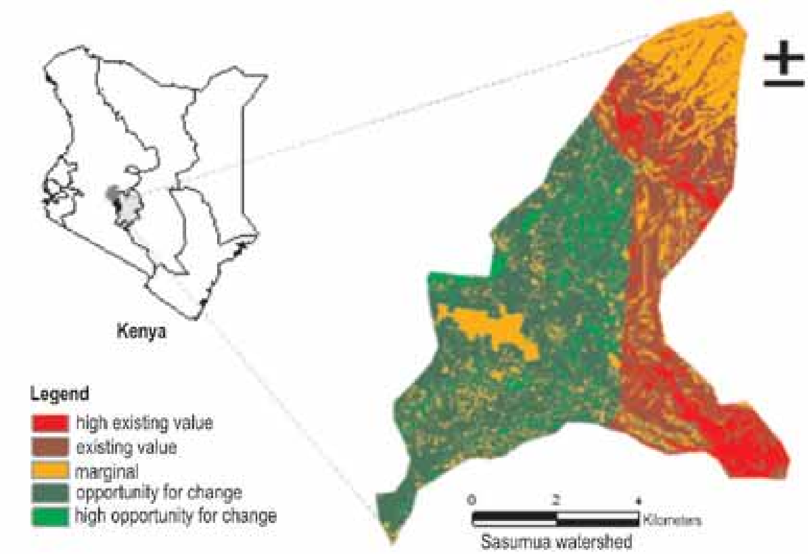


Figure I.4. Polyscape output for PRESA's Sasumua watershed study area, trading-off flood mitigation and agricultural productivity services

Ecological modelling of buffers and filters

Hydrological models have traditionally focussed on the prediction of the temporal patterns of river flow, using hydrographs or flow records as the primary source of tests of model validity. In order to get a close match between 'modelled' and 'measured', such models usually require a large number of input data; where these input data are spatially explicit, the number of 'degrees of freedom' tends to increase rapidly and there are many opportunities for 'getting the right result for the wrong reasons'. That weakens the case for using the model to predict responses to possible future conditions that may well be outside of the validity range of the model. Rather than focussing on precision, model developers might focus on 'robustness' or the ability of a model to give reasonable answers under a wide range of conditions. In many situations, the properties of the probability distribution of future flow regimes is more interesting than the day-by-day precision in the predicted hydrograph. In the context of 'watershed services' as discussed here, the concept of 'buffering' emerges as an important intermediary between externally induced fluctuations in rainfall and the type of variation in stream flow that is the result. Box I.4 describes the technical aspects of quantifying the degree of flow persistence and buffering.

Box I.4

Buffering and flow persistence

The counterpart concept to 'climate variability' is 'buffering'. The greater the buffering, the more the 'mean conditions' rather than 'daily variability' will determine the outcome of climate change in a given location. Sensitivity to climate variability can be greatly decreased by enhanced buffering. Your house and clothes provide examples, protecting your body temperature from the air temperature recorded in a weather station. Increased variability of rainfall may lead to increased demand for buffering as an 'ecosystem service' (regulatory function).

In terms of water flows (streams, rivers), the degree of buffering can be quantified by the daily 'flow persistence' parameter (van Noordwijk et al. 2011b).

$$Q_{t+1} = p\, Q_t + \bullet$$

Where Q_{t+1} and Q_t refer to the river flow at day t and t+1, respectively, p is the flow persistence parameter and • is a random variable for increases in flow reflecting recent rainfall. If p = 1 the add-o parameter • must be zero and we have a perfectly buffered watershed without any variation in flow. If p = 0 there is no temporal autocorrelation of river flow and • has the same statistical properties as Qt. The empirical value of p depends on the position in the landscape: the further along a river, the higher p and the more stable a river flow is. Empirical scaling rules for maximum flow of rivers differ from those for average flow. When large areas are considered, the low spatial autocorrelation of rainfall is a major stabilising effect on daily river flow, as peaks in rainfall at sub-catchment level are likely to occur on different days. For smaller areas, the flow pathway of water is a major determinant of the p parameter because for overland flow p may be zero (all such water reaches the stream within one day) while for groundwater flow it may be less than 0.05 (with less than 5% of the groundwater stock flowing into the stream in a single day) and for 'interflow' or 'soil-quick-flow' the p-value may be about 0.5. The condition of the soil, vegetation and drainage systems affects the flow pathways, aggregate p value and hence 'buffering'. Rather than the generic 'forest' versus 'non-forest' of popular hydrology, these determinants of the flow pathways allow for a location-specific understanding of buffering and the options to increase it. Climate-vegetation-soil-landscape models now exist (compare with intermezzo 3) that can tease apart the relative contributions of land-use change and climate change to predicted change in buffering, and the degree to which land-cover configurations can compensate for predicted climate change as a form of adaptation.

Enabling or disabling criteria for realistic output

To ensure that the anticipated results are plausible with an envisaged reward mechanism, the following checklist is useful.

- All major stakeholders are clearly identified, including their roles and responsibilities in provisioning, monitoring, accessing and using (and misusing) environmental services.
- All stakeholder groups agree (or nearly agree) on what the environmental service is, how important and valuable the service is and to whom this is important.
- There is broad consensus among the stakeholders on what the problem is and how intensive this is.
- In general, all groups are clear on what is causing the problem, who is being affected and who is benefitting, if any, from the root problem.
- It is clear what needs to change (for example, farming practices, pesticide use, resource exploitation, mismanagement).
- There is general agreement on the potential solutions to solve the problem/s and what is the 'cost' of such change.
- It is clear who are the beneficiaries of the environmental service.
- It should also be clear if the beneficiaries are willing to pay for the environmental services they are benefitting from.

Multiple levels of conditionality in rewarding environmental services

A payment and reward for environmental services' contractual agreement contains conditionality that should be fulfilled by all parties. The conditions of an environmental payments or rewards' scheme is that the conditions are agreed in a transparent manner and imposed in a conservation contract (Box I.5). When a PES scheme focuses only on its efficiency, the conditionality only refers to 'you get what you for pay' principle, that is, environmental services' providers only get the payment if they can provide an increase in measurable environmental services. Less environmental services equals less payment, resulting in less cost for conservation activities.

In reality, this type of condition does not work, at least in action research sites of RUPES and PRESA in Asia and Africa. In this sub-chapter, we present multiple levels of conditionality for these schemes that can be applied in different situations, depending upon the local context. The broader understanding of conditionality leads to the inclusion of the fairness element in a scheme.

