Session I

Securing the Mountain Environment

Chair: Mr Egbert Pelinck

Keynote Paper – Securing the Mountain Environment: Advanced Technologies for Mountain Environment Research and Management

Dr Massimo Antoninetti, Ev-K²-CNR Committee

Introduction

It has been widely accepted that mountain regions are at risk of severe degradation. This is due to their sensitivity to global changes and a growing unsustainable exploitation of natural resources including poorly regulated tourism, unsound agricultural practices like overgrazing, the relentless harvesting of fuelwood, and the mismanagement of water resources. A sound scientific base is required in order to ensure good management practices, from local protected areas to central policy-level decision making. When it comes to the management of mountain regions, this is rarely or only partially available, especially in developing countries.

The extent of the impact of this reality is not fully appreciated. This is primarily due to the cultural and biophysical complexity of mountain regions and the fact that, to date, the scientific theoretical basis has not been sufficiently adapted to such extreme environments. The environmental constraints of mountain terrain, in many cases greatly hampers or prevents the application of data collection methodologies extensively used at low altitudes. Furthermore, the sharing of data and information is, in some cases, at such a basic level, or is the result of such isolated, intensive investigations, that it runs the risk of turning into misinformation.

Taking the Khumbu Valley as a case in point, we can examine its environmental degradation due to population pressure and infrastructural demands linked to growing tourism. This is coupled with a natural setting that tends towards problems such as accelerated soil erosion and sensitivity to climate variations as evidenced by the fragile mountain ecosystems. The need for multi-disciplinary coordinated monitoring and improvement schemes has become urgent if we aim to achieve truly sustainable development and guarantee genuine environmental conservation.

The Italian Ev-K²-CNR Project is an example of the application of advanced technologies to mountain research that aims to contribute to sustainable management processes. Our Pyramid Laboratory-Observatory at 5050 masl, near Mount Everest Base Camp in the Khumbu Valley, provides a unique and exceptionally equipped logistical base with a self-sufficient renewable energy system and a fully equipped scientific laboratory. For nearly 15 years, with the constant support of our National Research Council and our Nepali partners at the Royal Nepal Academy of Science and Technology, it has been possible for hundreds of researchers from around the world to study and monitor the mountainous environment of the Khumbu Valley year round.

While we are not suggesting that laboratories be built in all high mountain valleys, the application of advanced technologies can significantly help to reduce, or even remove, the objective difficulties that mountains pose for scientists, decision makers, and communities who must face and solve the environmental problems related to a more humane and sustainable development of the world's highlands.

Fields of action for advanced technologies

Modern technologies are being consistently conceived and produced so as to be more easily used in nearly any situation. However, researchers should be aware that instruments may need periods of testing, or special adaptations, to work in extreme conditions of low atmospheric pressure (around 550 Pa at the Pyramid), high solar radiation, and a daily temperature oscillation of up to 30°C a day.

Nonetheless, several innovative research technologies have been successfully tested and applied to multi-disciplinary environmental research in the Khumbu region. I will discuss in particular the following technologies:

- global positioning systems (GPS)
- automatic weather stations
- long-range pollution transport monitoring systems
- geographic information systems (GIS) and multi-source/multi-format data handling and sharing
- clean technologies and renewable energy systems

Global Positioning Systems (GPS)

Since having 'gone public' some years ago, the applicability of GPS technology to science has been demonstrated repeatedly. It is particularly appreciated in mountainous terrain, be it to precisely determine the coordinates of natural hazards, or to geo-reference field data.

One example of its application is in the field of glaciology. Continuous monitoring of glaciers makes an important contribution to our understanding of global changes and the impact of the greenhouse effect. Yet conventional surveying approaches are frequently hindered by poor visibility, steep terrain, and bad weather, and also by the inadequacy of glacier maps based on aerial photographs that make the plotting of contours difficult due to the featureless nature of large areas covered by snow.

Our years of GPS-aided research on the glaciers of the Everest region, such as the Changri Nup, have confirmed a constant retreat of the uncovered glacier terminus and a significant increase in the size of small seasonal lakes. The monitoring and documenting of deformations with millimetric precision is made possible using GPS measurements in real time kinetics by connecting portable GPS instruments to a master station at the Pyramid laboratory using an innovative technique via a cellular satellite telephone and by taking static measurements. These activities have been integrated with repeated observations made using laser scanning technology able to trace a three-dimensional outline of the entire glacier terminus so as to monitor evolutions from year to year.

It is worth noting here another key application of technology, well known to our colleagues at ICIMOD and UNEP-Asia, the mitigation and prevention of glacial lake outburst floods (or GLOFs). GPS is also being successfully employed to study the risks of outburst floods on the Imja Tcho glacier lake. Recently, a seven-metre anomalous cave-in of the debris covering, caused by a rapid melt of the ice below, was measured on this glacial lake. Thanks to ICIMOD and UNEP's work on another at-risk glacial lake, the Tsho Rolpa, a gated canal has been constructed to lower the water level and an early warning and sensing system installed in the lake and along the downstream valley.

Other applications of GPS technology deal with the acquisition of gravimetric and geological data in the area, considered one of the most seismically active regions in the world. GPS technologies have also assumed an important role in the saga of the measurement of Everest's altitude, which is influenced by fluctuations in the depth of snow on the summit. This past summer the debate was finally put to rest when an Italian-Tibetan-Nepali team used an innovative instrument formed by a ground penetrating radar and a GPS receiver system (antenna and recorder) to calculate the actual rock height of Everest. Proving science is not an end in itself, this 'GPS/Georadar' will now be adapted for use by Alpine rescue squads in locating avalanche victims.

Automatic weather stations

Only since 1994, when the first automatic weather station with bi-hourly continuous data collection became operative at the Pyramid site, have regular climate measurements at high altitudes (5000 masl) been possible. This monitoring process has since become known for the exceptional regularity of its measurements. The Pyramid automatic weather station marked the starting point of Ev-K^2-CNR's wider involvement in international climate and meteorological research. A landmark moment in this evolution was the inclusion of the Pyramid Meteor-Group in the World Meteorological Organization (WMO) Coordinated Enhanced Observing Period (CEOP)/Tibet Project as of 2002.

