Shangri-La Workshop 2009

Sustainable Land Management in the Highlands of Asia

18-22 May 2009, Northwest Yunnan, China

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Foreword

The Highlands of Asia play the role of an 'Asian water tower' as they supply water and regulate the climate in upland and lowland areas of Asia adjacent to them. Despite their diversity and complexity in terms of the land and peoples across their three principal zones, viz., the highland Plateau, the upland watersheds, and the lowland plains, they present quite a uniform set of ecological and economic challenges.

Land degradation, one big challenge in the Highlands of Asia, is quite possibly the main environmental issue worldwide. While erosion is a natural process and different erosive processes have helped to shape the earth's land surface over millions of years, in places human interference and action have increased the land degradation potential and affected infrastructure and the lives of millions of people. Land degradation negatively affects the livelihoods and food security of local people – poor people in particular - in the upstream areas through degradation of the natural resource base. Downstream, the sediment loads resulting from widespread erosion leads to reduced life spans of reservoirs, abrasion of hydro-electrical equipment in hydropower stations, increased flood risk due to increased riverbed levels and other infrastructural problems. On the Tibetan Plateau – located at the heart of the Highlands of Asia with extremely low precipitation and very high evaporation rates in the West, and excessive rainfall and temperate climate in the South East - a number of different degradation processes can be observed, be they wind erosion, water erosion, or mass movements. These processes are responsible for some of the highest sediment loads in the rivers originating on the plateau and extended areas that have fallen prey to desertification. To what extent these processes are human induced is still subject to scientific research. Sediments are believed to be from human induced erosion by forest clearing and intensified grazing. Desertification as a result of excessive pressure on grasslands and low water availabilities has further claimed good and productive areas. These areas provide little more than sediment sources nowadays and directly affect the food security of nomadic herders.

Over the past decades temperatures on the Highlands have increased by 0.16 and 0.32 degrees Celsius per decade for annual and winter temperatures, respectively. This resulted in the decrease of permafrost, destabilizing many areas on the Highlands. Glaciers were observed to melt faster than in the years before. This increasing trend is projected to continue significantly with the currently observed trends of global climate change. At the same time precipitation mainly in the winter was also observed to increase and is further projected to increase. However, due to increased temperatures, less precipitation is expected to fall as snow resulting in reduced snow cover and volume. Earlier thawing of snow cover well in advance of the spring season may result in severe spring droughts. With the projected scenarios for temperature and precipitation trends, natural vegetation zones on the Highlands will change substantially. The temperate grassland and cold temperate coniferous forest areas could expand and temperate as well as ice-edge deserts may shrink. These changes may result in a shift of the boundary of the farming-pastoral transition region and provide favourable conditions for livestock production. However, this transition zone is also in the area of potential desertification and serious consequences may occur if protection measures are not taken.

As mentioned above, the current environmental changes pose a serious threat to people's livelihoods in the Highlands as well as to people living downstream. The poor are the most vulnerable and women are most affected as, in the Highlands of Asia, women are disproportionately involved in natural resource-dependent activities, such as agriculture and pasture, compared to the out-migrating men looking for off-farm jobs. The resource-dependent activities are directly dependent on climatic and land conditions. Most fundamentally, the vulnerability of women in the Highlands is affected by their relative insecurity of access and rights to resources and sources of wealth such as agricultural and pasture lands.

In May 2009, an interdisciplinary team facilitated by the World Agroforestry Centre (ICRAF), the Sino-German Technical Cooperation Programme Renewable Energy, Rural Development and Qualification in Tibet Autonomous Region, P.R. China and the International Centre for Integrated Mountain Development (ICIMOD) joined with national partners from regional countries in the Highlands of Asia and other international participants to take part in a unique learning process, to gather experiences, and to exchange information and knowledge about the dynamics of land use in the region. This Shangri-la workshop on Sustainable Land Management in the Highlands of Asia involved an interactive approach including regional reviews, case studies, thematic group presentations and discussions, field trips, and synthesis. This publication summarizes the outcomes of the Shangri-la workshop and provides insight into land use dynamics and sustainable land management options in the highlands of Asia.

We are proud that we could be a part of this learning process, and owe particular thanks to the Kunming Institute of Botany, Chinese Academy of Sciences for their local support. We are grateful to the Swiss Agency for Development and Cooperation (SDC), Swedish International Development Cooperation Agency (SIDA) including Swedish Environmental Secretariat for Asia (SENSA) and the Sino-German Technical Cooperation Programme Tibet for their generous financial support for this workshop.

This publication will be of benefit to all those interested in the Highlands of Asia, its vulnerable people and its vulnerable landscape.

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Acronyms and Abbreviations

BGS	beginning dates of growing season
CA	Conservation Agriculture
CAC	Central Asia and the Caucasus
CACAARI	Central Asia and the Caucasus Association of Agricultural Research Institutions
CAS	Chinese Academy of Sciences
CBD	Convention on Biodiversity
CCD	Convention to Combat Desertification
CDM	Clean Development Mechanism
CGIAR	Consultative Group on International Agricultural Research
CHT	Chittagong Hill Tracts
DEM	Digital Elevation Model
DESIRE	Desertification mitigation and remediation of land
EGS	end dates of growing season
ELF	experienced leader farmer
FCCC	Framework Convention on Climate Change
FtF	farmer to farmer
GBM	Ganges-Brahmaputra-Meghna
GHG	green house gases
GIS	geographic information systems
GLOF	Glacial Lake Outburst Flood
GMS	Greater Mekong Subregion
GTZ	German Agency for Technical Cooperation
HKH	Hindu Kush-Himalaya(s)
ICARDA	International Center For Agricultural Research In The Dry Areas
ICIMOD	International Centre for Integrated Mountain Development
ICRAF	World Agroforestry Centre
IPCC	Intergovernmental Panel on Climate Change
ISET	Institute for Social and Environmental Transition
IWMI	International Water Management Institute
KIB	Kunming Institute of Botany
LADA	Land Degradation Assessment in Drylands
LF	leader farmer
LGS	lengths of growing season
MoA	Ministry of Agriculture
M-POWER	Mekong Programme on Water, Environment and Resilience
MRC	Mekong River Commission

NAFRI	National Agriculture and Forestry Research Institute
NEPCAT	Nepal Conservation Approaches and Technologies
NGOs	nongovernmental organisations
NSSC	National Soil Survey Centre
PES	payment for environmental services
PFU	Programme Facilitation Unit
SDC	Swiss Agency for Development and Cooperation
SENSA	Swedish Environmental Secretariat for Asia
SIDA	Swedish International Development Cooperation Agency
SIWI	Stockholm International Water Institute
SLM	sustainable land management
SSM	sustainable soil management
SSMP	Sustainable Soil Management Programme
SWC	soil and water conservation
TAAAS	Tibet Academy of Agricultural and Animal Hunbandary Sciences
TAR	Tibetan Autonomous Region
TWO	Transboundary Waters Opportunity
UN	United Nations
WOCAT	World Overview of Conservation Approaches and Technologies
YHB	YanHe Basin

Introduction

Shangri-La workshop on "Sustainable Land Management in the Highlands of Asia"

The Shangri-La workshop explored ongoing research and practical initiatives addressing issues of land-use and land degradation from environmental changes in the highlands.

The workshop reflected on some of the state of art of research findings in soil and water conservation, degradation and desertification, physical and social vulnerability, livelihoods and environmental services locally and regionally in the highlands of Asia and the adjacent lowlands.

The workshop aimed to explore issues of sustainable land management at present and in future under the impact of various global changes (and in particular climate change) across many levels – from village and watersheds to transbasin and global.

The workshop brought together about 66 participants comprising scientists, practitioners, researchers, representatives of governmental and nongovernmental organisations (NGOs), and students from more than 19 countries and 40 organizations for five days to share and discuss practical experiences and research findings from the highlands of Asia.

The Highlands of Asia: Vulnerability, adaptation and innovation

The people in the highlands of Asia are finding themselves increasingly vulnerable to loss of livelihoods and assets as well as the dislocation and fragmentation of ecosystems and socio-cultural entities.

The drivers of land degradation include climate change and land use/cover change in the context of global environmental change.

Land degradation is a crucial cause of socio-economic vulnerability affecting the livelihoods and food security of local people in the upper tributary watershed areas. Downstream areas cannot be ignored as the increased sediment loads of rivers resulting from widespread erosion leads to reduced life-spans of reservoirs, increased risk of flash floods and further erosion of arable lands as well as other infrastructural problems.

The highlands of Asia have extremely low precipitation and very high evaporation rates in the western region - one of the driest mountain areas - and excessive rainfall and temperate climate in the southeast region. A number of different degradation processes can be observed such as wind and water erosion.

These processes are leading to some of the highest sediment loads in the rivers originating on the Tibetan plateau and have expanded the areas affected by desertification. Desertification of rangelands and grasslands as a result of excessive grazing and other pressures combined with lower water availability is affecting large areas that were formerly very productive. Now these areas provide little more than sediment and affect the food security of nomadic herders.

Defining the Highlands of Asia

The term "highlands of Asia" refers to the highland plateaus and mountain ranges at elevations above 1000 masl. The highlands of Asia occupy about one-fourth of Asia's land surface anc comprise the inner and south Asian mountains. They contain the most extensive and rugged high altitude areas on Earth as well as the most extensive areas of glaciers and permafrost outside high latitudes. Although the highlands provide a home for less than a tenth of the Asian population, the region is the source of ten of the largest rivers in Asia, the basins of which are home to over 1.3 million people.