Box I.5

Components of a PES contract

- Stakeholders involved and their specific roles (providers, buyers, intermediaries and other parties)
- Definition of terms that might create confusion, such as, 'carbon sequestration'
- Rights and obligations of each stakeholder
- Terms of payment
- Schedule of verification
- Sellers' guarantee
- Conflict resolution mechanism
- Period of the contract
- Handling changes and innovation in the contract that might occur in the future ('change and risk management strategy')
- Force majeure
- Map of location
- Signatures of all parties

A conditional scheme should dynamically connect environmental services provision with rewards or compensation in such a way that there is effective and transparent implementation of the scheme. Van Noordwijk and Leimona (2010) introduced five levels of conditionality (Figure I.5). It is less likely that all four levels of conditionality are instantly available to make a comprehensive scheme, hence, it is more practical to use a 'tier' approach, depending on the level of conditionality available. This will give room for observation of a particular scheme at a given level of conditionality and for identifying/analysing opportunities for more improved pro-poor mechanisms. Constructing mixed strategies within different levels of conditionality is possible to achieve effective and transparent schemes. For example, a contractual agreement is made to guarantee a certain amount of payments for conservation activities (third level) with a bonus payment, such as a share in net benefit, if environmental services' providers can show a certain agro-ecosystem condition (second level) or increase in measurable environmental services (first level).

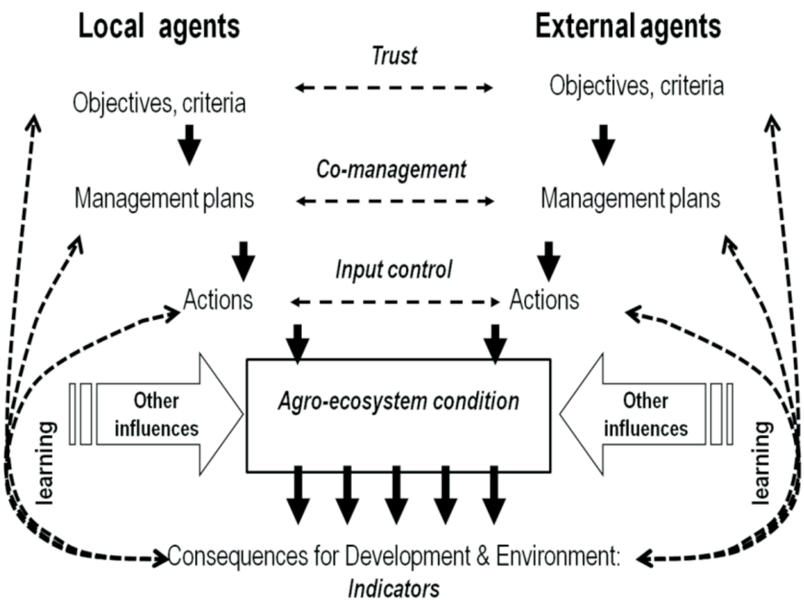


Figure I.6. Five levels of conditionality for agreements on environmental services' rewards schemes between local and external actors. Source: van Noordwijk and Leimona 2010

At Level I, the contractual relationship is based on the establishment of a set of criteria and indicators of actual delivery of anticipated environmental services. For example, for watershed function, the basis of payment is per cubic metre of clean water from a watershed, the amount of electricity produced from a hydroelectric scheme or the level of sedimentation reduced. 'Pay for what you get' (and no more) is attractive for environmental services' buyers. Ideally, the parameter(s) should be easy to measure and agree upon by the sellers and the buyers. However, there may be substantial costs and complications involved in measurement. Environmental services' baselines are debatable and the level of provision is often strongly influenced by external factors, such as 'year-to-year' variation in rainfall, extreme natural events and processes of global change. Payments, mostly of the financial type, are usually divided by the term of the contract and spread over time as more environmental services are being provided. However, time-lag in supplying such services might constrain the achievement of the desired service level.

To fully implement the conditionality at Level I may not be fair, especially for poor environmental services' providers who have little capacity to absorb risks. The RUPES River Care case study outlined the course of an agreement between a community living in a village in a riparian zone and a hydropower company (Intermezzo 16). The case described the Level I conditionality where the percentage of sedimentation reduction determined the amount of payment received by the community. Just a month before the contract ended, when the community had fulfilled about 80% of the activities committed to in the contract, a landslide occurred in an upstream forest. The natural disaster increased the level of sedimentation in the river but, since it did not directly occur in the village area, the article of force majeure could not be applied. In this case, with Level I conditionality, the provider was very resilient but had no control over the terms of the contract. Subsequently, they only received about USD 278 because sediment reduction was less than 10%.

At Level II, the contractual relationship is based on the actual status of the agro-ecosystem; this is known as a stock-based approach. It has potential advantages over flow-based accounting of environmental services at Level I because it is easier to observe and measure. Many sophisticated techniques are available to monitor ecosystem conditions, such as remote sensing. However, the cost of these types of monitoring is high; imagery may not be complete; and the procedures are not free from errors.

At Level III, providers receive rewards if they perform conservation activities based on their contractual agreement, regardless of whether environmental services' benefits are obtained or not. Buyers will adjust their willingness to pay if they clearly understand that activities carried out by the providers will contribute to improving the supply of environmental services. This may make sense for risk-averse, poor providers, but this practice is almost similar to common public investment projects, where governments pay farmers at or below local minimum wages. Reflecting on the River Care case, the situation would be different if the contract was based at Level III conditionality or was an activity-based agreement. The River Care group members would receive full payment if they accomplished all agreed activities.

The focus of Level IV conditionality is the overall management approach that strengthens the scheme: this relies on community-scale decision and control processes. The contractual agreement at Level IV is broadly defined as a management plan developed by all stakeholders in a participatory manner. The management plans might indicate specific actions and desired level of incremental improvement in environmental services but those indicators do not influence the level of payments. Risk-sharing among the actors involved in the scheme characterises these levels of conditionality. The conditionality takes a further step back and is expressed in terms of trust. Conditionality based on trust obviously requires mechanisms for evaluating if previous trust has been justified. Beyond that, this type of conditionality may form the basis for a long-term and more equitable relationship. The implication is that support and trust for mutually agreed objectives become the main bases of the scheme.

The eco-labelled tea production in Kenya provides an interesting case for analysing these conditionality levels (Intermezzo 17). The Sustainable Agriculture Network standard combines the criteria of Levels II, III and IV conditionality. For example, under its 'Ecosystem conservation' principle (Article 2.8), it states that an agroforestry system's structure must meet some requirements, such as:

a. the tree community on the cultivated land consists of minimum 12 native species per hectare on average;
b. the tree canopy comprises at least two strata or stories; and
c. the overall canopy density on the cultivated land is at least 40%.

Overall, the role of environmental services' intermediaries acting as 'honest brokers' is important in assisting local communities meet the conditions of their contract. Basic steps are to constantly recognise community rights, provide links for risk-sharing between all stakeholders and facilitate conflict resolution. Externally, it is important to correct policies that promote environmentally harmful practices or/and discriminate against poorer farmers.