Thanks to its unique characteristics and potential for providing insights into the interaction between the Asian monsoon and the Himalayan barrier, the Pyramid automatic weather station has been accredited as the Coordinated Enhanced Observing Record Himalayan reference site. Additional stations have since been installed along the Khumbu Valley at 2700, 3500, 4250, and 5050m, resulting in the only vertical high altitude weather monitoring network. These solar-powered automatic weather stations are reachable on foot and continuously monitored by local staff. They are among the most accurate and efficient in the Himalayan range, recording World Meteorological Organization standard data on digital loggers with mass memory on memory cards. The network has been expanded recently to include an additional station at Urdukas, along the Baltoro glacier in Pakistan near K^2 base camp.

Long-range pollution transport monitoring systems

The AWSs in the Khumbu Valley form the base of Ev-K^2-CNR's multidisciplinary climate and atmospheric research project 'Stations at High Altitude for Research on the Environment in Asia (SHARE-Asia)'. This project foresees the expansion of the monitoring network throughout the Hindu Kush-Karakoram-Himalayan region and aims to use the data collected to perform analyses on:

- ocean, soil, and atmospheric interaction mechanisms governing the monsoon climate system;
- the distribution and transportation of pollutants related to the atmospheric brown cloud; and
- mechanisms determining the presence of pollutant depositions found in air, snow, and lake sediment samples at high altitude.

As stipulated in our preliminary agreement with UNEP-Asia, the primary contribution of these installations will be to increase our understanding of the interactions between the vast extent of haze hovering over most of Asia, known as the atmospheric brown cloud, and the major Asian mountain chains. The role of the mountains has yet to be fully comprehended, both in terms of their function as a circulation barrier and as a potential collection point for the deposition of particulate components, consisting of sulphates, nitrates, organics, black carbon, and fly ash, among other substances, which can be transported far from their source.

The potential global consequences of this haze include climate change and impacts on ecosystems, the water cycle, agriculture, and human health. The network of ground-based monitoring stations that UNEP plans to establish throughout Asia, to study the composition and seasonal pattern of the haze, already include monitoring sites run by ICIMOD in the Kathmandu Valley and lower hills. Ev-K^2-CNR's input will be to capture traces of aerosols and particulates accumulating at sensitive high altitude automatic weather station sites in Nepal and Pakistan, allowing climatic, atmospheric chemical, and ecological measurements to be carried out above the cloud's level of maximum density (3000m). This partnership is an excellent example of how quality research, promoted in cooperation with regional intergovernmental organisations, can directly influence capacity building efforts and bring scientific results to the notice of governments.

Understanding the complex relationship between climate, meteorology, environment, and human activities also implies explaining the mechanisms that lead to the discovery of traces of pollutants, even in these remote areas. Thanks to the support of the Pyramid facilities and its logistical expertise in operating in high mountains, Ev-K^2-CNR has been able to combine periodic samplings of glacial ice, of surface snow up to 7000m, and of water from about 35 Khumbu Valley lakes to study the effect of pollutant loads in Himalayan precipitation and indirectly assess the quality of the air above while identifying the possible origins of the pollution. Besides identifying elements such as lead, cadmium, copper, and zinc, these studies have focused on finding traces of heavy metals, like those from the platinum group, coming from vehicle catalytic converters thousands of miles away.

Radio analytical and spectrochemical techniques have also been applied in studies on atmospheric pollution processes in which analyses of trace elements (V, Mn, Cr, As, Co, Zn, Fe, Se, Sb, Cs, Sc, La, and Br) were carried out in the Everest region, using lichens as biomonitors of trace metals. A sampling campaign for airborne particulate matter collection at the Pyramid Laboratory was also carried out later; samples of total suspended particulate matter (TSP) and different particle size fractions (PM10 and PM2.5) were collected.

Geographic information systems (GIS) and multi-source/ multi-format data handling and sharing

Mountain environmental changes and the effect of human activity on mountain environments are often only directly and immediately observable by consulting diverse sources of data and information. The study of such information requires specific tools to analyse variations occurring over time. The increasing availability of huge repositories of data, accumulated at different times and with diverse techniques and instruments, opens up new research fields of time-varying process analysis. This is paramount for a wide spectrum of applications related to impact assessment and decision making for the management of natural resources and the study of climatic variations; fields of great significance for sustainable development.

Due to the amount of data, naive management and analysis are no longer acceptable. New elaboration procedures must be identified and validated and supported by software systems capable of efficiently storing and retrieving information based on both spatial and temporal features. Traditional GIS often include database facilities and sometimes provide the means to represent temporal information and dynamics somehow associated with the spatial framework, which emphasise static representations of reality, but these may not be enough.

In response to this new technological challenge, Ev-K^2-CNR, The World Conservation Union (IUCN), ICIMOD, and Cooperazione e Sviluppo Onlus (CESVI) (an Italian NGO) have joined in a World Summit on Sustainable Development (WSSD) partnership initiative, with the support of the Italian Ministry of Foreign Affairs, to develop a decision support system (DSS) for the Hindu Kush-Karakoram-Himalayan region. A DSS can be defined as a computer-based system that integrates data sources with modelling and analytical tools; facilitates the development, analysis, and ranking of alternatives; assists in the management of uncertainty; and enhances overall problem comprehension. Our in-progress DSS, to be piloted in the Sagarmatha National Park in Nepal and replicated for the Central Karakoram National Park in Pakistan, will include geo-referenced and dynamic scientific data forming a base for predictive models that aid in decision making on natural resource management. The data stored in GIS-based systems will be rendered consultable through formal methodologies (rules), employing specific logical and computational modules (functions). The system will be completed by input, in terms of thorough interpretive knowledge, from multidisciplinary scientific experts, and the involvement of local actors and decision makers, supported by institutional capacity building and technical scientific training components.

Clean technologies and renewable energy systems

Waste management and the production of heat, cooking fuel, and electric energy are some of the most important issues that need to be addressed to reduce human impact on the environment in widely populated and visited remote areas. Ev-K^2-CNR has tested and successfully employed alternative energy systems, like photovoltaic and mini-hydroelectric systems, at surprising levels of efficiency even under the most extreme conditions. These experiences can be, and are being, replicated in similar mountain environments.