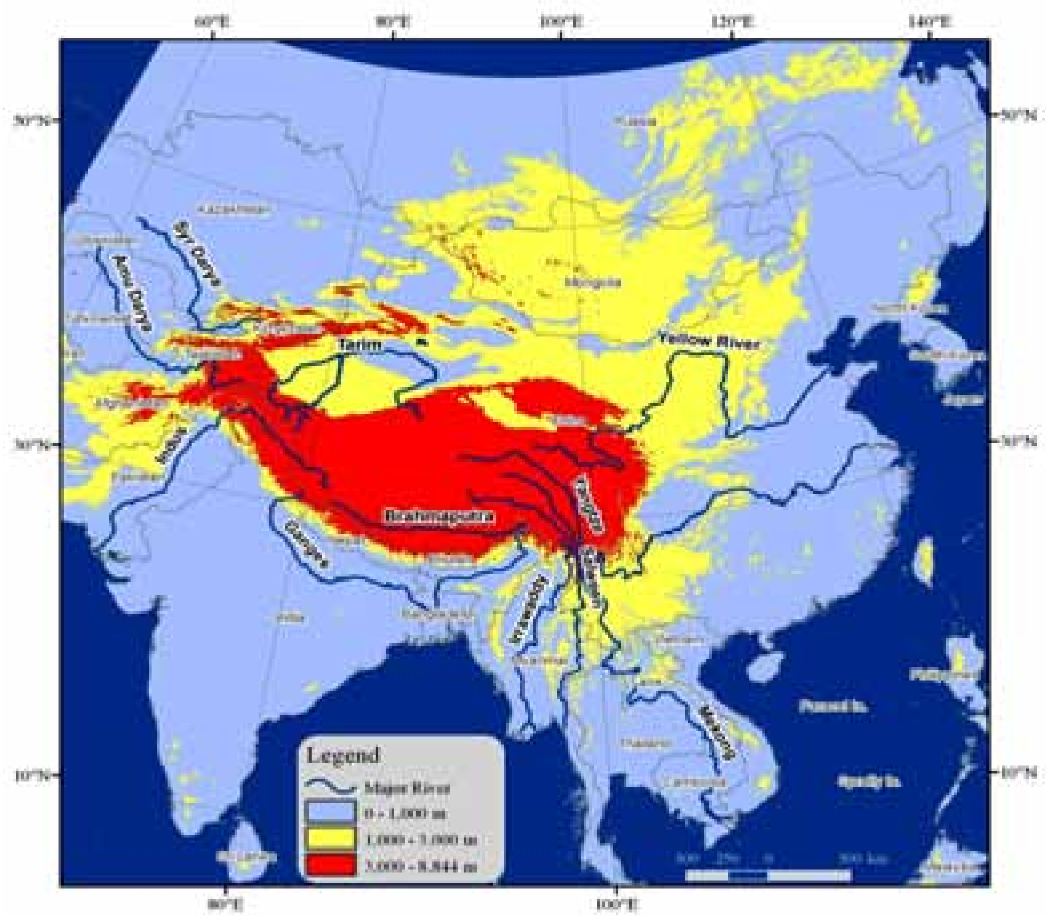
The highlands of Asia have been ignored in comparison to other natural ecosystems, even though history has shown that when ecological change takes place in the highlands, changes soon follow in the valleys and in the lowland plains.

The Tibetan Plateau, located at the heart of the highlands of Asia, plays the role of an 'Asian water tower' as it supplies water and regulates the climate in upland and lowland areas of Asia adjacent to it. Geographically it covers the high altitude Qinghai-Tibetan Plateau as well as the Pamir Plateau, Yun-Gui Plateau, and Loess Plateau and other mountain ranges connected to it.

The highlands of Asia, the largest and most topographically complex ecosystem in the world, play a unique role in global climate and climate change processes. The highland climate is influenced by the Asian Monsoon, the Inner Asian high pressure system, and the winter westerlies. The Tibetan Plateau also has an important impact on climate circulation in the region and on the Asian monsoon. The area itself has several distinct climatic regions which are characterized by variations in rainfall. The eastern edge of the Tibetan Plateau is relatively humid, with rainfall of 400-700 mm annually, the southern central area is semi-arid, and the western and northern parts of the Tibetan Plateau are arid with rainfall of less than 100 mm per year.

Climate change is not new but magnitude and spatial reach in the highlands can make climate events catastrophic. The cascading effects of rising temperatures and loss of ice and snow in the region are affecting, for example, water availability, biodiversity, and global ecological feedbacks (Xu et al. 2009).

Map of Asian Highlands showing key regions and river basins



Synthesis

The workshop saw a rich variety of presentations and discussions in plenaries, small groups and poster sessions as well as a one-day field trip. The workshop heard of new concepts and paradigms as well as state of knowledge reviews, research and knowledge gaps. A number of project-oriented presentations introduced approaches, technical innovations and initiatives for ecosystem protection and recovery. Many presentations highlighted types of land use, management and degradation including mismanagement or over-use of natural resources.

A one-day field trip brought about a closer view of some of the people, ecosystems and issues being discussed.

This report attempts to review the five days of the workshop. In order to retain the richness and flavor of the presentations while also trying to maintain brevity, we have organized the presentations and discussions into selected themes. The report also points to the ways forward outlining agendas and needs for research and policy in the concluding section.

Key Messages from the Shangri-la Workshop

True to the extreme diversity of the region, the key sustainability issues span a wide range of ecological and social areas; however, many of the livelihood challenges faced by people in highland ecosystems are quite similar.

Across this tremendous diversity of contexts and complexity, there is a growing sense of shared understanding in the knowledge and scientific community about critical issues: land and ecosystem degradation; risks and disasters including landslides and floods; scarcity and yet also abundance of water; soil erosion and sedimentation; climate change impacts and vulnerability of people along with adaptation efforts; and the exploration of livelihood options.

Much effort is being placed in bringing together multiple stakeholders as well as to engage in the public policy process to address social and ecological conditions and seek creative as well as pro-active responses and solutions.

The Shangri-La workshop has resulted in commitments to:

- Adopt holistic systems thinking and further strengthen understanding of ongoing research and grassroots initiatives
- Inform and support local people to better understand the impacts of global change as well as the value of their knowledge in relation to the adaptation and sustainable development
- Promote the sustainable land management to reduce global warming and enhance livelihood and exchange of experiences
- Explore institutional innovations and people's adaptation particularly to climate change
- Identify weak areas of both scientific and indigenous knowledge across scales and institutions
- Strengthen linkages between science and policy as land use decisions are a highly political activity
- Catalyse further research, pro-active responses and policy dialogue towards sustainable management of the Asian highlands

New Paradigms, Rethinking Concepts

Recognising complexity, addressing bias

The highlands of Asia are often viewed in simplistic terms viz. the high Himalayan ranges with steep slopes, peaks and glaciers exposed to the threats of climate change; the plateau areas and valleys that are dry and prone to over-grazing and ecosystem degradation; the middle areas with too much water and sediment leading to floods and erosion; the lowlands depending in many ways on the activities of the upstream population.

The workshop presentations showed the fallacy of such simplistic views, highlighted the complexity and diversity of the highland ecosystems and showed the many ways these ecosystems are used for local livelihoods. Rather than compartmentalizing issues or ecosystems (eg. drylands, rangelands, seasonally flooded wetlands), there is a need for a holistic perspective.

The view of the "highlands' often inherently contains a lowland bias or philosophy that holds significant consequences for the management of the highlands. Upland agriculture and forestry management is a good example: lowland-driven policies for sedentarization and a prioritization of unsustainable lowland demand/consumption can often come at the cost of upland livelihood security. A

reversal in the more dominant lowland view of highlands can lead to a better appreciation and understanding of highland complexity.

From the aerial to the grassroots

Managing resources sustainably on the local level is essential for achieving sustainable land management. It is therefore important to have the toad's eye-view to incorporate local or grassroots perspectives of land management. The grassroots view also acts in contrast to the conventional practise of the bird's eye-view of remote sensing, landscape characterization indices, mapping and modeling with geographic information systems (GIS).

The toad's eye view emphasizes the potential of local environmental initiatives and researching instances where local communities formulate their own plans and activities despite many obstacles including neglect of the resource, resistance from the state officials or even opposition from local elites or influential people.

However, the bird's eye view cannot be entirely discarded given its usefulness in some situations such as transboundary water management where uncertainty and asymmetries in the information available to each side and the development of water resources shared by more than one state poses many governance challenges including geopolitical considerations. One example is the Ganges-Brahmaputra-Meghna (GBM) river system. The upper riparians here are Nepal, Bhutan, India and China. India is uniformly the middle riparian while Bangladesh and India are both lower riparians. Another example is the Mekong River Basin where Yunnan province in China is the upper riparian and the so-called "lower Mekong" comprises Cambodia, Lao PDR, Thailand and Vietnam

GIS-based spatial analysis and modeling approaches can be relevant and effective (Adamson 2006) in these basins where the paucity of, or restrictions on, sharing information about river and water flows in national rivers or tributaries pose challenges to both national as well as transboundary water governance.

Desakota

There is a new emerging landscape in Asia that is now widely known as desakota (a combination of two Indonesian words: "*desa*" for village, "*kota*" for town). First described in the McGee-Ginsburg model (McGee 1991) that captured the socio-demographic dimensions of the desakotas emerging from rapid urbanization processes, these regions can be considered neither simply urban nor entirely rural.

Desakota places or regions are characterized by an intense mix of agricultural and non-agricultural activities that often stretch along corridors between large city cores. Incomes in these regions are a mix of livelihood options ranging from agriculture to seasonal urban migration and even funds flowing from cities across the globe. Yet little is still known about the socio-economic and ecological dynamics of these landscapes of emerging desakota regions in Asia. Transitions to sustainable management have to take into account the dynamic nature of these desakota spaces and their mix of livelihood options.