Ensuring participation and transparency for a voluntary approach

The concept of rewarding people for the environmental services they provide suggests a straightforward relationship between at least one seller and one buyer over a well-defined environmental service. However, in reality, such schemes are multifaceted, involving multiple stakeholders in a complex transactional process that involves negotiations over goals and means of developing schemes. A scheme is considered 'voluntary' when participation of landowners is based on personal decision, even in a collective action setting, and willingness to cooperate both for private and public benefit. Although such willingness often signifies an acceptable level of payment, that is, the payment offered exceeds the opportunity costs of current practices, there are other motivational factors for participation of landowners, such as social pressure to protect the environment.

In any case, the engagement of sellers of environmental services must be based on free choice rather than on being the object of regulation, and both seller and buyer must voluntarily agree on the contractual scheme. However, this is not easy when the bargaining power of stakeholders is unequal and information shared among actors is asymmetric. Sellers, who are in many cases poor upland dwellers, have less bargaining power compared to their lowland counterparts, the buyers, who are often educated urban dwellers. Can the bargaining power of sellers and buyers be completely equal?

Our experience in applying the procurement auction for sedimentation reduction in Indonesia (Box I.6) suggests the auction process can embrace both efficiency and fairness in a voluntary conservation contract with some considerations in its implementation (Leimona et al. 2009). The procurement auction mainly aims to increase the efficiency of a scheme by better allocation of contracts to farmers with lower opportunity costs. However, in this case study, the auction was carefully designed to be biased towards marginalised participants, ensuring the fairness element it was emphasised.

A procurement auction becomes more transparent in contract allocation compared to a top-down selection process by intermediaries or buyers. Participants openly know who the winners are and why. In addition to that, contract allocation can be based on various factors to emphasise efficiency (that is, targeting participants with land with higher quality environmental services' provision) or fairness (that is, targeting participants with low income). Trade-off of efficiency and fairness in this procurement auction is clearly described by Jack et al. (2008).

Box I.6

Efficiency and fairness in procurement auctions for environmental services

An environmental services' contract procurement auction is an alternative policy mechanism to extract from the providers the information on level of payments or incentives that at least cover all their costs in joining a conservation program (Latacz-Lohmann and Schilizzi 2005, Ferraro 2004). It is defined as 'a process through which a buyer of environmental services invites bids (tenders) from suppliers of environmental services for a specified contract and then buys the contracts with the lowest bids' (Ferraro 2008). Procurement auctions for conservation contract have been successfully implemented in the United States, Australia and Europe. The award of contracts on the basis of competitive bidding is a method frequently used in procuring commodities for which there are no well-established markets, such as in markets for environmental services.

The World Agroforestry Centre conducted an experimental procurement auction for watershed services (Leimona et al. 2009) (Table I.1). The setting of this study was a watershed in Lampung, Indonesia, where soil erosion had broad potential for on-site and off-site damage. The most direct on-site effect was the loss of top soil from coffee farmlands that dominated the watershed and low agricultural productivity in the long term. The off-site effects included siltation, water flow irregularities, reduction of irrigation, water pollution and agrochemical run-off. The soil sediments could reduce the capacity of a reservoir located downstream of the watershed, hence, adversely affecting irrigated agriculture and hydroelectricity generation.

Table I.. Characteristics of reverse auction design

Characteristic	Implementation
Auction type	One-sided, sealed bid, procurement auction
Bidding units	Willingness to accept
Budget limit	Predetermined, concealed
Number of rounds	7 provisional, 1 binding
Announcement of provisional winners	By ID number
Bid timing	Simultaneous
Pricing rule	Uniform, lowest rejected price
Tie-breaking rule	Random in determining tied winners
Bidder number	Known, fixed
Activities contracted	Determined in advance

The auction in Indonesia was designed using a uniform price rule for fairness reasons. The literature on auction design finds that uniform pricing is more likely to reveal farmers' true opportunity costs because bidders only determine the chance of winning. However, uniform pricing is relatively less cost-effective compared to the discriminative price rule.

The auction was a multiple contest consisting of eight rounds with a last binding round. The benefit of multiple rounds was that farmers learned from the rounds of the auction. However, the announced last round may have introduced forms of strategic behaviour. Concealing the number of rounds gives participants higher uncertainty because they have their own subjective probability distribution about the chance of it being the last round. By announcing the last round, the benefits from farmers' learning on the previous round and the advantages of a one-shot auction for the last round were combined.

The rate of accomplishment at the final monitoring was moderate. The reasons for this were various, ranging from lack of leadership and coordination among farmers' group members, difficulty in finding grass seedlings to accomplish the contract, and coincidence with the coffee harvest. In this specific case, a private contract tends to be more successful compared to a collective contract when leadership is lacking or there is no 'champion' in the community. Institutional aspects and contract flexibility might influence the accomplishment of conservation efforts. Analysis showed that there were no significant differences in level of understanding, complexity and competitiveness and conservation awareness between compliant and non-compliant farmers.

The design of an experimental auction should fit the overall objectives of a conservation program. In this case, the challenge was to design and administer a fair auction for farmers with low formal education, prone to social conflicts, and influenced by power structures within their community.

Source: Jack et al. 2008, Leimona et al. 2009

Pro-poor: access, design and outcome

In reforming institutions to create an enabling environment, the rural poor and socially marginalised groups must be directly involved. Obtaining ‘buy-in’ through their recognition and participation will foster ‘co-investment’ for sustained provision of ecosystem services. This will reduce negative externalities as well as the backlash associated with enforcement of stringent policies and laws. This is achievable by ensuring that financing mechanisms like carbon credits do not harm the poor or differentially benefit them. This also addresses social justice issues.

Identifying rewards that match with people’s needs and expectations is one particularly important aspect of pro-poor approaches (Leimona 2011). The findings from focus groups at the different sites in Asia suggest that there is a substantial variation among communities concerning poverty concepts and reward preferences, which provides important insights into the various dimensions that well-targeted reward schemes need to address. Our analysis concluded that rewards in the forms of human capital, social capital and physical capital—referred to as non-financial incentives—are very often the most preferred and possible types of rewards. Contribution to non-financial incentives such as strengthening social capital can increase levels of social cohesion and trust within a community and with its external links, which in the end can lower transaction costs. In other cases, the rural poor may prefer direct payments rather than in-kind rewards, but their coming together promotes collective action and learning. However, the pro-poor dimension is often constrained by policies and legislation that limit access, use and management of specific resources.