We are now also applying ISO 14001-standard methodology in developing waste management protocols for the Pyramid Laboratory and for large scale climbing expeditions. The most common waste management solution in mountain areas is transportation to the nearest urban centre for disposal. In the case of the Khumbu Valley, this is Kathmandu. This involves cost and pollution risks that are not sustainable. Alternative solutions are thus being sought which could lower the volume and weight of waste transported down valley, such as the use of a mini-incinerator recently developed for use at K2 Base Camp. This approach, combined with an environmental code for expeditions and trekkers, as well as awareness raising for local communities and workers, will help reduce the quantity of non-biodegradable waste and facilitate the proper management and disposal of what is produced.

Conclusion

Modern advanced technologies are greatly improving our knowledge of the complex interactions between the environment and human activities, even in the most remote areas of the world. The progress of micro-technologies means that compact, portable instruments can be developed while also improving performance and reliability. Satellite observation systems, namely optical, infrared, and microwave imageries, offer us a unique opportunity to trace phenomena in the atmosphere, or on Earth, back to their origins. News, information, and data can reach everyone in real time through the existing telecommunications network. However, these technological opportunities must foresee the involvement of experts to avoid the misinterpretation of data and resulting errors, while reaching out to as wide a user community as possible, including those who may seem unrelated or often remain excluded (i.e., local stakeholders and communities).

In the case of mountain regions, especially in developing countries, this entails appropriate scientific training for local research institutions and capacity building for local stakeholders. For this, we are grateful to organisations like ICIMOD. Over the past 20 years, ICIMOD has consolidated its leading role as a centre dedicated to the promotion of balanced environmental and economic development of transboundary mountain ecosystems. Only multidisciplinary expertise like ICIMOD's can successfully contribute to avoiding the risks posed by the inappropriate adoption and use of advanced technologies, while ensuring that their benefits are taken advantage of for the maximum common good.

Panel Topic – Impacts of Global Warming and Climate Change on Mountain Ecosystems[1]

Mr R Rajamani, former Secretary, Government of India, Ministry of Environment and Forests

Introduction

A caution may be in order at the beginning that this does not claim to be a well-researched scientific paper. The author has the disadvantage of not having full access to material databases, and also a personal background of only some involvement in policy formulation in the environmental field some years back; but also the dubious advantage of a deep interest in mountain ecosystems and some exposure, during various positions held in the civil service, to facets of mountain ecosystems. These advantages lend themselves to a holistic analysis and identification of gap areas in scientific thinking. On that note, I will first look at the nature of, and role of, mountain ecosystems (which include geographical elevations of 1000 metres and above).

Mountains provide over 60% of the fresh water resources of the world. This is partly through the conservation of rainwater in different forms – in vegetation, in deep rock formations, in internal aquifers that discharge into springs, and so on. Many rivers and streams have their origins in the hills and mountains of the world. Waterfalls are the product of such ecosystems.

These ecosystems harbour nearly half of the biodiversity hotspots in the world. This estimate is based on the inventorying of the flora and fauna done so far and has yet to cover so many life forms as yet unstudied or researched. Mountain ecosystems are fragile and subject to geological and other factors affecting their composition, structure, slopes, snow, soil, and vegetation cover. There are some mountain ecosystems in the world which have yet to stabilise after tectonic, volcanic, and other natural changes. This adds to their instability and makes them more vulnerable to climate change than other ecosystems.

Mountains are inhabited by many poor people. Nearly 80% of mountain people live below the poverty line and often have to depend on depleting natural bounty in the mountains, or on out migration. They have to resort to making changes in the mountain ecosystems in search of a livelihood. This includes activities such as building, grazing, and farming, which deplete the natural resources in the mountains including the soil and vegetation cover, which also conserves water. Such changes are compounded by natural phenomena like blizzards, avalanches, heavy snowfalls, and intense precipitation of rain. These manmade changes set off chain reactions leading to greater natural hazards like landslides.

Against this background, it may be useful to recapitulate the special characteristics that set mountain ecosystems apart from other ecosystems.

[1] Note: the author is grateful to ICIMOD, GBPHIED, and EPTRI for their help in preparing this paper.

Special characteristics

As mentioned above, mountains are fragile. They are storehouses of fresh water. Their biodiversity is often unique, leading to the description of some mountain areas as biodiversity 'hotspots'. Many species of flora and fauna are endemic or peculiar to mountain ecosystems. These species have various values as medicine, food, and for nutrition, which are distinct, based as they are on local features like well drained soils or temperate climate. The high plant diversity in mountain ecosystems adds to their resiliency and even acts as a cushion against natural events like landslides. The natural resources of the mountains include rich forests (which often act as sponges for water), herbs, minerals, and also the valuable germplasm of cultivars, the product of traditional farming systems, which are organic and conservation oriented. Of the 20 plant species that supply 80% of the world's food, six are found in the mountains.

The equable temperature and climate of the mountains contrasts with the tropical or near tropical conditions of the plains, especially in latitudes near the equator. This attracts tourists. In countries like India, locations in mountain areas of sacred sites that are venerated by people (often associated with sources of water or special flora or fauna) attract more tourists.

Mountain people do suffer from poverty and their health is affected by malnutrition and inadequate insulation from the vagaries of nature. However, they are rich in culture and this has spin offs, not only for religious lore and spiritual themes, but also in the production of beautiful handicrafts and special agricultural and horticultural produce. The ethnic knowledge that they possess in relation to herbal cures and the special terrain of their surroundings is such that it opens up vistas in health, mountaineering, and more.

Impacts of global warming

Each one of the above characteristics can be affected by global warming and climate change. The impact of global warming and climate change will not only be on water resources, like glaciers or glacial lakes, but also on soil, vegetation, sustainable farming, industry, and tourism. A combination of these various impacts can aggravate both the life and livelihood securities of mountain people.

Glaciers and water

Many organisations like ICIMOD are concerned about the recession of glaciers due to accelerated global warming. In the normal course, these glaciers thin out in the summer, feeding lakes, which in turn feed the rivers. The glaciers are renewed by snowfall and low temperatures in winter. However, if there is a rise in temperature, due to factors like global warming, glaciers can melt fast and flow rapidly into glacial lakes that form behind the newly exposed terminal moraines. Such lakes can burst, leading to a phenomenon called glacial lake outburst flood – with ominous consequences for the terrain below.

An example of the retreat of glaciers is the Gangotri Glacier in the Indian Himalayas. This glacier seems to be retreating faster in recent times. Between 1780 and 1900 (a little over 100 years), it receded by 0.3 km, but in the 100 years between 1900 and 2000, it receded by over one km!