SustainAgility

Going beyond the concept of sustainability, sustainAgility is the property of a system that supports actors to cope with change, to be adaptive and resilient. SustainAgility is part of *multifunctionality* that embeds trade-offs in domestication and intensification, representing a local optimum that resists change. The concept has increasingly emerged in discourse on climate change and adaptation strategies particularly for agro-ecosystems (Verchot et al. 2007). The concept of 'sustainAgility' has been a useful framework for climate change planning to reduce vulnerability and to increase the resilience of agricultural systems.

In upland agro-ecosystems, farmer management can play a large role in adaptation. But agro-ecosystems also differ in the way they can sustain the "farmer's agility" to respond to external pressures, stresses and fluctuations. SustainAgility allows farmer's agility in finding and fitting in new components and continue at different levels of complexity, from sustainability of cropping systems to that of livelihoods (Vandermeer et al. 1998).[1]

Understanding poverty in the highlands

The term 'poverty" needs to be understood as a complex phenomenon that involves not only issues of food security, nutrition, health care, education, clean drinking water and sanitation services. But also availability of different livelihood options including off-farm income and access to land or natural resources as well as governance issues such as exclusion or marginalisation in decision-making or discrimination. This understanding also has consequences for evaluating poverty: for example in the Mekong region, the lowland areas have greater poverty density but also equally a greater density of "non-poor" areas. There are different kinds or levels of poverty in the uplands that entails the need for a range of approaches to deal with their consequences.

[1] Adaptation of agro-ecosystems - and thus sustainagility - can be based on essentially two mechanisms, one internal and one external to the current system. Agro-ecosystems, especially those rich in agro-diversity and biological resources (natural resource capital), can adapt (depending on their human and social capital) by increasing the use of currently under-exploited local resources, or on the basis of (locally or globally) new technology (new crops, new cultivars, new management practices, new external inputs), depending on their financial, human and social capital.

Is the climate change discourse overwhelming debate on development?

Climate change was a recurrent topic or concern in the workshop. However there was also debate on how much or even if the apparent changes were "global climate-change induced" and not just seasonal or annual changes in weather patterns.

There was also caution of the danger of the climate change discourse overwhelming discussion on the every-day development issues with the consequence that both political attention and investments fall away from immediate societal concerns such as education, health, water supply and local development.

State of Knowledge Review

The workshop comprised presentations of state of knowledge reviews. Some key areas and findings are summarised below.

Sediment loads, fluxes and implications

The presentation on an overview of the sediment loads in the Himalayan Rivers showed the contribution of the greater Himalayan region's rivers for sediment supply, transport and deposition as well as sediments load changes and driving forces.

The greater Himalayan region

The Himalayan mountain ranges are the youngest and also among the most unstable. Rainfall patterns are determined mainly by the summer monsoon that deposits often above 2,500 mm of rain annually on the outer ranges.

The Himalayan mountain range separates the monsoon climate of south Asia from the cold and dry climate of central Asia. The Himalayan region covers 4.3 million sq. km. with geographical extensions to Pamir, Karakoram, Tibetan plateau, Indo-Burma, CHT-Bangladesh, and the Southwest China Mountains. The eastern Himalayas alone has 25 eco-regions ranging from upper tributary watershed to grassy rangelands. About 200 million people live in the mountainous areas and another 1.3 billion in its 10 major river basins.

The Himalayan environment provides a combination of high altitude and rugged mountain topography, high relief, active tectonic process and intense monsoonal rain.

More in-depth knowledge of the water and sedimentation processes can supplement efforts to dealing with the vulnerability of the Himalayan region to hazards and disasters such as floods, avalanches, landslides, hailstorms, droughts and earthquakes.

The sediment flux to oceans – the rise and fall of sediment loads deposited in coastal areas – has a far-reaching impact on the riverine, estuarine, coastal, and shelf area ecosystems with implications for aquatic ecology and fisheries that respond to decline of suspended sediment and channel changes.

Changing sediment loads in the Himalayan Rivers

The findings showed that:

- Sediment loads: High sediment flux from large Asian rivers
- South and Southeast Asian rivers are more important for sedimentation than Chinese rivers
- Himalayan sediment supply was mainly from the high mountains between 1000-3500 m due to frequent slope failures and severe surface erosion and lower and hilly areas from 500-1000 masl because of intensive human activities
- Decline in sediment fluxes to oceans from the 11 combined large Asian rivers to over half or from 4.3 to 2.1 Gt/year
- Chinese rivers (Yellow, Yangtze and Pearl) now contribute less compared to South (Brahmaputra and Ganges) and Southeast Asian rivers (Irrawaddy and Mekong)

- In three types of rivers - Yellow, Indus and Ganges – there was significant decline in both water and sediment,
- Significant decline in sediment only was found in Yangtze, Pearl, Red, Mekong, and Chao Phraya.
- No obvious change in water and sediment in the Salween and Irrawaddy, and the Brahmaputra rivers
- Declines in sediment are mainly due to dam and water diversion infrastructure and to a limited extent due to soil conservation

Land degradation and its causes

The pace, magnitude and spatial reach of human alterations of the Asian highlands are unprecedented. Land use and land cover change and its associated degradation in highland ecosystems are, however, poorly documented, and its causes are not fully understood. Land degradation directly impacts biodiversity; contributes to local and global climate warming; is the primary source of soil degradation and green house gase (GHG) emission; and affects regional hydrological processes and water resources. Such changes also determine, in part, the vulnerability of places and people to climatic, economic or socio-political perturbations. Rather than population growth and poverty, political economy factors focusing on differential power and access enforced by dominant social structures are often the primary causes of land-cover change in the region. Opportunities and constraints for new land uses (such as green house agriculture) are created by markets and policies, increasingly influenced by global factors including climate warming. Extreme biophysical events occasionally trigger further changes. Various human-environment conditions react to and reshape the impacts of drivers differently, leading to specific pathways of land degradation in the Asian highlands.

Rangeland degradation and rehabilitation

There is a widespread belief that rangelands have relatively constant carrying capacities derived from their native agro-ecological potential and that stocking strategies exceeding these capacities cause degradation. The intrinsic variability of rangeland productivity in arid regions, however, makes it difficult to distinguish directional change (e.g., loss of biodiversity, soil degradation) from readily reversible fluctuations, such that interpretations of “degradation” and “desertification” must be viewed cautiously. Arid rangelands are increasingly seen as non-equilibrium ecosystems.

Modification in the biological productivity of these rangelands at the annual to decadal time scales is governed by a combination of human and biophysical drivers (e.g., inter-annual rainfall variability, extreme climatic events). State policies throughout Asian highlands are framed under the assumption that pastoralists overstock rangelands, leading to degradation. The resulting management strategies aim to control, modify, and sedentarize the traditional patterns of pastoralism, including the development of fencing and store-feeding for long-term exclusion of grazing. Two common pathways follow: weakened indigenous pastoral systems that lead to undermining local economies and resource institutions, local overstocking and degradation. Alternatively, exclusion and reduced grazing may lead to a "loss" of species diversity, a change in vegetation cover, and "reduced" plant production. In alpine rangelands, policy-driven bans on the use of fire and climate-driven tree-line shift lead to increasing woodland vegetation cover.

Grasslands are the main source of soil carbon loss in China. About 90% of grasslands are degraded to some extent with overgrazing being the main anthropogenic cause of degradation. About 67% of China's counties exceed theoretical stocking rates by >20%. One gap is that the "legal tools" for grassland conservation and management are still incomplete. Moreover, China's "Grassland Monitoring System" for monitoring rangeland degradation although initiated is under-funded and as yet incomplete.

Addressing land degradation in rangeland areas requires improved understanding of the drivers of land use change that contribute to degradation, and a thorough investigation of possible ways to address these drivers. At a technical level, many options exist, and several countries in the region have experience with research and demonstration projects to improve livestock and rangeland management. However, as management institutions vary among countries in the region, some technical measures that are suitable in one place may not be so suitable elsewhere. Fencing is a prime example of this.

With the possible exception of Mongolia, the rangelands are not as crucial for food security at a national level as arable lands, and hence can be used for carbon sequestration. Further research in these specific areas given below is required.

- If China initiates a national carbon cap and trade system, research would have to be done now in advance to prepare a case to demonstrate that agriculture and rangelands are suitable to participate in this future system;
- Even where the biophysical potential to sequester carbon has been research and established, and the implementation costs of technical measures are well-known, the opportunity costs for households are less well documented, especially in pastoral areas;
- Methods for developing biophysical baseline scenarios using historical data exist; but modeling of socio-economic dynamics is weaker at present.

Eastern Himalayas: Climate change vulnerability of mountain ecosystems

The eastern Himalayas comprise six biomes dominated by tropical, subtropical and temperate broadleaf forests. The region is rich in strict endemics with a greater concentration in the south and eastern parts with 8 to 16 species. The different ecosystems have undergone land cover changes: (+) shrubland (90%), bare areas (7%), cultivated land (3%); and (-) snow cover (35%), grassland (17%), forest (48%) and water bodies (0.1%).

The presentation showed:

- Increased magnitude of warming with elevation, with areas >4000m experiencing the highest warming.
- Eastern Himalayas is experiencing widespread warming. The warming in the period between 1970 to 2000 was generally higher than 0.01°C/yr and future projections show trends up to 6°C/yr n some areas expected by 2060
- Annual mean temperature is expected to increase by 2.9°C by the middle of the century.