As described at the beginning of this chapter, the level of conditionality that an environmental service rewards contract can achieve is variable. It ranges from tangible benefits for the providers that are linked to the actual enhanced delivery of environmental services (Level I), through maintenance of agro-ecosystems in a desirable state (Level II) and performance of agreed actions to enhance environmental services (Level III) to the development and implementation of management plans to enhance environmental services with respect for local sovereignty in conserving the environment for both local and external benefits (Level IV). Based on these levels of conditionality, three paradigms have been distinguished: commoditisation of environmental services (CES); compensation for opportunities skipped (COS); and co-investment in environmental stewardship (CIS) (Box I.7, van Noordwijk and Leimona 2010).

Box I.7

Paradigms in rewards for environmental services: CES, COS and CIS

Paradigms refer to a way of thinking, a mindset that is used to analyse and interpret the world around us. Language matters, as it influences the emotional values and expected repertoires of action (Swallow et al. 2009, Kosoy and Corbera 2010). The most commonly used label, 'payments for environmental (or ecosystem) services', refers to a buyer/intermediary/seller perspective of markets. It is most closely associated with:

CES = Commoditisation of environmental services: if these services can be 'repackaged' into marketable entities or commodities, the efficiency of markets as institutions can be expected to balance supply and demand and provide incentives for a level of 'environmental services production' that matches demand, at least in theory.

In practice, however, government agencies and/or private sector entities regulated by government have been the primary 'buyers' because collective action is needed. Demand is thus regulated, but also the supply, as the measurement of environmental services is too complex and costly and land-use types such as 'forest' are used as proxies:

COS = Compensation for Opportunities Skipped: standardised price levels applicable over large areas are used for inducing voluntary restrictions of land use to increase the environmental service level and/or to compensate rights holders for involuntarily accepting such restrictions. A Costa Rican PES innovation and many programs that followed it were essentially using a COS paradigm, even though they used CES language.

In practice, however, contested rights prevent the effective use of a COS paradigm and a third paradigm covers most of the current practices in Asia and Africa:

CIS = Co-Investment in Stewardship of natural capital as a basis for future environmental services flows: sharing responsibility, risk and resources in the form of 'co-investment' also implies respect and recognition for the roles, rights and responsibilities of the various parties involved. The use of proxies is acceptable, as long as these are regularly evaluated and revised.

Modified from van Noordwijk and Leimona 2010

Co-investing in ecosystem management with communities will promote collective learning and action through enhancement of social capital. Devolution, decentralisation and negotiation support approaches ensure the participation of the poor in the design and implementation of schemes. Co-investment also ensures social justice, cohesiveness and improved livelihoods through alternative streams of income from transfer schemes for environmental services. There are opportunities for phased strategies. After creating a basis of respect and relationship through the paradigm of CIS, there may be more space for specific follow-ups in the paradigm of CES for actual delivery of environmental services to meet conservation and service additionality objectives.

Intermezzo 16.

The Rio conference and *Reshaping the International Order* in relation to forests, trees and agroforestry

Fifteen years before the 1992 Rio conference that established global governance mechanisms for environmental issues, the third report to the Club of Rome was published under the title *Reshaping the International Order* (RIO) (Tinbergen 1976). This report, formulated by a group of about 20 experts from developing as well as developed countries, reflected the way the 'West', 'East' and 'South' were seen at the time in the context of the poverty–environment nexus. It followed the 'limits to growth' debate of the first report to the Club of Rome.

Now that we look back on 20 years after Rio, we can reflect on whether or not Rio has contributed to RIO. We may note that the triangular relationship of the 1970s was folded into a dichotomy in 1992, with 'Annex-I' and 'Non-Annex-I' countries as a fundamental concept in the UNFCCC and the Convention on Biological Diversity. Lack of progress in achieving the goals of the UNFCCC can be attributed to a considerable degree to the discrepancy between this dichotomy and a world in which 'emerging economies' became more prominent year by year, reaching the status of the Number 1 emitter of greenhouse gases, in the case of China, around 2009. Breaking out of a black-or-white language of victims-and-villains and addressing the realities of the environmental challenge is needed to break the current deadlock in negotiations.

Two other dichotomies are equally limiting the emergence of efficient and fair solutions:

1) The way 'forest' was segregated from the rest of the landscape and singled out as the environmental policy target turned a quantitative gradient of tree cover and resulting functions into an 'in-or-out' challenge for definitions. The term 'forest' did not, and even until now does not, have an operational definition that allowed its use as identifier of policy domains. A lot of energy was wasted on 'afforestation/reforestation' ideas that could not be applied within the 'institutional forest' areas because being 'temporarily unstocked' did not mean they were 'deforested' (van Noordwijk et al. 2008). Similarly, controversy over the scope of REDD+ in relation to plantation forestry and tree crop plantations has cooled the initial enthusiasm of efforts to protect forests. With separate rules being negotiated for 'agriculture' and 'forests' we are still a long way from 'reducing emissions from all land uses' (REALU, van Noordwijk et al. 2009).

2) The way the 'mitigation' issue was segregated from 'adaptation', with separate policy frameworks and funding streams created a strong path dependency in the debate, with negative incentives for activities such as agroforestry that can clearly contribute to both (Verchot et al. 2007, Neufeldt et al. 2009). Adaptation discussions were for long seen as undermining the case for deep cuts in emissions and mitigation efforts. The 'limits to adaptation' debate (Kandji et al. 2006) can reconcile the two. Actions on the ground can be much more salient, credible and legitimate if the two concepts can be combined into 'mitigadaptation' but national policies and international debates in the UNFCCC maintain separate agendas.

We can conclude that in both cases the framing of issues in the Rio agreement has hindered the emergence of evidence-based mechanisms that address the problems of rural poverty and environmental degradation and that regularly revisiting the key underlying assumptions of environmental policy is essential for making progress. The role of agroforestry research in challenging the myth perceptions and false dichotomies of environmental governance is a 'louse in the pelt' of forest-based institutions but it may help to achieve the overall Millennium Development Goals of poverty reduction and environmental sustainability (Garrity 2004).

Figure I.6. Agroforestry sits at the nexus of three United Nations (UN) conventions—Biological Diversity (CBD), Climate Change (UNFCCC) and Combating Desertification (UNCCD)—and is central to achieving the Millennium Development Goals

Intermezzo 17.

The altruism puzzle resolved: George Price's equation in a human development context

Charles Darwin was aware that the social insects—bees, ants and termites—were a serious challenge to the mechanism that he perceived to drive the continuous process of adaptation in biological evolution. Individuals appear to readily sacrifice themselves for the greater good of the group, undermining the mechanisms for 'survival of the fittest'. With greater understanding of the mechanisms of genetic inheritance and the DNA coding of life, the issue remained and most of the 'group selection' concepts that were posed as explanations fell short of what 'selfish genes' were understood to do. In mathematical terms, however, George Price solved the problem with a very elegant equation in 1970 (Figure I.7).