A study of 5000 glaciers spread over 43,000 sq.km of the Indian Himalayas, estimated that glaciers are retreating at an average rate of 18-20 metres per year[2]. This has led to widespread discussions on whether or not this is another phase of glacial history that is likely to be reversed, or if it is likely to worsen, and if so what the consequences will be?

A study of the big Gandhisagar Lake near Chaurabari Glacier shows that its major contribution of water is not directly from glacier melt, but from snow melt from the valley sides. Such findings and studies do pose questions as to whether or not there is a direct relationship between global or local warming and snow melt. The answers to these questions are important in view of the long-term consequences that such recession and melts can have for mountains and floodplains in terms of loss of productivity and other impacts on regional economies.

In the context of mountain water resources and the impact of changes on their regime, it may be useful to ponder whether or not it suffices to concentrate only on disaster mitigation studies of the type done by ICIMOD and other institutions, or if we should be looking at basic and controllable causes, whether local or global, in a preventative mode. Such speculation and findings may have to be extended to the other special characteristics of mountain ecosystems like biological diversity.

Biodiversity

The Conference of Parties has selected mountain biodiversity as one of the major themes for in-depth consideration under the Convention on Biological Diversity. The follow-up studies or actions will cover:

- activities to facilitate the maintenance, protection, and conservation of the existing level of endemic species, with a focus on narrowly distributed taxa;
- programmes to restore degraded mountain ecosystems and biodiversity to enhance the capacity of mountains to cope with climate change or recover from its negative impacts by establishing corridors to enable the vertical migration of species;
- key research on the role and importance of mountain biodiversity; and
- the identification of factors responsible for the retreat of glaciers and measures to minimise the impact on biodiversity.

These studies are no doubt very important. Changes in endemism can occur if the upward migration of life zones takes place as a consequence of global warming. However, mitigating or preventive measures should also be related to the direct cause, whether it is global warming isolated from other causes like anthropogenic pressures

[2] Naithani, A.K.; Nainwal, H. C.; Sati, K. K.; Prasad C. (2001) Geomorphological evidences of retreat of the Gangotri glacier and its characteristics. In *Current Science*, 80: 87-94

and local phenomena, or these other causes themselves. If these other causes remain, mitigating measures against global warming alone cannot help. In addition, the facts must be firmly established, based on time series data, whether relating to glacial recession or the upward migration of species.

The nature of studies undertaken so far

Some examples are given of the nature of studies undertaken by some of the institutions covering the Hindu Kush-Himalayan region. The GB Pant Himalayan Institute of Environment and Development, at Kosi Katarmal in Uttaranchal, depicts in its Annual Report for 2002/03 that research and development have been directed more towards aspects of land and water resource management in the Himalayan mountain ecosystem. Topics connected with conservation or biological diversity also figure prominently in the studies. Most of these studies are correctly linked to improving the living conditions of marginalised or poor groups in the mountains, or to the study of degradation in watersheds. In the Institute, biodiversity studies are undertaken on habitat fragmentation in protected areas and ecologically sensitive habitats, focusing on location specific issues of a short-term nature. Long-term studies relate to bio-resource inventorying, conservation with participation of the people, and studies of disturbances in forests due mostly to anthropogenic factors like habitat fragmentation. No specific study was noticed linked to global warming.

In ICIMOD, some activities, such as the People and Resource Dynamics Project (PARDYP) do address mitigation concerns in relation to natural disasters. However, this is not linked to the effects of temperature variation, local or global. There is some expectation that this would be dealt with in the integrated programme on Water, Hazards and Environmental Management (WHEM). One of the initiatives under the latter is to develop an understanding of the linkages between glaciers, glacial lakes, and climate change. However, it is not clear if this will include a deep study of the relationship between global warming data and data on the physical phenomena affected.

The effects of global warming on the other special characteristics of mountain ecosystems – like cultivars, climate, tourism, and traditional knowledge systems – and through these characteristics on poverty and health, are not taken up as major programmes by most institutions. In India, there are hardly any programmes studying the effects of climate change on mountain/hill ecosystems like the Western Ghats, the Eastern Ghats, or the Aravallis.

Recommendations

Taking all of the above into account, the following recommendations are made in relation to possible future areas of study and for action plans in mountain ecosystems in the context of climate change.

- Specific projects should be undertaken, drawing on studies of the rise in temperature and/or humidity in mountain ecosystems. Such studies must use time series data, which is available from global and local level meteorological institutions.

- In parallel, studies should be undertaken to isolate the effects of other causes, like anthropogenic pressures and heat island effects. Some of these may arise from deforestation, excessive building activity, or conversion of water bodies for non-water uses.
- The direct impact of global warming on all of the special characteristics of mountain ecosystems should be researched.
- As studies get underway, interim suggestions for the prevention/mitigation of likely damage should be given to planners, policy makers, implementers, and civil society on a precautionary basis.
- In some cases, studies on indicator species with a focus on endemism may be undertaken, relating them to global warming.
- ICIMOD must persuade the Global Environment Fund and the Secretariats on the Convention on Biodiversity and Climate Change to fund such projects as a priority, as mountain ecosystems suffer from greater degradation, human misery, and out migration, which in turn affect other ecosystems like those of the floodplains and their peoples.
- ICIMOD can undertake studies on Indian mountain ecosystems in collaboration with institutions like the GB Pant Himalayan Institute of Environment and Development (Himalayas), the Environment Protection Training and Research Institute, Hyderabad-Eastern Ghats, and the Centre for Science and Environment, Indian Institute of Sciences, Bangalore-Western Ghats.

Panel Topic – Environment Services and Upstream-Downstream Relationships in Pakistan

Dr M Sharif Zia, CSO/Incharge, Natural Resources Division, Pakistan Agricultural Research Council (in association with Dr A.W. Jasra, Director and Dr I. Ahmad, Deputy Director, NRD, PARC)

Introduction

The northern mountains of Pakistan in the Hindu-Kush Himalayas (HKH) are mainly comprised of the Northern Areas, Malakand division, Hazara division, and Azad Jammu and Kashmir. These mountains cover an area of 115,340 sq.km. The region is characterised by steeply dissected mountain slopes with strong higher relief. There is great variation in regional and altitudinal rainfall from arid to humid; in seasonality from monsoon to Mediterranean; in temperature from subtropical in the valley to arctic at high altitude (cool, cold, very cold); and in altitudinal range from less than 1000m to more than 8600m. The mountain slopes support mainly unstable, excessively drained, shallow to moderately deep, gravelly loam soils on bed rock. Without vegetation cover and with high rainfall erosivity and soil erodibility in the humid monsoonal zone, these soils are subject to severe sheet, rill, and gully erosion (GOP 2001).