The impacts of climate change in the Eastern Himalayas are expected to be more pronounced than the global average with the following implications:

- Hydrological change to impact functions and services of wetlands
- Successional shift from wetlands to terrestrial ecosystem
- Vulnerable ecosystems that would be affected include ephemeral habitats (seasonal) and riverine island ecosystems e.g. Majuli of Assam
- Vulnerable entities include varieties of upland rice (dryland/wetland in the entire northeastern region), indigenous bean varieties, cucurbits, and citrus.

Watersheds at the smaller scale: Hydrological processes and small watersheds in Southern China

Ongoing research on hydrological processes in smaller watersheds in southern China (Kejie watershed) presented variations in rainfall, hydrology and land-use to show the effect of climate/land-cover change on mean annual hydrological processes in the meso watershed.

This kind of preliminary research is useful to help decisions on what kind of land cover and vegetations appropriate for the watershed, and for watershed management at smaller scales of villages and towns/districts. DeFries and Eshleman (2004) suggest that the understanding of the consequences of land-use change for hydrologic processes and integrating this understanding into the emerging focus on land-change science are major needs for the future. These consequences include:

- Changes in water demands from changing land-use practices, such as irrigation and urbanization;
- Changes in water supply from altered hydrological processes of infiltration, groundwater recharge and runoff and
- Changes in water quality from agricultural runoff and suburban development.

This requires truly integrated research involving different disciplines and can now build on the already established international networks of scientists and the use of remotely sensed information that was not available a decade ago.

Phenology dates modelling and responses to climate change in Tibetan Plateau

Formerly, phenology monitoring[2] has not been applied in Tibet. One study from Kunming Institute of Botany recently attempted to:

- Model the beginning dates of growing season (BGS), the end dates of growing season (EGS) and lengths of growing season (LGS) of the vegetation in Tibet
- Analyze the spatial and temporal distribution pattern of BGS, EGS and LGS from 1982 to 2006
- Explore the climate change impact (including both temperature and precipitation) on phenological dates

[2] Phenology monitoring (http://en.wikipedia.org/wiki/Phenology) is the study of periodic plant and animal life cycle events and how these are influenced by seasonal and inter-annual variations in climate. Phenology has been principally concerned with the dates of first occurrence of biological events in their annual cycle. Examples include the date of emergence of leaves and flowers, the first flight of butterflies and the first appearance of migratory birds, the date of leaf colouring and fall in deciduous trees, the dates of egg-laying of birds and amphibia, or the timing of the developmental cycles of bee colonies.

The impact of phenological dates change can be traced to: Carbon, water, and nitrogen cycles; grazing systems; grass production; duration of pollination season; distribution of diseases. The study analyzed the linear relationship between the phenological dates and climate factors such as temperature and precipitation.

The study found:

- Linear relationship with climatic factors
- Non-linear inter-annual change trend
- Certain areas are sensitive such as: Wide valley from Shiquanhe through Gaize to Selin Lake in central of northern Tibet; Central part of southern Tibet

Knowledge Gaps

The knowledge reviews also pointed to gaps where more research and information or response strategies would be needed such as on local efforts at adaptation and climate change mitigation. In upland research, in particular in the Mekong river basin, more attention needs to be given to gender and ethnicity issues.

Sedimentation in the HKH region

The presentation showed that there is not much work done on sediment fluxes and impacts from climate change. The study recommended the holistic study of sediment and its related issues in the framework of Earth System Science across the HKH Rivers, including but not limited to:

- Link the upper with the lower reaches
- Developing a continuous monitoring programme and updating the data for these major rivers
- Sediment responses to climate changes (ice and snow melting, temperature and precipitation changes) and land surface disturbances (e.g. land use/land cover changes, dams/road constructions, and water consumption etc.)
- Sediment impacts on habitats and in-stream biodiversity
- Sediment budget linking suspended sediment load with slope erosion, river bank collapse, and river channel erosion

Eastern Himalayas: Vulnerability assessment to climate change

The findings pointed out that:

- Annual precipitation changes are quite variable, decreasing at one site while increasing in site nearby but little data is available

- Gaps exist in consistent and representative data; overall regional data centre is required to consolidate the research and information
- More information is needed about the vulnerability of both the eastern and western Himalayas ecosystems in particular long-term monitoring of climatic conditions and its impacts on climate sensitive environmental and socio-economic units

Carbon soil sequestration

Climate change mitigation could also be achieved through soil carbon sequestration, improvements in rice culture, livestock/manure management and cropland management. Such agricultural mitigation potential has been calculated as 5.5-6 Gt of CO_2 per year by 2030 (IPCC 2007).

The State of the World Report 2009 (World Watch Institute 2009) recommends strategies to increase soil carbon through sustainable land management (SLM) and thus use the soil as a carbon sink. There are four main areas of focus: enriching soil carbon through SLM, developing high-carbon cropping systems, protecting carbon stores such as forests and grassland, and rehabilitating degraded areas.

Today around 1600 billion tons of carbon are stored in the soil, about three times the amount stored in the vegetation cover. However, soils could store substantially more carbon dioxide than they do today. Sustainable land management is key in this regard. Soil organic matter can be increased considerably by using sustainable cultivation methods such as, for example, organic farming, agroforestry, minimum tillage, green manuring, and mulching.

Optimistic estimations indicate that 5-15% of carbon dioxide emissions from fossil fuels could be fixed in the soil each year. However, the fact that this store is limited, and the risk of carbon dioxide being released back into the atmosphere at a later stage, prohibits using these measures to replace efforts to reduce fossil carbon emissions. Enriching soil carbon can do no more and no less than complement reduction of fossil carbon emissions.

The Sustainable Soil Management Programme (SSMP) in Nepal is focusing on reducing the vulnerability of upland agriculturalists to climate change. SSMP practices are linked to commodities and provide value addition at grassroots by alternative high values crops, organic production, off-season and simple village level grading and processing. Key SSM management practices contributing to resilience against the adverse effects of climate change include: promotion of agroforestry, fodder and fodder tree cropping, promotion of new improved crop varieties, SSM-based in- and off-season vegetable production.
Soil sample analysis results show that SSM practices indeed increase the soil organic matter, and nitrogen and phosphorous content in the soil.

Thus agriculture and smallholders have tremendous potential to mitigate GHG emissions. However, soil carbon sequestration with a high potential for climate mitigation from the agriculture sector and engaging as well as benefiting smallholder farmers, is presently outside the scope of the clean development mechanism (CDM). Linking farmers to carbon trading and financing mechanisms is needed which requires an enabling environment with appropriate policies, institutions, capacity building and an agreed system of property use, rights, and access.

Critical Ecosystems, Vulnerable People and Adaptation

There are many highland ecosystems such as rangelands, wetlands, and sloping lands that are facing ecological threats and posing social vulnerability to the peoples living in these areas. Some of the ecological issues are salinity, watershed degradation, gully erosion.

Climate change as driver of change

For many ecosystems, climate change was a frequently mentioned issue as a driver of change (another being land-use).

Some of the upland perspectives point to the following climate-change related environmental and livelihood vulnerabilities:

- increasing number of droughts
- more erratic rainfall distribution
- glacial melt and flooding due to glacial lake outburst flood (GLOF)

- extreme rainfall events – amount, intensity, and frequency
- soil erosion, and fertility decline
- increase in temperature leading to shorter growing cycle of crops, increased pest occurrence (or new kinds of pests) and low crop yields or cropping failure and loss of livelihood

Some places and people of concern:

- Eastern Himalayas: Ephemeral seasonal ecosystems viz. riverine islands and wetlands are going to be most affected by the impacts of climate change
- Afghanistan: Concerns about perceived reduction in patterns and amounts of snow and rainfall
- Pastoral ecosystems: Climate change can accelerate pastoral degradation induced by overgrazing (see example below in section 5.3)
- Highland lakes could face increased water scarcity in the future; meanwhile the rising levels of lake waters in other areas could lead to flooding and loss of pasture lands.

"People's adaptation" to climate change

Many different groups of people live in these ecosystems and also respond or adapt differently to changes. Some of the people are: pastoralists/nomads; upland farmers (mainly depending on rainfed agriculture); lowland farmers (with or without access to irrigated land); urban dwellers in mountain cities; tourism industry and entrepreneurs; downstream communities.

Local knowledge, institutions and assets

One presentation based on eastern part of Tibetan Plateau on "Local knowledge, climate change, resilience and adaptation" succinctly stated: "Knowledge needs institutions to function; Institutions support asset building and representation."

People's responses especially to climate change is more often viewed as sector-based; but it is important to view these responses as "people's adaptation" which means incorporating the local knowledge-institutions-assets as part of sustainable management practices.

The workshop acknowledged the complexity of these socio-ecological systems and discussed the varied responses and adaptive strategies.

Some of the different groups and their adaptation strategies or needs are:

Downstream communities and lowland farmers

- Dialogue with upstream communities on watershed and river basin management
- Water storage and distribution infrastructure; water conservation and water-harvesting measures including on-farm water saving initiatives
- Riparian zone protection
- Flood control measures and flood warning systems
- Basin-wide water planning including environmental flows
- Payment for environmental services to uplands and agroforestry systems

Pastoralists

- Improve rangeland management; rehabilitation of grazing land; multiple uses of rangeland
- Fodder production and storage for winter season
- Getting organised into territory-based pasture user communities
- Challenging sedenterization policies; seasonal migration to urban areas for work

Upland farmers

- Changing crop type to reduce impacts of unseasonal drought; conserving traditional crop varieties

- Diversifying livelihood options including migration for off-farm income and improving on-farm income generation options
- Development of agroforestry techniques
- Strengthening local institutions

Urban dwellers in mountain cities

- Increasing water-use efficiency
- Better urban planning

Tourism operators and others

- Start micro-loans for small-scale businesses
- Benefit sharing with local communities in tourism sites
- Re-investment in conservation of tourist attractions
- Improving marketing facilities for tourism
- Understanding and being prepared for the shifts in tourism patterns

Tibetan pastoral system

In the Tibetan Autonomous Region (TAR), pastoral systems are facing increasingly vulnerability due to inaccessibility, fragility, and marginality. The vulnerability leads not only to a limited base for sustaining livelihoods but more important results in high degree of risks and uncertainty for local livelihoods.