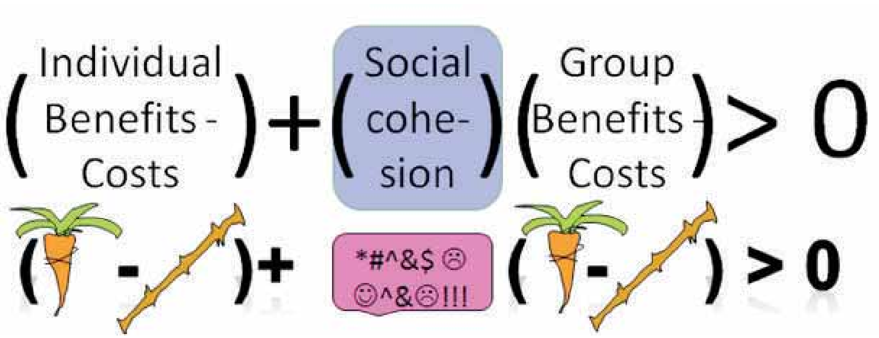


Figure I.7. Simplified version of the George Price's equation that relates the net effects of individual behaviour on the costs and benefits of all other individuals to the private costs and benefits via a matrix of 'relatedness' or 'social cohesion'; the carrots, sticks and sermons of Figure H.1 address different terms of this equation and can work against each other or in synergy

The same concept can be used to understand the role of 'carrots', 'sticks' and 'sermons' in attempts to modify land-users behaviour towards greater group benefits. Expectations of individual rewards (carrots) or law enforcement (sticks) interact with the knowledge of perceived costs and benefits for others, modulated by the degree of relatedness or social cohesion.

Of specific current interest is the idea of 'crowding out' social cohesion by emphasis on individual payments. It seems likely that shifts from 'pro-social' to 'individual' behavior can be induced by promising relatively small financial benefits and that the return to 'pro-social' domains is relatively slow. There may (further evidence from the field is needed) be a risk that small payments targeting individuals have a negative overall effect: they reduce social cohesion while not providing sufficient incentive to replace and exceed the social motivation levels to care for environmental services.

J. Increasing resilience and sustainagility by support of social and ecological buffers

There are five key points in this chapter.

1. Resilience requires focus on the process of adaptation rather than the result of adaptedness.
2. Buffers exist in ecological, social and economic senses and reduce the short-term need for adaptation.
3. Increased vulnerability can be as much due to loss of filter functions as to increased external sources of variability and stress.
4. Ecosystem-based adaptation operates at landscape scale and needs to link the social dimensions of human behaviour to the dynamics of ecological buffers and filters.
5. Sustainagility is a key concept in ensuring that future options are not compromised by sustainability (persistence) measures.

The real challenge for any governance system is to govern as little as necessary, but no less. Most rules induce human beings to try and circumvent them, not because the rules are void of any public rationale and advantage but because the immediately perceived negative impact on the individual seems disproportionate to the public gains.

In the final analysis, 'adaptation' is not about providing a set of solutions that increase 'adaptedness' (Box B.1), as important as such solutions may be in the short term, rather, it is about:

1) increasing the ability to recognise problems early enough;
2) access to resources that allow different solutions to be feasible;
3) the ingenuity of individuals or small groups to create new solutions; and
4) the social and governance context that supports the spread of innovations once they pass tests of consistency and undesired side-effects.

Climate-change adaptation has to be open ended, with a focus on the processes of innovation and 'sustainagility' for the longer run.

Buffers/filters as a unifying concept

Throughout the preceding chapters we have used a terminology of buffers and filters, providing quantitative definitions for specific buffer functions (for example, Box B.1) and a conceptual, qualitative understanding for others. Buffer effectiveness can be defined in a generic way on the basis of the ratio of variance of a quantitative property after and before (or with or without) the entity that buffers. Filters, similarly, are measured by the reduction of the mean of a specific signal. In many cases, buffer and filter functions are linked and they can be treated as a group. The concept applies to physical properties (such as radiation, wind speed, humidity, temperature (minimum, maximum or mean over a specified time period)), biological properties (dispersal and migration of organisms, such as pest and disease or pollinators/seed dispersal agents), economic properties (financial flows, financial transactions linked to extreme events and pressure points such as insurance mechanisms) and social properties (with psychological stress as a measurable quantity, for example) (Fig. J.1).

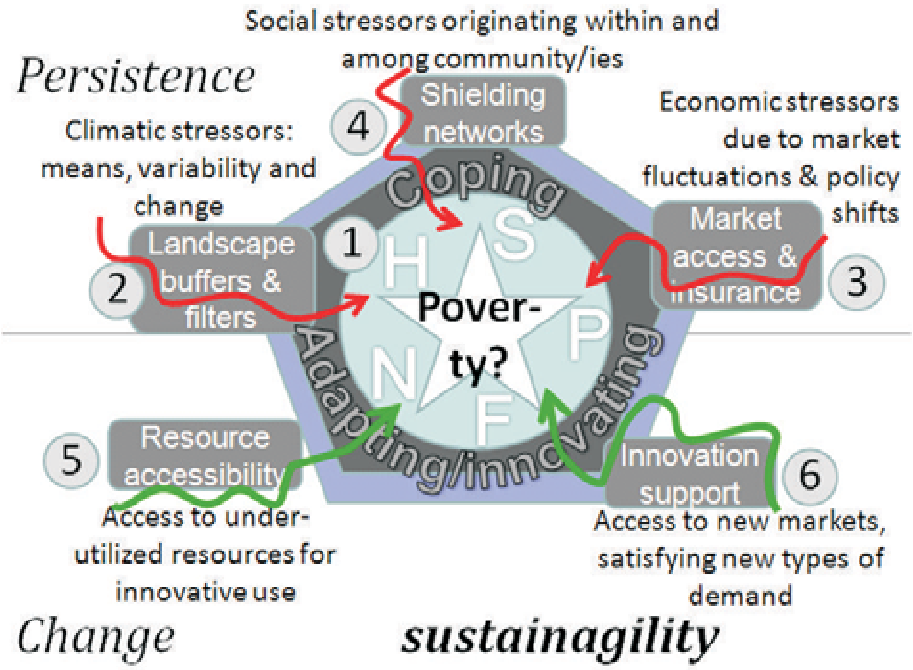


Figure J.1. Human livelihoods at the centre of the graph and surrounded by the five capital types (N = natural, H = human, S = social, F = financial, P = physical infrastructure) can be shielded from the external sources of variability and stresses through social networks, economic insurance mechanisms and/or ecological buffers and filters at landscape scale; buffers and filter also influence the opportunities for change through resource access and innovation support, as aspects of sustainagility

This representation suggests a number of important conclusions that may require further scrutiny and should be seen as hypotheses at this stage.