The northern mountains provide the most important catchments for two vital dams, Tarbela and Mangla. Of the total 202,062 sq.km catchment area, about 74,793 sq.km lies within Pakistan. These catchments are drained by the Indus and Jhelum rivers and numerous tributaries discharging about 139 MAF [million acre feet, ed] of water. These mountain areas support a wide range of agricultural crops, fruit trees, forests, medicinal plants, and rangelands, and play a key role in the socioeconomic uplift of the people living in the area (GOP 2001). Mountainous and sub-mountainous regions in the HKH part of Pakistan are potential sources of natural resources for the country. The sustainability of this belt is threatened by overgrazing and the destruction of forests to meet the fuelwood and timber requirements of its inhabitants. In addition, extensive and intensive cultivation to grow more food for the increasing population, together with expansion of cultivation to marginal steep sloping lands, is leading to severe soil erosion, landslides, siltation, and the degradation of watersheds. Increases in the upstream population are resulting in further fragmentation of already small holdings, which may not be able to provide a sustainable livelihood for the upstream people. This in turn causes migration to downstream areas, where upstream people are employed in industry and other non-farming enterprises. The pressure of urbanisation causes a direct loss of productive agricultural land, and problems of soil and water pollution threaten downstream agricultural productivity (Figure 1). Land degradation, desertification, and increasing poverty are the main issues for these areas. The concept of environmental services, in the context of the upstream and downstream scenario, is not very clearly understood in Pakistan. In addition, there is no legal mechanism for payment for environmental services. It is believed that all of these issues are common in countries in the HKH region. This paper addresses all of these important issues so that common strategies can be formulated to reduce land degradation and poverty in all countries in the region.

Environmental land degradation in mountain regions

Land degradation and desertification

Mountain ecosystems harbour a wide range of significant natural resources and play an important role in the ecology and economic processes of the earth. As upstream mountain populations and accessibility to mountain areas have increased, mountain resources and people have moved downstream, and environmental degradation has gone upstream.

There is a high incidence of environmental degradation in mountain areas due to their extreme fragility. Mountain ecosystems are characterised by factors such as geomorphic energy, steepness, isolation, and low temperatures, which cause vegetal growth and soil formation to occur very slowly. Soils are usually thin, young, and highly erodible. Under these conditions, farming in marginal mountain areas can easily cause environmental imbalances. Once eroded, mountain areas may need hundreds of years to recover.

Deforestation, landslides, land degradation, desertification, and glacial lake outburst flooding are key environmental issues. Mountain areas are particularly susceptible to natural hazards mainly in the form of earth surface processes such as avalanches, rock falls, debris flow, volcanic mud flow, glacial lake outburst floods, and other types of

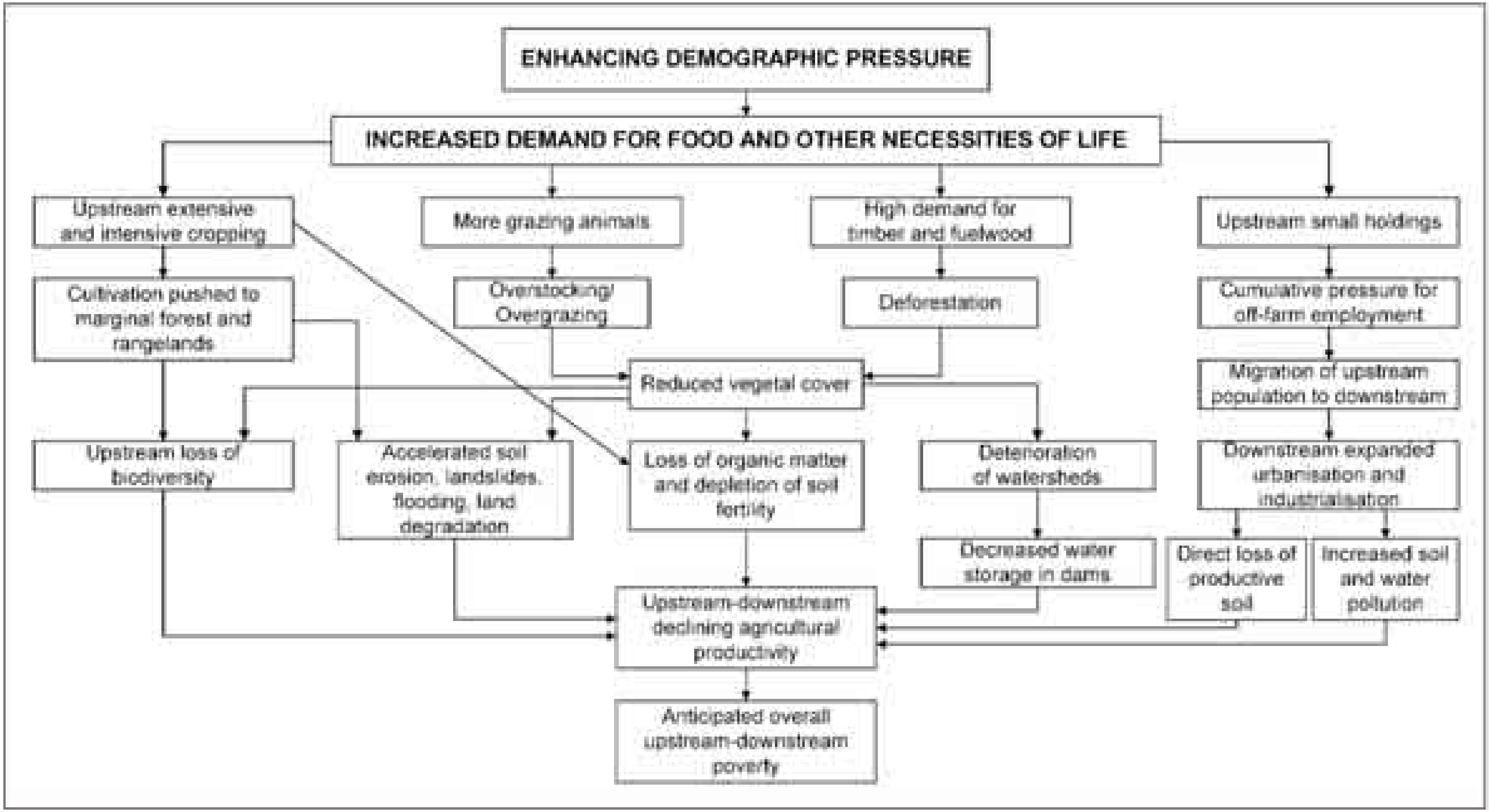

Figure 1: Upstream-downstream relationships with reference to population pressure, soil degradation and poverty in the HKH region (Source; Zia 2004)