Inaccessibility to public services and markets, ecological fragility, and marginality leads not only to a limited base for sustaining livelihoods but more importantly is also resulting in high degree of vulnerability, risks and uncertainty to the local populations. About 2.8 million Tibetans are currently settled in the TAR Tibet, of which 1/3 of them are nomads and pastoralists using the pastoral system, but live in area of 2/3rds of TAR.

The pastoral system in Tibet can be divided into two major groups, pure pastoral system and agro-pastoral system. The pure pastoral system is largely a nomadic pastoral system; the Tibetan plateau has one of the largest nomadic pastoral areas in the world. Pure pastoral system is often found above altitudes of 4,200 masl. Agro-pastoral systems exist at elevations of less than 4,200 masl and where crops can also be grown. For most of the pastoralists of Tibet, yak, sheep and goats are the only means of sustaining their food security and livelihoods. The nomads of the Tibetan region are very strong in terms of institutions for taking care of the pastoral ecosystem. Yet the vulnerability of the ecosystem means special needs

Rapid global warming and the impacts of climate change pose additional burdens for the pastoral system by accelerating pastoral degradation. Other challenges include the specter of water scarcity in the future while at the same time the rising levels of water in some lakes can lead to loss of pasture lands.

Ganga-Brahmaputra-Meghna (GBM) Basin

The GBM river systems constitute the second largest hydrologic region in the world after the Amazon with a total drainage basin of about 1.75 million square kms (Samarakoon 2004). This is shared by 5 countries: Bangladesh, Bhutan, India, Nepal, and the People's Republic of China (Tibet). The estimated population is more than 600 million,

Some of the pressures faced by the GBM basin are:

- Water resources development (hydropower and irrigation development in particular)
- Pollution from industries, urban areas and agriculture
- Fuel wood and fodder collection
- Overgrazing
- Improper land use
- Mining and urbanization with increased water demands for industrial/urban water use
- Drying of water sources

Existing governance problems in the GBM river systems continue due to the lack of genuine cooperation including sharing of information among the riparian states and to decisions taken by one co-riparian country without fully considering the upstream and downstream transboundary consequences in the other countries.

The research needs are:

- Watershed hydrology at different scales and the linkages between watersheds and basin
- Water storage in wetlands and their impact on watershed hydrology
- Impact of river basin transfers

Information flows can be improved and strengthened by:

- Creation/strengthening of river basin authorities at different scales involving all stakeholders
- Putting information in public domain
- Forming a regional hydrological database for the GBM river basin and regional data sharing

Arid basins: Tarim, Indus, Yellow River, Mongolia

The Tarim Basin is a large basin occupying an area of more than 400,000 km^2 (150,000 sq mi). It is located in the Xinjiang Uyghur Autonomous Region in China's far west. Originating in the Tibetan plateau in the vicinity of Lake Mansarovar, the Indus river runs a course through Ladakh district of the state of Jammu and Kashmir of India and then the river enters Pakistan in administrative division of Northern Areas (Gilgit-Baltistan), flowing through the North in a southerly direction along the entire length of the country, to merge into the Arabian Sea near Pakistan's port city of Karachi. The Yellow River is the second-longest river in China (after the Yangtze River). Originating in the Bayan Har Mountains in Qinghai Province in western China, it flows through nine provinces of China and empties into the Bohai Sea.

Some of the main issues and challenges are water, wind and soil erosion; soil salinity; over-use of chemical fertilizer; pasture degradation; water scarcity combined with lack of water harvesting measures (water loss or leakage due to unsuitable water management); conflicts on water demand and water allocation for agriculture, hydropower, industry and domestic purposes;; and climate variability affecting hydrological flows.

Research and technological needs are:

- Rehabilitation of abandoned crop lands
- Combining revegetation with livelihood alternatives for farmers
- Optimization of farming systems
- Conservation agriculture for various eco-regions

Policy areas that need to be looked at are:

- Institutional mechanisms need to be strengthened given the inadequate policies for sustainable land management
- Policies to promote adoption of conservation agriculture
- Monitoring and assessment of water and natural resources
- Scenario-building for natural resource management in the future

Greater Mekong Subregion (GMS)/Mekong River Basin

The Greater Mekong Subregion is a geopolitical construct around the Mekong region and the Mekong River and encompasses Cambodia, Laos, Myanmar, Thailand, Vietnam, and the Yunnan Province of China.

Some of the main issues and challenges are:

- Incomplete view of the Mekong basin where the "upper" basin in the Tibetan Plateau is largely neglected in basin-wide decision-making
- Land-use and land cover change due to large-scale monoculture plantations (e.g. rubber)
- Large infrastructure development (e.g. dams and roads) in the Mekong basin causing various impacts including on fish migrations and fisheries livelihoods, land use changes
- Transboundary water governance requiring rules and regulations; transborder resource extraction
- Soil erosion especially in the upper basin
- Expansion of monoculture tree plantations
- Land-use pressures of swidden cultivation

The research needs, questions and tools required are:

- Can payment for environmental services (PES) work for multifunctional landscapes in the Mekong basin
- What are the impacts on downstream areas from the existing upstream practices
- What are the risk perceptions of different social sectors about the various developments in the basin

- Tools and mechanisms for negotiating and resolving conflicts at different scales
- Monitoring and enforcement of laws on illegal cross-border trade in timber and wildlife
- Swidden transitions and good agroforestry practices (including using rubber crop)
- Climate change related concerns: shifting of production zones of major crops, water flow impacts, local coping capacities, developing carbon finance and biodiversity (pilot projects)

Praxis: Resilience, Local Knowledge, Institutional Innovations and Proactive Responses

The workshop heard a variety of presentations on technical approaches, traditional knowledge, and grassroots practices and innovations in land use management. Many presentations gave emphasis to working closely with farmers and local communities, increasing local participation in decision-making on projects and ensuring local voices were heard in project implementation.

The range of technical approaches covered practices for sustainable soil management, afforestation to recover from degradation and desertification, ponds for preventing soil erosion, addressing soil salinity, improving upland cropping practices, etc.

Below is a summary of selected country or regional approaches and innovations.

AFGHANISTAN: Water conservation

Rural communities in Afghanistan are vulnerable to natural disasters (including those possibly induced by climate change) such as flash floods, droughts, earthquakes, landslides that lead to blockages of roads and streams by soil slips, avalanches, and disease epidemics like malaria. The degradation of watersheds and rangelands and loss of Juniper forests and pastures to desertification multiplies the negative impacts on the livelihoods of local farmers.

Helvetas in Afghanistan is working on several practical and local-level measures to prevent and mitigate these impacts. For example, building protective infrastructure such as check dams, contour trenches and half-moon pits as well as wells and reservoirs helps to conserve water sources and maintain water supplies. The projects also include renewable energy and energy efficient technologies such as energy efficient community bakeries that reduce fuel wood consumption.

BANGLADESH: Small-holder cultivation of broad bean

In the low-lying areas of Bangladesh, the main land use is Rabi (winter) vegetable followed by local Aman (transplanted) paddy. In most years, the transplanted paddy either gets damaged by floods or provides very low yields to sustain livelihoods of farmers.

Since 1998, the farmers changed their land use to cultivate Boro (irrigated winter paddy) followed by bean on mounds to adapt to the flood in the Kharif (rainy) season. The

farmers make mounds in May after the Boro harvest and 2-3 seedlings of beans are dibbled or planted on the fertilized mound by mid-May to June. As bean production in the small areas gives a very good return from most of the deeply flooded areas, more farmers are taking up practicing bean cultivation in mounds instead of transplanted Aman paddy.

BHUTAN: Farmers the key to participatory planning

Land degradation impacting on local livelihood security is a large concern for Bhutan. However, integrated sustainable land management (SLM) remained a new concept that was not put into practice. This changed in 2004 with severe flashfloods and landslides that catalyzed the government's response. One result was that SLM became a high priority for the government. A National Action Programme for land degradation is also being prepared.

At present, integrated/participatory SLM planning is being undertaken with farmers as key component in planning and decision-making. Two SLM projects in Bhutan have created a very conducive environment for enhancing SLM in the country.

Some key features of the SLM projects are:

- Participatory planning approach is done at a community level
- The process is very simple and easy to follow
- The project identifies and promotes farmers as a key stakeholder for SLM
- All opportunities are provided for farmers to participate and plan their own SLM strategies

The projects in Bhutan have showed that participatory planning at community level has been a great success in building a strong foundation for SLM in the country. Upscaling of the approach countrywide is the next key challenge, but success is assumed, as now the projects are already closely interlinked with the government system.

CENTRAL ASIA: Sustainable land management in the context of climate change

Central Asia's countries (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) are facing both mismanagement and over-use of natural resources. Some of the socio-ecological impacts are salinity and water-logging, water and wind erosion in irrigated and rainfed areas, overgrazing. The presentation from Kazakhstan showed how land degradation can be controlled by increasing "No-Till" and reducing summer fallow as well as enhancing crop diversification.