1) The combined impact on human livelihoods of the various sources of variability, pressure and stresses on the five assets under direct control of an individual or household defines poverty and human wellbeing, with coping and adaptation/innovation approaches based on exchanges between asset types.
2) From an internal observers' perspective it is hard to distinguish between 'loss of buffer/filter functions' and 'increased external variability' causation of increased stress; the 'local climate change' perception could as well be caused by 'loss of buffer/filter effects' as by global climate change; the increased price fluctuations can be due to changes in global markets and/or losses of intermediate buffer functions[21].
3) From an overall system health perspective the buffers and filters are the 'endogenous' part of a system that can be managed, protected and enhanced, while external sources of variability cannot be controlled; optimising buffer/filter management requires understanding of the cross-links of buffers, for example, the substitution of social safety-nets by more individualistic financial insurance mechanisms connects social and

[21] The 'financial crisis' of 2008 was triggered by the linking of insurance mechanisms that collectively failed because they had become too tightly linked and lost the partial independence needed for risk reduction; the global economy paid the price where individuals had benefited from 'efficiency gains' that consisted of reducing buffer and filter effects

financial filter functions; climate change may imply a greater future relevance of buffers and filters of all types.

Responsiveness requires pressure

The idea of optimising buffers and filters has to deal with two types of challenge.

1. Buffer functions are linked across scales: while building higher dykes along a river is a good way of reducing the local risks of flooding it increases the risks downstream. It has taken engineers and governance agencies a long time to understand that maintaining riparian wetlands and allowing overflow areas may be a better way to protect downstream areas than increasing the number or size of dykes; similarly, it took time to understand that building higher chimneys to reduce the local negative impacts of air pollution was effectively displacing and spreading the problem rather than dealing with it. Less popularly understood is the relationship between control of industrial sulphur dioxide (SO_2) pollution and the more rapid increase of global temperatures after the 1970s: SO_2 served as a cooling gas and filter of incoming global radiation rather than as a greenhouse gas and its reduction allowed the increase in atmospheric CO_2 to be directly expressed in temperature increases. Control of atmospheric So_2 pollution had many advantages in reducing 'acid rain' effects but it aggravated global warming.
2. Biological and human systems require clear signals that there is a problem before action is taken (Figure J.2). As long as buffers and filters are effective, there is no selective advantage in dealing with the underlying problem. In an 'evidence-based' world,

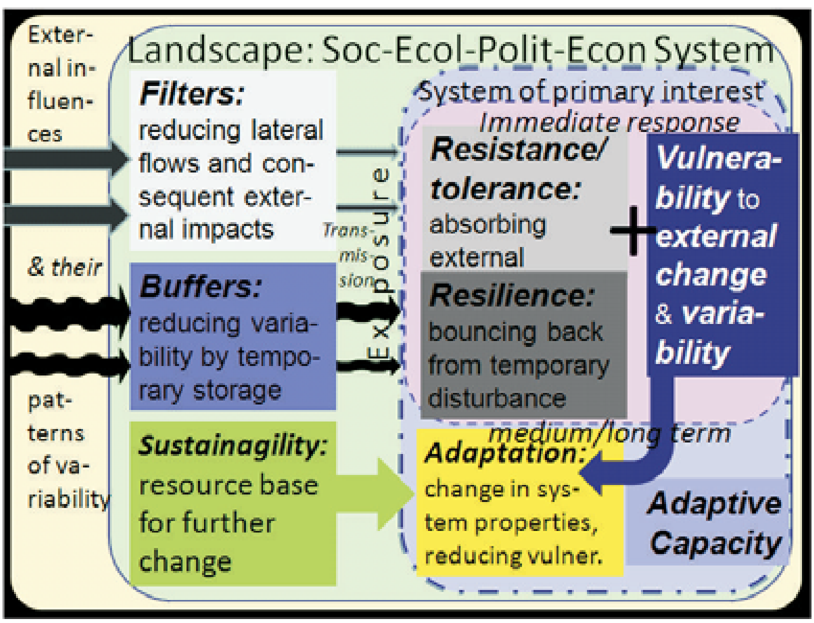


Figure J.2. Nested layers of sub-system properties that reduce the impact of external variability (or increases in variability) on the wellbeing of individuals/households: buffers and filters reduce exposure while part of the resultant variation can be handled within the coping range or at least the resilience domain that prevents long-term damage; adaptive responses normally need a trigger that suggests a selection advantage of new ways of reducing actual vulnerability politicians and the general public that elects or supports them need to be shown the evidence that a problem is serious before they are likely to act. We may need to distinguish here between buffers and filters that act in an 'outer shell' before 'exposure' is measured and the internal properties of a regulated system that allow it to 'cope' by tolerating variability and/or internally absorbing it, followed by the 'resilience' (or bouncing back) properties that imply that short-term pressures do not lead to long-term negative consequences. True vulnerability starts where the resistance, tolerance and resilience responses are insufficient. However, such vulnerability may trigger adaptive responses that go beyond 'bouncing back' but imply a longer-term change in the system properties.

3. Adaptive responses require triggers (selection pressure), adaptive capacity (innovations and variations being tried) and underutilised resources that can be used in new ways.

Potentially the 'intelligent' use of adaptive capacity in humans can be one step ahead of biological adaptive responses that need the selective pressure to be actually expressed. Rationality might, in theory, lead humans to listen to early warning signals and respond before the precipice is reached (Rockström et al. 2009). One needs to be an optimist to recognise such rationality in the reality of political processes and international negotiations regarding climate change.

Ecosystem-based adaptation and sustainagility

Current understanding of the role of landscape buffers and filters in reducing human vulnerability to global climate change can be summarised in the statements that

1) Landscape-scale interactions between external variability and landscape elements, via buffer and filter effects, have historically reduced human vulnerability;
2) Agricultural intensification and the simplification of landscapes for large-scale mechanised land uses has lead to a reduction of buffer and filter functions, partially replaced by technical substitutes; and
3) Current 'ecosystem-based adaptation' may need to restore lost buffer/filter functions and enhance them, based on a good understanding of how they work and what their limits are.

A major function of landscape buffers and filters may well be that they allow ecological corridor functionality for otherwise vulnerable biota. Maintaining the biological resource base of life on the planet is probably the most relevant 'insurance premium' that we should be rationally inclined to pay, even though we may never know what parts of it will actually be used in the sustainagility responses of future generations. Current pressures of climate change are still such that maintaining the basis of future adaptation as a process is more urgent than increasing adaptedness in the here and now.