floods. The disaster database of the Office of US Foreign Disaster Assistance/Centre for Research on the Epidemiology of Disasters (OFDA/CRED) recorded a total of 2557 hazards worldwide between 1991 and 2000 (Iyngararasan et al. 2002). Losses from natural hazards in mountain areas have been increasing as a result of the over exploitation of natural resources, deforestation, and the construction of infrastructure such as buildings, roads, irrigation canals, and dams. Climate influences the weathering process, erosion, sediment transportation, and hydrological conditions. Climate also affects the type, quality, quantity, and stability of vegetal cover, and therefore biodiversity. Mountain systems are particularly sensitive to climate changes. The major triggering factors for landslides and debris flows are heavy rainstorms, snowmelt run off, and the human modification of mountain slopes.

Rising temperature trends in the Himalayas and their vicinity between 1977 and 1994 (Shrestha et al. 1999), resulted in glacier shrinkage, thawing of permafrost, late freezes, and early break-up of ice on rivers and lakes, the poleward and altitudinal shift of plants and animal species, the decline of some plant and wildlife populations, and earlier emergence of insects (IPCC 2001). A more general trend is that plant and animal species are expected to shift upstream.

Regional haze could have a potentially significant impact on the monsoon climate, water stress, agricultural productivity, and human health. The most direct effects include a significant reduction in the amount of solar radiation reaching the earth's surface, an increase (50-100%) in solar heating of the lower atmosphere, suppression of rainfall, a reduction in agricultural productivity, and adverse health effects. These will be of concern in both upstream mountain regions and downstream areas.

Aerosols directly alter the hydrological cycle by suppressing evaporation and rainfall. With respect to agricultural production, a decrease in the amount of solar radiation received by vegetation can impact on productivity, directly and indirectly, through induced changes in temperature and the hydrological cycle.

Mountains have been described as 'water towers' – the source of freshwater for billions of people around the world (Iyngararasan et al. 2002). Climate change, especially the rise in temperature, will result in the loss of water due to glacier shrinkage (IPCC 2001). The Himalayan glaciers are also melting at a rapid pace resulting in the formation of dangerous lakes.

Factors encouraging degradation in mountain areas include climatic variation and unsustainable human activities such as overcultivation, overgrazing, deforestation, and poor irrigation practices. The main unfavourable social, cultural, and political factors include low literacy rates, high female workloads, and lowland interests.

Increasing population trends (human and animals) will exert more pressure on forests and rangelands. With such increases in population, demand is growing for more cultivable land, fuelwood, timber, and fodder. As a result, soil degradation, particularly in the form of landslides and soil erosion, is increasing at an alarming rate, resulting in anticipated reduced crop productivity (Zia 2004).

Desertification – a reduction in the ability of land to support vegetation leading to a vicious cycle of poor vegetation and poor soil – is caused by the complex interaction of physical, biological, political, social, cultural, and economic factors. Although desertification has become a global issue, it remains poorly understood. Available estimates of areas affected range from one-third to about a half of the world's land. Estimates of people affected range from one in six to one in three (Toulmin 2001). One common estimate is that desertification and land degradation affect almost 30% of the global land area and nearly 850 million people. The problem of desertification is becoming more and more serious each year. For example, the deserts of China are expanding each year by 2460 sq.km at a cost of US $1.52 billion (Iyngararasan 2002).

Measures to reduce environmental degradation

Environmental degradation can be controlled by controlling population growth, creating off-farm employment opportunities, and stopping deforestation and overgrazing by adopting best practices. A detailed account of best practices for the cold and dry zone of the HKH is given by Shaheen (1998). Deforestation can be controlled by stopping the expansion of crop cultivation on steep sloping lands; by reducing the use of wood for fuel by providing alternative energy sources; by the forestation of mountain areas and watersheds; and by growing horticultural plants and grass legume mixtures in these areas. Environmental degradation can only be reduced through the sustainable management of forests, watersheds, and rangelands with the involvement of local communities in development activities and in creating alternative opportunities for their sustenance. Illicit tree cutting, felling, and grazing have to be controlled at any cost. The cultivation of value-added shrubs, such as tea, would be more profitable in watersheds and mountains. Practices to counter the damage caused by overgrazing include reducing livestock numbers through increased market off-take, sterilisation, and stopping or controlling livestock movement by switching to stall feeding for meat and milk production. Introducing improved breeds and reducing losses from disease would allow farmers to maintain output levels with fewer animals.

Poverty in the Hindu Kush-Himalayas

Poverty Scenario

The overall poverty situation in the HKH countries presents a dismal picture. High population growth rates, increased population pressure on natural resources, relatively limited opportunities for occupational mobility, and imperative outmigration are prominent features of the ongoing scenario in the mountains. There is an equally important and more disturbing trend with respect to the indicators of human development. The relationship between population pressure and poverty is well explained by Zia (2004) in a flow diagram (Figure 1). In all the HKH countries, population is rising at a rapid pace and this is likely to aggravate the poverty situation. Using a poverty threshold of two dollars a day, which is no generous standard by any means, well over two-thirds of the people in Bangladesh, India, Nepal, and Pakistan live in poverty (van der Liden 2004). As a result of poverty, many people sleep hungry. According to the FAO (2003) World Hunger Map, the situation is worst in Afghanistan, followed by India (Figure 2). However, the situation is comparatively better in Nepal and Pakistan. According to UNDP (1996), the upstream population is poorer than the downstream and people in rural areas are poorer than urban populations.

Poverty alleviation

Despite some major constraints in mountain areas, with the right policies and programmes, and with the participation of the people, poverty conditions can be substantially altered. Poverty eradication, however, cannot be achieved through one short effort; a common philosophy underlying many development projects. Poverty eradication needs continuous attention as communities move from one threshold to another.