Overall in the region, a number of measures have been tried and are showing success in halting degradation and recovering land areas:

- Afforestation of degraded areas and rangelands
- Genetic enhancement of cultivars (all)
- Integrated crop-livestock management (rangeland)
- Soil management (conservation agriculture, mulching)
- Erosion control through afforestation techniques and selection of suitable species

CHINA: Dryland degradation and rehabilitation

Degradation of the rangelands is a combination of national and human impacts. More than 90% of China's grasslands are considered degraded. One of the initiatives of the Chinese government is giving contracts of grassland areas to households for sustainable management. Also a "grassland monitoring system" has been started; a monitoring report is expected to be completed that would provide comprehensive details of the state of China's grasslands.

Revegetation of the Loess Plateau

The Loess Plateau, in western China, is a water-limited agricultural region with deep erodable soils. It is a heavily dissected landscape i.e. some areas are too steep for cropping. The region is remote from China's developing markets on the eastern seaboard. In combination, all these factors mean farmers relying solely on agriculture are among the poorest in China. The low proportion of perennial vegetation cover and intense summer monsoon rainfall largely contributes to severe soil erosion problems on the Loess Plateau. (See http://www.clw.csiro.au/ReVegIH/ for more details.)

ReVegIH (Re-Vegetation and its Impact on Hydrology) Programme

A solution to this agricultural problem is large-scale re-vegetation using perennial plants (grasses, shrubs and trees). The aim of the re-vegetation programme in the Loess Plateau is to reduce soil erosion and thus improve water quality of the Yellow River. The project aimed to develop a GIS-based tool to predict the impacts of re-vegetation on the region; data is used from 58 meteorology and 38 hydrology stations.

The approach is to develop a spatial information system using interpolated meteorological surfaces, landscape position derived from a Digital Elevation Model (DEM), and remotely sensed information of land-cover.

The output is expected to be the development of software that will allow high-level agricultural policy makers to develop different scenarios for re-vegetating the YHB. Outputs also include "Re-vegetation Suitability Maps" and outlining the "priority zones" in the landscape.

HIMALAYAS: Ponds for gully stabilization

In the south face of the Himalayas, degrading natural resource base, declining soil fertility, and rising pressure on land resources have led to degradation of farms and farming systems. The natural dynamics of the south face of the Himalayas shows annual rainfall at over 1,200 mm (in 60-70 days during the monsoon period) with a maximum intensity of 540mm/day (recorded) and about 300 mm in winter (some in the off-season). There is loss of soil in the first few rains and increased loss of nutrients throughout the monsoon season.

One measure that has been introduced by the Institute for Social and Environmental Transition (ISET) in Nepal with implementation by the Department of Soil Conservation and Watershed Management is to build ponds that reduce the peak of the monsoon hydrograph and save water for winter. The ponds help to manage monsoon runoff as well as provide landslide and gully stabilization. These measures have resulted in also increasing farming yields by over 50% such as for maize. In general terms, the approach is to keep the water where it touches the ground, be it in ponds mentioned above or in terraces, contour trenches etc. or to increase the 'green' water.

INDIA: Watershed development for enhancing productivity in hill and mountain agro-ecosystems

Watershed projects in the uplands of northern India help increase groundwater recharge and reduce soil and run-off losses in the steep slopes. Watershed development is viewed as a holistic systems approach with community participation for:

- Soil and water conservation in ridge to valley
- Maximum utilization of rain water
- Sustainable, low cost, location specific technologies
- Land-use for optimizing production system
- Livelihood and income generation through rural micro-enterprises

The watershed development projects have achieved the following successes:

- Increase in groundwater recharge
- Reduction in soil and run-off losses
- Changes in cropping patterns and increase in cropping intensity
- Diversification of farming systems with increases in productivity
- Increase in employment generation and reduction in rural-urban migration

LAO PDR: Uplands food security, income generation and sustainable utilization of natural resources

Upland cultivation in the northern region of Laos is facing changes due to shortening of the fallow in the swidden cultivation system leading to farming practices becoming less sustainable.

Measures initiated by the National Agriculture and Forestry Research Institute (NAFRI) are helping to enhance farmers' food security and livelihoods and maintain sustainable farming and land-use practices. Some crucial points are that agriculture processing and marketing are of importance for agriculture development in uplands; Capacity development of district and villages institutions are an important factor in dissemination and wider adoption of technologies

Some of the measures of NAFRI include;

- Increased rice productivity through the use of improved crop variety and intensive production techniques (for lowland rice)
- Increase productivity of livestock
- Cash crop as alternative for swidden cultivation
- Sloping land technologies and inter-cropping such as planting cash crops like tea

MONGOLIA: Land cover change, local livelihoods and vulnerability in the Keerqin Steppe region

After 1979, rural reforms in Mongolia made the transition from a planned economy towards a market economy. The household became the base unit instead of the collective and land was contracted (rented) to families. Around 1981, livestock were distributed to families and the process of contracting grasslands to households started in 1999.

One of the main ecological issues that is pointed out by farmers is drought followed by hail storms, and heavy rain and flooding. The northern region also has strong winds leading to wind erosion. The ecological stress factors can lead to variability in crop production. Ground water resources are also being affected as farmers sink wells to expand their irrigated land area. The decrease in water table has varied from less than one meter over several years to more than 2 meters a year.

Coping strategies include:

- Changing crop type to reduce impact of drought
- Savings from a high income year used in the low income years
- Borrow money or grain; occasionally local county government provides grain or fertilizers or helps to build houses

NEPAL: Sustainable Soil Management (SSM) for food security

The uplands of Nepal are facing an increasing number of droughts as well as erratic rainfall distribution. In addition, other possibly climate change-induced events are resulting in extreme rainfall (in terms of amount, intensity, and frequency), soil erosion and increases in temperature. Cumulatively these changes are making the growing cycle of crops shorter, lowering yields and increasing pest occurrence. For most upland farmers, all these individual and cumulative changes can translate into crop losses and reinforce livelihood insecurity.

The Sustainable Soil Management Programme (SSMP) in Nepal is attempting to deal with these changes and support farmers' adaptation and strengthen local livelihoods. SSM practices contribute to resilience against the adverse effects of climate change. There is less dependence on external inputs through using compost, farmyard improvement, bio-pesticides, etc.

The SSMP emphasizes:

- Extension work through leader farmers (LF), experienced leader farmers (ELF), and farmer to farmer (FtF) diffusion
- Farmer-centered, decentralized extension and participatory approaches

Networks and Initiatives

World Overview of Conservation Approaches and Technologies (WOCAT)

With the majority of people in developing countries being directly dependent on land resources, WOCAT focuses on making better use of scarce resources with the aim of promoting sustainable land management. In many parts of both industrialised and developing countries, soils are not managed in a sustainable manner. WOCAT views as important the maintenance and improvement of the quality of natural resources is thus an important step towards improvement of rural livelihood and poverty alleviation, and finally, towards more sustainable development. (See http://www.wocat.net/.)

WOCAT was established as a global network of soil and water conservation (SWC) specialists. It facilitates more efficient use of existing know-how and, consequently, of development funds. It thus helps to optimise the implementation of appropriate SWC and to avoid duplication of effort.

WOCAT's vision is that land and livelihoods are improved through sharing and enhancing knowledge about sustainable land management. The focus is on four dimensions of knowledge: SLM know-how; tools and methods; information sharing and networking; research, training and education.

WOCAT provides tools that allow SWC specialists

- To share their valuable knowledge in soil and water management
- Assist them in their search for appropriate SWC technologies and approaches
- Support them in making decisions in the field and at the planning level.

WOCAT also contributes to the implementation of United Nations Conventions, such as the Convention to Combat Desertification (CCD), the Framework Convention on Climate Change (FCCC), and the Convention on Biodiversity (CBD). WOCAT has active country initiatives in Asia.

Recently two country books/fact sheets have been published:

1. Best Practices for Land Degradation Control in Dryland Areas of China (please see http://www.gefop12.cn/e/LearningCenter/tabid/60/ctl/ViewNews/mid/663/ItemID/933/Default.aspx)
2. Natural Resource Management – Approaches and technologies in Nepal : NEPCAT Fact Sheets (2008) (please see http://books.icimod.org/index.php/search/publication/518)

Desertification mitigation and remediation of land (DESIRE)

DESIRE or Desertification mitigation and remediation of land is a global approach for local solutions that aims to:

1. Develop and test promising prevention and remediation strategies against desertification and land degradation in 18 hotspot areas around the world in close cooperation with local stakeholders
2. Disseminate results to different stakeholders, amongst others using a web-based harmonized information system. (See http://www.desire-project.eu/index.php.)

The DESIRE project encompasses a set of 18 study sites around the globe that are affected by one or more desertification related problems. One research site in China is the Yanhe River, a tributary of the Yellow River.

These sites have been investigated for a number of years; different methodologies were used and different types of information gathered. An important objective is to inventorize the areas and make a first series of desertification maps based on the available information. Fragile arid and semi-arid ecosystems, in particular, are in urgent need of integrated conservation approaches that can prevent and reduce widespread degradation.

Land Degradation Assessment in Drylands (LADA)

The Land Degradation Assessment in Drylands project (LADA) started in 2006 with the general purpose of creating the basis for informed policy advice on land degradation at global, national and local level. This goal is to be realized through the assessment of land degradation at different spatial and temporal scales and the creation of a baseline at global level for future monitoring. The project will complete its activity by 2010. (See http://www.fao.org/nr/lada/index.php?/Overview.html for more details.)