The design of current global programs for the way agriculture and food systems can respond to climate change suggests that this insight is not yet widely shared. It remains easier to track the definition and spread of specified technologies than it is to assess farmer capacity to innovate and to increase farmer access to resources that allow new approaches to emerge. Throughout this book we argue that diversity and multifunctionality provide opportunities for change and future use beyond what we can currently foresee and predict. Trees, as all other biota, have the capacity to self-adapt and human adaptation strategies should aim to synergise with the biological process of adaptation, rather than try to engineer and design solutions that can then be expanded following the management styles of the corporate sector.

K. Research priorities

The editors

Our review of the evidence on how trees and people can co-adapt to climate change has provided a reasonable basis to act now, in support of multifunctionality of landscapes. Multifunctionality is worthy of support from the perspective of environmental service provision. We found a considerable level of support for the hypothesis that 'Investment in institutionalising rewards for the environmental services that are provided in multifunctional landscapes with trees is a cost-effective and fair way to reduce vulnerability of rural livelihoods to climate change and to avoid larger costs of specific "adaptation", while enhancing carbon stocks in the landscape.' (Figure K.1).

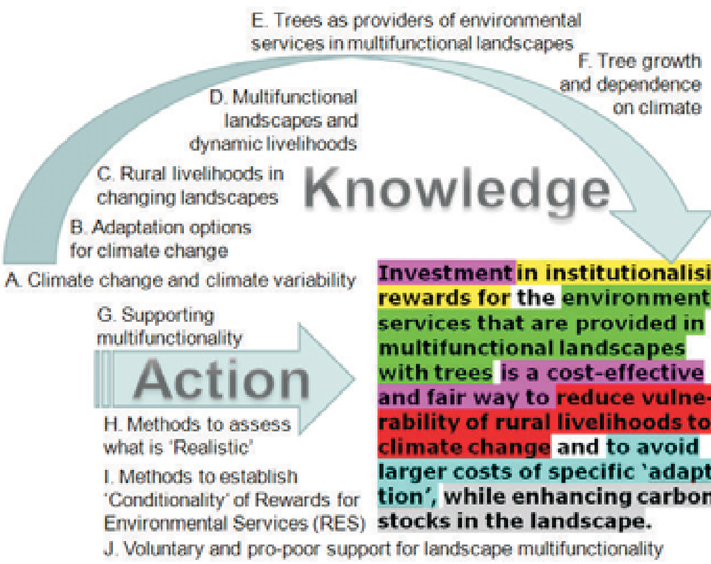


Figure K.1. Overview of the preceding questions, leading to current understanding of the various elements of the overarching hypothesis

In the first chapter we summarised the content of this book and listed ten points that were ready for direct action, even if details of the underlying science will continue to be refined. We here present further issues where research may need to clarify the options before widespread use.

Ideas for further research

- Combine ecological and environmental economics frameworks to analyse the risks to local livelihoods posed by climate change and globalisation of trade
- Explore new approaches to integrate the space-time dynamics of landscape functions in socio-ecological systems that acknowledge the political economy as well
- Elaboration of adaptive options that also maintain 'high carbon-stock livelihoods' on the LAAMA–NAMA and NAMA–GAMA frontiers
- Investigate a more detailed functional interpretation of tree diversity in dynamic landscapes in representative ecological zones in various stages of tree cover transition
- Research ways of enriching public perceptions of causality and choice of options beyond current stereotypes of forest, climate, floods and economic growth
- Reflect on how multiple knowledge systems, multiple stakeholders and multiple action perspectives can be effectively combined

- Identify priority areas for action
- Expand institutionally the rapid appraisal methods, which have already been tested at pilot scale, that acknowledge multiple knowledge systems and perceptions
- Refine the operational rules for use of climate-change adaptation funds
- Further analysis the degree such funds can be channelled through PES mechanisms for 'preventing the increase of vulnerability'
- Develop an efficient way to package qualitative with quantitative methods for enhancing conditionality of RES contracts promoting and monitoring impacts of tree-based mitigadaptation options
- Test the three PES paradigms of co-investment and risk sharing (CIS), offsetting opportunity costs (COS), and optimal-threat theory for commoditised environmental services (CES) in reducing climate vulnerability
- Develop a more proactive use of tree germplasm that anticipates climate change

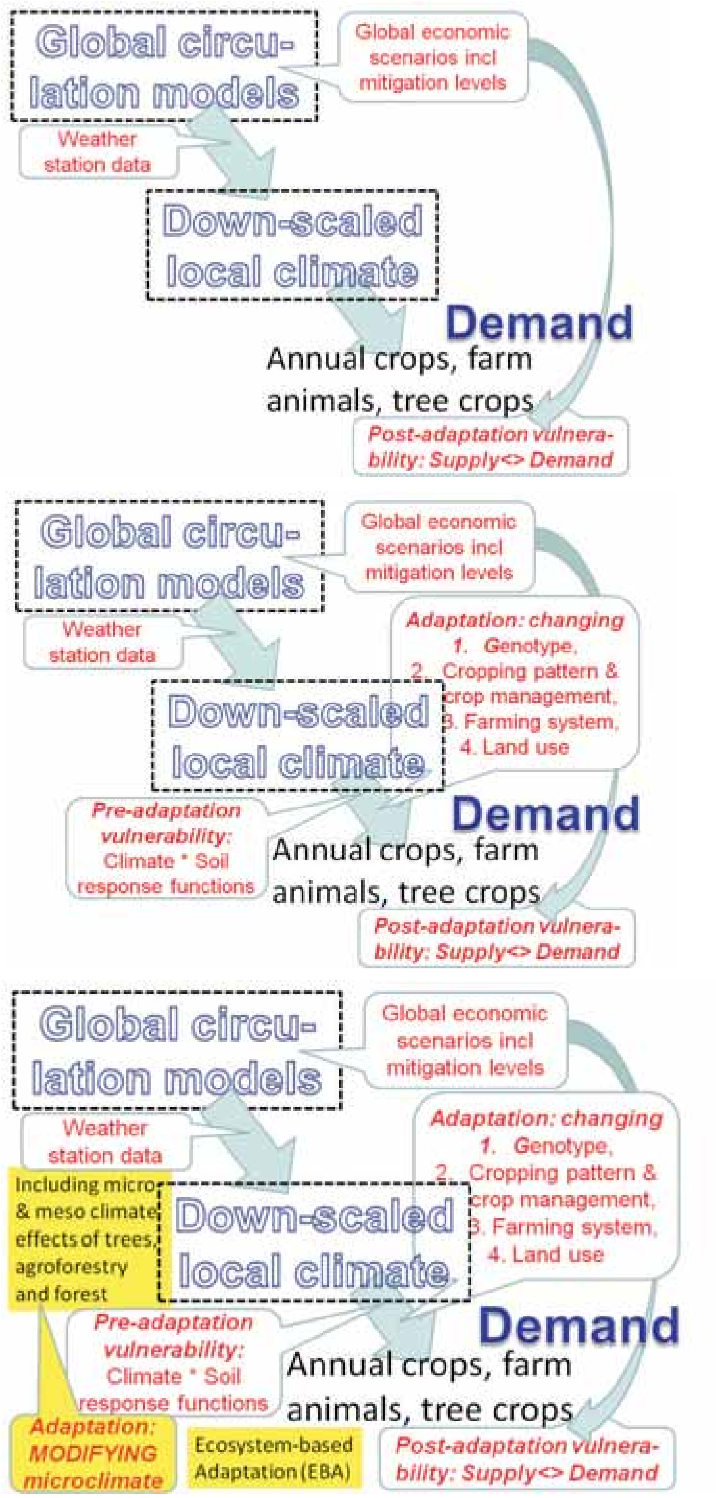
Revisiting the way climate-change adaptation is analysed