Van der Liden (2004) reported a dramatic poverty reduction in the People's Republic of China and southern countries. It was found that in cases of poverty reduction in Asia, an

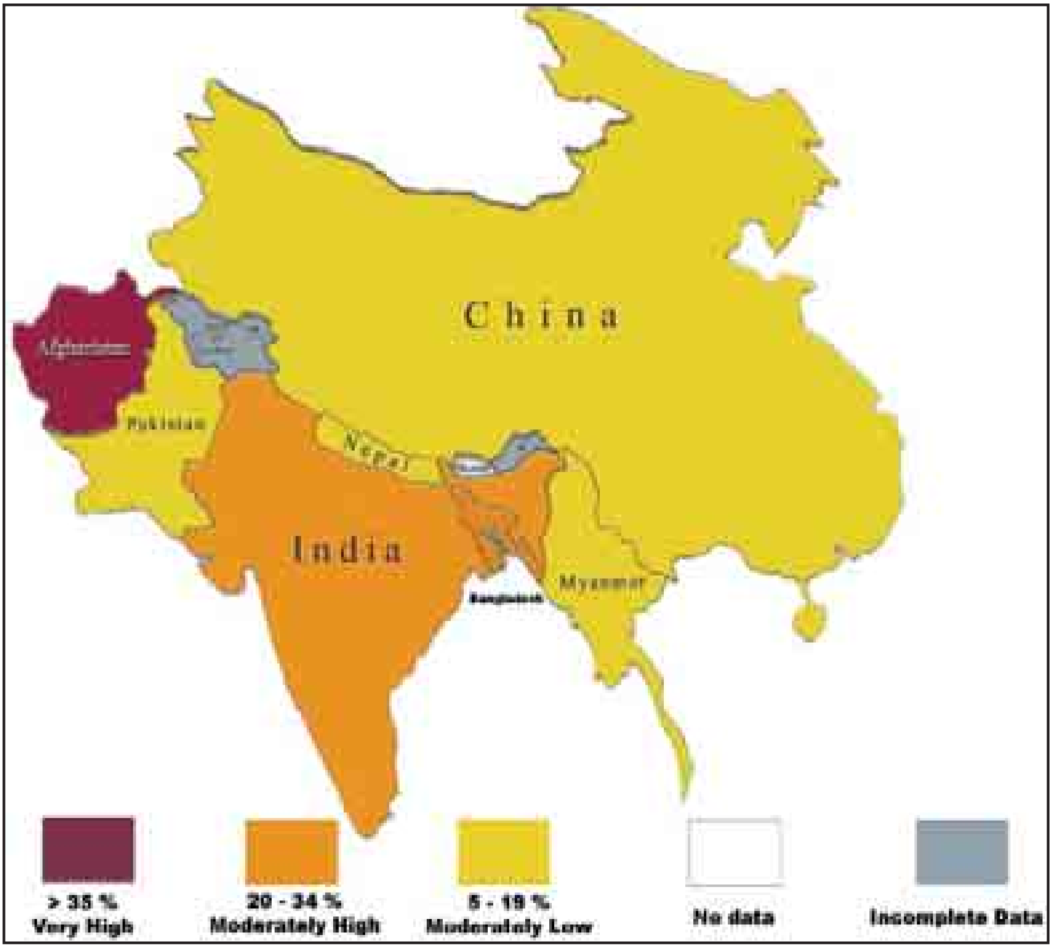

Figure 2: Hunger map of the HKH region (Source: Extracted from World Hunger Map, FAO 2003)

increase in mean income was the single most important factor in reducing poverty. High rates of economic growth not only generate economic opportunities for the poor, but also increase the resources that governments have at their disposal to invest in the poor.
In Bangladesh, India, Nepal, and Pakistan, the majority of the poor (more than 75%) live in rural areas, which depend on agriculture. Investment in rural roads, irrigation, rural electrification, and extension services would help considerably to improve their living standards.

Increasing the level of investment in basic education and health care is important to ensure that the poor participate meaningfully in their country's economic growth. The fate of the poor is not only linked to agriculture, but also to other sectors, through migration, trade, and remittances. The growth in these sectors, particularly in industry, has contributed less to poverty reduction in South Asia than it has in East and Southeast Asia. Policy makers must focus on generating high rates of sustainable growth, while ensuring that the benefits of this growth are spread over all sections of society. Pakistan will fully support ICIMOD's proposed strategy for poverty alleviation in mountain areas (ICIMOD 2000).

Upstream – downstream environmental services in Pakistan

There is no authentic infrastructure in relation to upstream-downstream services available in Pakistan. The information compiled in this paper is the result of discussions among soil, agroforestry, and wildlife scientists.

Upstream services

Over 90% of the Earth's fresh water is stored in ice, which together with seasonally stored snow, provides water on melting. Thus mountains are sources of fresh water which is used upstream and downstream for drinking, domestic use, fisheries, irrigation, hydro-electricity, industry, recreation, and transportation. Water is a major source of cheap power generation used by upstream and downstream populations for domestic and industrial uses.

In Pakistan, a 60% inventory of the Hindu Kush-Himalayan region has been completed in a collaborative project by PARC and ICIMOD. The project identified a total of 2808 glaciers covering a total glaciated area of about 7703 sq.km and with total ice reserves of about 1612 km^3 (WRRI 2004).

Upstream regions are rich sources of biodiversity in the form of forests, rangelands, medicinal plants, and wild races containing genetic material for crops and fruit trees. Forests provide wood for fuel purposes upstream, and timber and timber products for household use, both upstream and downstream. Forests also provide a clean environment by consuming carbon dioxide. In addition, upstream regions are a rich source of minerals, gems, oil, and gas. These upstream areas also contain beautiful landscapes, which attract tourists from rich downstream communities (i.e., eco-tourism).

Downstream services

Downstream areas are generally used for agricultural purposes and provide food in the form of wheat, rice, fruit, vegetables, sugar, milk, and cooking oil for upstream and downstream populations. Most industries are located in downstream areas. Almost all industrial products, such as cloth, medicines, fertilisers, pesticides, chemicals, detergents, electrical appliances, vehicles, and heavy machinery for road construction are provided to upstream people by downstream people.