LADA's definition of land degradation is: "Land degradation is the reduction in the capacity of the land to perform ecosystem functions and services (including those of agro-ecosystems and urban systems) that support society and development".

Among the activities of LADA-China are: National land use systems mapping, national land degradation assessment; national land use change (land cover change). Some of the methods used are: Field survey, transect lines, household interviews for social and economic factors.

The project on "Sustainable Land Management Technologies and Approaches in Dry-land Areas of China" has collected 49 case studies of best practices for sustainable land management in the drylands of China

Transboundary governance: Sharing benefits

Transboundary Waters Opportunity (TWO) Analysis

The presentation on "Transboundary Waters Opportunity (TWO) Analysis" by Stockholm International Water Institute (SIWI) showed how to use the TWO as a framework for promoting sustainable and equitable use of transboundary water resources. The aim is to transition from sharing *water* (quantity) to sharing *benefits*. (See for more details http://www.siwi.org/.)

The TWO analysis can be used in many situations:

- In formal negotiations or in training situations to demonstrate possible alternatives for countries sharing water
- Act as a "compass" to identify the need for subsequent detailed investigations for countries which are to undertake political negotiations; looking at cooperative strategic pre-investment analysis to identify development options and trade-offs
- It can act as a scenario tool to illustrate longer-term changes and future options in a non threatening manner
- It can identify opportunities for public and private financiers to support initiatives taken by riparian countries.

Mekong River Basin knowledge networks

Mekong Programme on Water, Environment and Resilience (M-POWER) is a action-research knowledge network that comprises researchers, scientists, NGOs, and others in a broad network to include the countries of the Mekong River Basin: Cambodia, Laos, Myanmar, Thailand, Vietnam, and the Yunnan Province of China (see section 5.6 for details).

Transboundary governance in the Mekong region has focused on the Mekong River and its tributaries and the commensurate regulations, rules and guidelines for water flows and national country-level undertakings. The main transboundary organisation, the Mekong River Commission (MRC) has its membership comprising Cambodia, Lao PDR, Thailand and Vietnam; China is not a member of the MRC. An incomplete view of the Mekong basin has resulted in predominant attention given to the lower basin tends and not quite enough to the uppermost reaches such as the Tibetan Plateau. The MRC is founded on the worldview of "Blue Water" raising concerns about the lack of policy efforts on "Green Water" (see section 8).

To address these and other water-land governance issues and to build tools and mechanisms for cooperation, negotiation and benefit-sharing, the M-POWER network has been involved in action-research on different themes within the broad rubric of water governance. These themes are: irrigation, floods, fisheries, upland watersheds, urban waterworks.

The Abu Dhabi dialogue and knowledge forum

The Abu Dhabi dialogue is an ongoing dialogue on South Asia Water Cooperation among senior government, academic, and civil society members from Afghanistan, Bangladesh, Bhutan, China, India, Nepal, and Pakistan. The Abu Dhabi dialogue stemmed from the '1st International Conference on Southern Asia Water Cooperation', a regional meeting held in Abu Dhabi in September 2006. Subsequently, key participants from the seven countries, with the support of the World Bank, agreed to sustain the momentum and continue the engagement on water cooperation in South Asia. They formed the 'Abu Dhabi Group', established the 'Abu Dhabi Dialogue' as an informal consultative process, and organized the '2nd Abu Dhabi Dialogue' in Bangkok in July 2007. The theme for this 2nd meeting, selected from the recommendations of the 1st meeting, was 'the Rivers of the Greater Himalayas': the changing conditions in the headwaters, the pressures in the floodplains and deltas, and the challenges of, and opportunities for regional cooperation.

The Abu Dhabi dialogue has followed an informal and non-attributable format with convergence on the following common themes: to sustain group dialogue; to promote awareness and participation; to undertake joint research studies and training; to promote data sharing; to build and to strengthen institutions; and to focus on the major rivers rising in the Himalaya as a common theme.

The Abu Dhabi knowledge forum is an off-spring of the Abu Dhabi dialogue with the objective to conduct coordinated research and training activities especially increased scientific efforts in order to advance the knowledge of climate change impact on snow, ice and water resources, and the subsequent impact on people's lives and livelihoods in the greater Himalayan region.

The Abu Dhabi scientific forum was launched with two overarching objectives. One is to establish a cooperative knowledge-based partnership among scientists and knowledge institutions in the Greater Himalayan Region. The other is to trigger and encourage regional science cooperation within the field of water in its widest sense.

More specifically, the forum has: provided an opportunity for scientists and water professionals from the greater Himalayan region (in this case Afghanistan, Bangladesh, Bhutan, China, India, Nepal and Pakistan) to meet and build partnerships; identified strategic areas for research and cooperation among scientists from several countries.

Ways Forward: Key Themes, Strategies, Research Needs and Policy Questions

Key themes

"Low flow" vs. "E-flows" for environmental services

Low flows is the water flow in the river or water body during the dry season and at times when the river flow is sustained by water stored in the groundwater, in the soil or originating from glacial melt. E-flows or "Environmental flows" describe the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems. This includes the lows, high pulses and floods across the hydrological regime of a river.

E-flows conserve ecological integrity and maintain ecosystem services. E-flows need to be taken into account combining natural, physical, and social scientists with traditional or

local ecological knowledge. E-flows also need to encompass a broad range of conditions –ranging from low flows to floods –to support the health of the whole ecosystem and ecosystem-related values, not just minimum flows or individual species.

Blue water vs. green water

"Blue" water is water withdrawn for irrigation from rivers, lakes and aquifers; "green" water is precipitation consumed by rainfed and irrigated agriculture and by non-agricultural terrestrial ecosystems. The major question emerging from the workshop was that adequate attention is already given to blue water but how to make green water concerns find policy salience?

Climate change and adaptation

Climate change adaptation is now very sector-based and not really people's adaptation. There is a need to incorporate local knowledge to support people's adaptation strategies.

- People-oriented adaptive strategies for climate change are needed
- How do people cope with climate change and climate variability
- Soil sequestration is presently outside the scope of the CDM; small-scale farmers cannot benefit from carbon trading
- In-depth understanding needed of the combination of land-use and climate change impacts

Strengthen information flows

The importance of sharing information was emphasised especially on hydrology and water flows and in particular among co-riparian states in the case of transboundary rivers (see also section 5 this report).

Research relevance

Research can make an important contribution to the formulation and implementation of resources management policy. The workshop emphasized that research should be more problem-oriented and explicit about what works and what doesn't. Ways should be sought to further interlink scientific research with the needs of local communities in the highlands.

- Research for local or grassroots needs especially in the farming sector
- Research learning as an "implementation agenda" viz. using networks, sharing of information
- Integrating scientific knowledge with local perspectives and needs

Some area-specific research needs, policy questions and initiatives

Ecological and hydrological processes

- How does urban migration impact ecological, hydrological processes?
- Identify SLM practices suitable for climatic variability or climate extremes in critical ecosystems
- Identify hydrological impacts of land use and land cover change at different scales from the plot to the basin
- Provide data on water (rainfall, surface, ground water) availability and water use for highland-lowland systems (high spatial and temporal resolution)

Drylands

- In arid areas, Conservation Agriculture (CA) needs to be highlighted; research areas include agronomic techniques, constraints to CA adoption, and agroforestry systems.
- Transnational cooperation mechanisms are needed viz. to undertake a regional review of dryland initiatives; sharing information about different CA initiatives since much CA research exists but in different languages; and networking for joint projects
- Some key groups and networks: CGIAR, ICARDA, CACAARI, CAC, PFU, Lund University

Highland-lowland initiatives

- Need a workshop to explore research on highland-lowland interactions: scales and levels of management viz. sub-watershed to river basin; upstream costs vs. downstream impacts; food supply flows; water and sediment issues
- Evaluate methods and assess potential for payment for environmental services including valuation of services other than water; non-monetary rewards; “polluter pays” principle from highlands to lowlands
- Research into transboundary governance to include impacts of infrastructure such as roads and dams; expansion of monocrop tree plantations; adapting and disseminating technologies
- Climate change opportunities and adaptations research including carbon sequestration; biodiversity conservation
- Link of the Asian water towers across organisations and institutions
- Some key groups and networks: WOCAT, ICRAF, ICIMOD, M-POWER, NAFRI

Networking and knowledge management

The main objective of SLM is to promote human coexistence with nature with a long-term perspective so that the provisioning, regulating, cultural and supporting services of ecosystems are ensured. Within SLM, there is a focus mainly on efforts to prevent and reduce land degradation through conservation technologies and their implementation approaches.

The use and sharing of information and experiences i.e. knowledge management, related to these efforts is a key networking asset for instance of WOCAT.

WOCAT's vision is that land and livelihoods are improved through sharing and enhancing knowledge about sustainable land management. The aim of WOCAT, as a network, is to increase the awareness and motivation of planners and decision makers as well as land users and agricultural advisors and to provide knowledge support concerning the advantages and disadvantages of available alternatives, based on a wide range of experience in the field.

For example, knowledge related to SWC / SLM: innovative methods and an extensive network of both land users and soil and water conservation specialists have enabled WOCAT to accumulate a wide base of know-how.

WOCAT's network includes SLM experts, technicians, extension workers, planners, and decision makers. They come from various on-ground projects, government ministries, universities and NGOs as well as international centres, UN organisations. There are 64 participating institutions world-wide that incorporate WOCAT into existing programs.