The first estimates of human vulnerability to climate change compared the predictions for 'downscaled' climate change (that means global climate change translated into predictions for local climates) with the requirements of crops, trees and farm animals and reported the sum of negative and positive effects (predicted minus current performance) as the predicted impact of climate change (Step 1 in Figure K.2).

In more sophisticated studies (Step 2 in Figure K.2), this 'pre-adaptation' vulnerability is compared to 'post-adaptation' vulnerability, after taking into account the options for changing the genotype of crops, cropping patterns and crop management, the choice of crops and/or farm animals and/or land-use patterns at large (including land abandonment in unfavourable locations and expansion of agriculture in newly suitable areas). Studies at Step 2 level require large databases, lessons learnt from 'climate analogues' (locations where the current climate is similar to what is expected in the future at a target location) and considerations of 'climate shift' (the shift along elevation or horizontal climate gradients).

There is, however, a further step. Intermezzo 5 indicated that the preferential location of weather stations for data collection outside of the zone of influence of trees implies a potential 'bias' in the way all current climate data are represented. Current downscaling techniques for global circulation models use the statistical properties of weather station data to infer future local climates. This would be fine if tree-less conditions would be the only option for agricultural production conditions. But, this approach tends to miss out on an important further approach to adaptation: landscape-scale modification of micro- and mesoclimates by increasing tree cover (Step 3 in Figure K.2).

In fact, the current records of temperature increase at weather stations do contain effects of changes in the surrounding landscape, as well as in global climate. Where weather stations have been engulfed in 'urban heat islands' they are omitted from the data series, but where 'coolness islands' of surrounding forest were lost, the data are accepted as they stand. New insights in the potential for micro- and mesoclimatic modification call for a re-examination of the empirical record of weather data in the context of the changes in the surrounding landscape. Such analysis might point the way to a further adaptation approach, based on (re-)introduction of dispersed tree cover in agricultural landscapes, as well as protection of closed-canopy forest in strategic locations. Research quantifying these relations has barely started.



Step 1. Human vulnerability estimates without considering adaptation

Step 2. Human vulnerability estimates including crop adaptation

Step 3. Human vulnerability estimates including landscape–mesoclimate adaptation

Figure K.2. Three stages in research on adaptation options to reduce human vulnerability to climate change

What are the frontiers of the emerging sustainagility science?

1. The ecological and environmental economics frameworks are recommended for analysing the risks to local livelihoods posed by climate change and trade globalisation. This is needed to test the 'rationality' of insurance premiums obtained from maintaining multifunctionality.
2. Current cross-scale approaches may be overly detailed and sensitive to poorly quantified parameters. New approaches are needed to integrate the space-time dynamics of landscape functions in socio-ecological systems, nested within global change in markets and climate.
3. While the language of a 'low carbon (flow) economy' has been common parlance, the need for options that are adaptive but also maintain 'high carbon-stock livelihoods' requires further elaboration on the LAAMA–NAMA and NAMA–GAMA frontiers.
4. A more detailed functional interpretation is needed of tree diversity in dynamic landscapes. The suggested interpretation includes quantifying the trade-off between selections for greater short-term benefit ('fitness') versus the costs of losing adaptability. The wide variation in tree life histories that come with the pollination (including dioeciousness) and seed dispersal strategies needs to be better reflected in the analysis of vulnerability of tree genetic diversity to domestication and other selection pressures.
5. Opportunities for enriching public perceptions of causality and choice of options beyond current stereotypes.
6. Reflection on the way multiple knowledge systems, multiple stakeholders and multiple action perspectives can be effectively combined.
7. At the local level, strategies for adaptation and mitigation have almost no distinction: local people use different means and strategies to cope with seasonal variability and adapt to established patterns of change in relation to changes in geopolitical and economic structures, opportunities and constraints, in an integrated fashion. Smallholders do not operate single-handedly: within their immediate environments a sustainable livelihoods and rural development framework for climate-change adaptation and mitigation becomes important for communication, financing and research.

What we need to test more widely, but has a credible concept and replicable methods

1. Appraisal methods and local capacity building: few generalisations in the sphere of natural resource management and environmental services hold true regardless of context and cost-effective rapid appraisal methods that acknowledge the multiple knowledge systems and perceptions are now available for site-specific appraisals. They have been transferred with success to some users beyond the method developers, but only where basic awareness of the approaches already exists. Further institutional expansion is needed, along with mainstreaming in generic education programs.
2. The operational rules for use of climate-change adaptation funds are still being refined. Further analysis is needed to what degree such funds can be channelled through PES mechanisms for 'preventing the increase of vulnerability' that might be the result of intensification/specialisation and loss of multifunctionality of landscapes. The level of site-specific detail needed of to 'make the case' needs to be tested.
3. While the rapid appraisal methods (see topic 1 above) seem to be very relevant in understanding issues and options from various perspectives, it is still a challenge to develop an efficient way to package the tools with more quantitative methods for

enhancing conditionality of rewards for environmental services (RES) contracts promoting and monitoring impacts of tree-based mitigadaptation options.

4. The practicality of the three PES (payment for environmental services) paradigms of co-investment and risk sharing (CIS), offsetting opportunity costs (COS), and optimal-threat theory for commoditised environmental services (CES) needs to be tested in reducing climate vulnerability.
5. The Convention on Biological Diversity constrains the cross-border movement of germplasm while protecting national ownership claims of biological diversity whereas climate change does not respect these borders and expands the natural range of some species in the long run. A more proactive use of tree germplasm that anticipates climate change may need to break the institutional deadlock on germplasm exchange (GSF = germplasm *sans frontiers*).