Science and policy dialogue

- How should highland scientist talk to those outside their group? There is a need to redefine problems with perspectives "outside the box"
- Success stories in effective land-use management in the Asian highlands
- Pro-active responses to include: policy briefings; high-quality scientific papers inter-regional dialogue events; using international gatherings and meetings effectively for science-policy interactions viz. Stockholm Water Week.
- Some key groups and networks: SIWI, ICRAF, ICIMOD, IWMI, M-POWER

Acknowledgements

We are thankful to the Kunming Institute of Botany, Chinese Academy of Sciences (KIB-CAS), World Agroforestry Centre (ICRAF) and the International Centre for Integrated Mountain Development (ICIMOD) for organizing this workshop.

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Appendices

Workshop agenda

The workshop was held from 18 to 22 May 2009 in Shangri-La in Northwest Yunnan, China.

Monday 18 May (Day 1)	
08:30 – 09:30	**Opening Ceremony** **Facilitator: Jianchu Xu** • Welcome remarks by Yongping Yang (Deputy Director, KIB-CAS) • Welcome remarks by Eklabya Sharma (Programme Manager, ICIMOD) • Introduction to participants and workshop: Jianchu Xu (China Representative, ICRAF) • Group photo
09:30 – 10:00	Tea and coffee break
10:00 – 1200	**Plenary 1 – Status and trends of Asian highlands (15 minute max)** **Facilitator: Yongping Yang** • Introductory remarks: Dipak Gyawali (the Director of the Nepal Water Conservation Foundation) • Land degradation, desertification and sustainable land management – An overview: Hans-Peter Liniger (WOCAT) • Too much water, soil erosion and sediment- Summary from review: Xixi Lu (National University of Singapore) • Rangeland degradation and rehabilitation situation in China: Yanming Shi (China Rangeland Monitoring Centre) • Carbon sequestration and carbon finance in China's rangelands: Andreas Wilkes (ICRAF)
12:00 – 13:00	Lunch break
130:0 – 14:00	**Plenary 2 – Vulnerable places and people** **Facilitator: Dipak Gyawali** • Assessment of climate change vulnerability in the eastern Himalayas: Eklabya Sharma (15') • Case studies (1o minutes for presentation, 5 minutes for discussion): • Vulnerability of nomads and pastoralists: Nyima Tashi (TAAAS) • Vulnerability of rural Afghan communities to climate change induced disasters" Presentation: Sanjeev Bhuchar (Helvetas-Afghanistan) • Sustainable Soil Management initiative for improving food security/livelihood and climate change mitigation through enhancing soil organic matter: Neeranjan Rajbhandari (Nepal/SSMP)
14:00 – 17:00	**Group work: Identification of vulnerabilities of different mountain dwellers and ecological zones** **Facilitator: Juerg Merz** • Tea and coffee break inbetween • Discussion and Summary of the day
18:00	**Welcome dinner** (Venue: Traditional Tibetan Guest House)

Tuesday 19 May (Day 2)

08:00 – 09:00	**Plenary 3 – Scenarios and land use decisions** **Facilitator: Andreas Wilkes** • Presentation on scenarios, dialogue and negotiation on integrated land management (15 minute, max) • presentations of research 'discoveries' + questions + discussions • Sustainable Land Management in the Context of Climate Change: Some Experiences from Central Asia: Alisher Mirzabaev (ICARDA-CAC) • Introduction of LADA in China: Wang Guoshen (LADA China) • Application of Integrated Ecosystem Management in Land Degradation Prevention in Gansu: Wang Yaolin (WOCAT, China)	
09:00 – 09:15	Tea and coffee break	
09:15 – 11:00	Panel presentation and group work: Identifying key issues and research questions	
	Facilitator: Eklabya Sharma **Panel 1: Ecological and hydrological processes** • Simulation of coupled relationship between land use and groundwater flow in the western arid land of China: Chengyi Zhao (Xinjiang Institute of Ecology and Geography) • Response of rangeland phenology to climate change in Tibetan Plateau from 1982 to 2006: • Haiying Yu (KIB)	**Facilitator: Jianchu Xu** **Panel 2: Traditional knowledge and resilience** • Participatory Integrated Assessment tool development– experiences from the SEAMLESS project: Sara Brogaard (Lund University, Sweden) • The Role of Local knowledge in rangeland management and climate change adaptation: Yao Fu (KIB)
11:00 – 12:00	Report back from group discussion: Questions and discussion	
12:00 – 13:00	Lunch – Break – Walk	
13:00 – 16:30	**Plenary 4 – Market place for adaptation** **Facilitator: Juerg Merz** • Market place for technical and institutional options for sustainable livelihoods (posters, 5 min short presentations)	
Inbetween	Tea and coffee break	
1630-1700	Recap in plenary Preparation for field trip: Jianchu Xu	

Wednesday 20 May (Day 3)

<table>
<tr><td rowspan="2">08:00 – 16:00</td><td colspan="3">Purpose of field trip
Research questions, tools and methods, group work</td></tr>
<tr><td>Group 1: Forest management
Nixi Township
Guide: Yufang Su</td><td>Group 2: Water management
Napahai wetland
Guide: Jianchu Xu</td><td>Group 3: Rangeland intensification
Xiaozhongdian Township
Guide: Andreas Wilkes</td></tr>
<tr><td>16:00 – 18:00</td><td colspan="3">Group work and preparing for presentation next day</td></tr>
</table>

Thursday 21 May (Day 4)

08:30 – 09:30	**Report back from each group for field trip**: Findings, knowledge learning, relevance to other countries, suggestions and recommendations
09:30 – 10:30	**Plenary 5 – Integrated approach for land and water management** ***(15 min, max)*** **Facilitator: David Thomas** • Multifunctional Agroforestry landscape: Van Noordwijk, Meine (ICRAF) • Political economy of landslides and ponds: Madhukar Upadhya (Institute for Social and Environmental Transition, Nepal) • Strategies for Checking Land Degradation and Enhancing Productivity in Hill and Mountain Agro-Ecosystem following Watershed Approach: G.P. Juyal (Central Soil and Water Conservation Research and Training Institute, India) • Participatory SLM Planning – an experience from Bhutan: Karma Dema Dorji and Tshering Dorji, NSSC, MoA; BHUTAN
10:30 – 11:00	Tea and coffee break
11:00 – 12:00	Group reflection in each table and feedback
12:00 – 13:00	Lunch break
13:00 – 14:00	**Plenary 6 – River basin management: upstream and downstream linkage** ***(15 min. max)*** **Facilitator: Juerg Merz** • Transboundary Waters Opportunity Analysis – a framework for promoting sustainable and equitable use of transboundary water resources: Rebecca Löfgren (Stockholm International Water Institute, SIWI) • DESIRE project and its progress in the Loess Plateau (Desertification mitigation and remediation of land–a global approach for local solutions): Fei Wang (Institute of Soil and Water Conservation, CAS) • Understanding watershed dynamics and its downstream impact: David Thomas (ICRAF)
14:00 – 14:30	Tea and coffee break
	Panel presentation and group work (Key issues, research questions, potential actions)

14:30 – 17:30	**Facilitator: Isabelle Providoli** Arid Basin: Tarim, Indus, Yellow River, Mongolia Speakers: (10 min) • Assessment and Control of the Impact of Re-vegetation on Water Resources—A case study in the Loess Plateau: Rui Li (Institute of Soil and Water Conservation, CAS) • Increasing No-Till and Reducing Summer Fallow to Control Land degradation in Semi-arid Steppe of Northern Kazakhstan: Mekhlis Suleimennov (CIMMYT-Kazakhstan • (Participants from Central Asian, India, Afghanistan, Pakistan, Mogolia, etc.)	**Facilitator: Luna Bharati** Ganga-Brahmaptura-Meghna (GBM) Speakers: (10 min) • Degraded land rehabilitation in the Indian Himalayan region : Experiences of the GBPIHED', P.P. Dhyani, (G.B. Pant Institute of Himalayan Environment and Development) • Environmental flows and climate change impacts in the upper Ganges river basin, India: Luna Bharati (IWMI) • (Participants from Nepal, India, Bangladesh, Bhutan, China, etc.)	**Facilitator: Kate Lazarus** Greater Mekong Sub-region (GMS) Speakers: (10 min) • Socio-economic impact of present land use and land cover changes in northern Laos: Vanthong Phengvichit (NAFRI) • Hydrological response to land use/climate change: Xing Ma (Yunnan Environmental Research Institute) • (Participants from Mekong region, Vietnam, Laos, Thailand, Myanmar, China, etc.)
17:00 – 17:30	Recap in Plenary		

Friday 22 May (Day 5)

08:30 – 09:30	**Plenary 7 – Synthesis** **Facilitator: Jianchu Xu** Brief synthesis of workshop so far: Rajesh Daniel (USER, Chiang Mai University) Discussion and revision
09:30 – 10:00	Tea and coffee break
10:00 – 12:00	**Moving forward** **Facilitator: Juerg Merz** • Working groups table discussions about joint activities • Networking and knowledge management (e.g., WOCAT) • Dry land degradation and desertification initiative (UNCCD, Andreas Wilkes, Li Rui) • Integrated watershed management initiative (Eklabya Sharma) • Science-policy dialogue processes (SIWI)
12:00 – 13:00	Lunch break

13:00 – 14:00	**Plenary 8 – Reflection and wrap-up** **Facilitator: Eklabya Sharma** • What happened at this meeting? What we learned and what we recommend! • By Nyima Tashi (Water Resource Institute of Tibetan Autonomous Region)
14:00 – 15:00	**Closing ceremony: Jianchu Xu**
15:00 – 17:30	Relaxing in Shangri-la
18:00+	Dinner and departure of some participants by flight

Saturday 23 May (Day 6) Departure of all participants

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Further Reading

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