The energy requirements of upstream people, in the form of gasoline, gas, petrol, diesel, kerosene, and candles are provided from downstream areas. Relief services in the case of a natural disaster are mainly extended by downstream areas to upstream areas. Most off-farm opportunities are extended to mountain inhabitants by downstream areas.

Payment for environmental services

Sustainable water development and the mitigation of natural disasters in river basins, depend on large-scale measures to protect upstream water sources and soils in mountain areas. The environmental services provided by mountains are often only noticed when they are lost (e.g., when downstream floods are caused by upstream deforestation). Similarly, most of humanity depends upon the fresh water that originates in mountain watersheds.

To date, when making land use decisions, upstream people have generally not taken the value of environmental services (such as those provided by their forests and other permanent soil protecting vegetation) into account. This is because they do not normally receive any compensation for these services. Nor do they invest in conservation practices in relation to watersheds to benefit their downstream neighbours. The lack of attention to mountain watersheds has resulted in the dangerous acceleration of erosion in catchments at the source, and in the dwindling availability of water downstream. In Pakistan, there is a lack of effective, long-term, downstream-upstream environment maintenance and compensation agreements.

In Pakistan, the issue of payment for environmental services is complicated because of its technical, socioeconomic, and sociopolitical nature. There is no direct system for the accurate recording of payments for environmental services. Downstream people have no tradition of negotiating environmental safeguards with mountain people. Nor do they have any legal or economic instruments or social organisation models for such a system. However, there is strong evidence of a large number of indirect payments for environmental services to peoples living upstream. This is being managed by the Government of Pakistan from the taxes paid by downstream dwellers, an account of which is given below.

- The Government of Pakistan provides PRs.4 billion in the budget for annual development plans in upstream areas, compared to a meagre contribution from upstream resources.

- Royalties for building big dams in downstream areas (such as Mangla and Tarbela) are being paid to upstream people.
- Food items and other necessities of life are being provided to upstream areas at almost the same rates as paid downstream. The huge cost of transportation is subsidised.
- The development of infrastructure, including road networks, hospitals, schools, airports, and irrigation channels (khool system) is financed by the government.
- A large number of mega environment conservation projects have been started by the Government and by various NGOs as listed below.
  - Mountain Areas Conservancy Project
  - Environment Rehabilitation Projects for North West Fronter Province (NWFP) and Punjab
  - Northern Areas Conservation Strategy Support Project
  - Northern Areas Development Project (NADP)
  - Protected Areas Management Project
  - Khunjerab National Park Project
  - Agha Khan Development Network (AKDN) comprising the Agha Khan Rural Support Programme (AKRSP), Agha Khan Cultural Support Programme (AKCSP), Agha Khan Education Programme (AKEP), Agha Khan Health Programme, and others
- Promotion of eco-tourism to attract international and national tourists in the form of exhibitions and events like the annual Silk Route Festival, the Shandur Festival, and car rallies.
- Subsidised rates for electricity, gasoline, coal, and airfares.
- There is no government tax system in northern areas located in the HKH region.
- There is a quota for upstream dwellers in education and service institutions in downstream localities.

The impact of policy implementation

Upstream benefits

Even though there is no system in place for the payment of environmental services, the Government of Pakistan and NGOs are doing lot for upstream people. This has a great impact on the socioeconomic conditions in upstream communities. The following benefits are directly reaching upstream communities.

- Large-scale micro financing by financial institutions for various development schemes.
- Mostly local people from upstream areas are employed in infrastructure development and mega environment conservation projects. This has provided upstream dwellers with local off-farm employment opportunities.
- The development of infrastructure in upstream areas has resulted in better marketing activities, communication links, education, and health facilities for upstream communities.

- Environment conservation projects have improved biodiversity conservation and reduced environmental and land degradation.
- Improved protection against natural hazards and disasters
- Improved chances for sustainable livelihoods
- A reduction in poverty
- Eventually a better upstream standard of living

Downstream benefits

Upstream environment conservation and reduced land degradation also have a positive impact on downstream people. Some of the benefits being harvested by downstream people are listed below.

- Improved water conservation in watersheds and increased storage in dams through reduced siltation
- More water availability for irrigation purposes and power generation
- Improved biodiversity conservation
- Better prospects for fisheries
- Improved agricultural productivity
- Reduction in land, water, and air pollution

Case Study: Mountain Areas Conservancy Project (MACP)

The Mountain Areas Conservancy Project (MACP) is funded by the Global Environment Facility (GEF), the United Nations Development Programme (UNDP), and the Government of Pakistan at a total amount of US $10.35 million for a seven-year period from 1999 to 2006.

The programme is based on a successful four-year pilot programme, the GEF Pre-Investment Facility Project titled Maintaining Biodiversity in Pakistan with Rural Community Development. The executing agency responsible for the overall coordination of the programme is the Ministry of Environment, Local Government, and Rural Development of the Government of Pakistan. The project is implemented by IUCN in Pakistan in close collaboration with the Department of Forestry, Wildlife, and Fisheries in NWFP and the Department of Forests, Parks, and Wildlife in the Northern Areas (NA). Collaborative partners are the Worldwide Fund for Nature in Pakistan (WWF), AKRSP, and the Himalayan Wildlife Foundation. The project is overseen at the national level by a Project Steering Committee and at the regional level by two Project Management Committees. The Project Management Unit is located in Islamabad. Regional Offices are in Chitral and Gilgit. There are six field units. The project is run by 37 professional staff members.

MACP is based on the premise that conservation activities are unlikely to be sustainable over the long term unless local communities are actively involved. MACP relies on the pioneering work done by AKRSP in community mobilisation and organisation and follows lessons learned during the pilot phase.

Project aim

MACP aims to protect biodiversity and ensure its sustainable use in Pakistan's Karakoram, Hindu Kush, and Western Himalayan mountain ranges, through the application of a community-based conservation approach.

Project objectives

The project has the following seven objectives or outputs:

- develop and strengthen capacity to conserve biodiversity at the community level;
- impart conservation values and provide avenues for information sharing on the management of wild resources;
- monitor the effects of project activities on biodiversity and socioeconomic indicators;
- assist communities to attract outside support for long-term eco-development;
- develop a knowledge base about components of biodiversity, particularly those suitable for sustainable use;
- assist the government to revise policy and legislation to better support participatory conservation; and
- develop endowment funds to meet the ongoing costs of conservancy management.

Project components

The project has three principle thrusts:

- to organise, empower, and boost the capacity of local communities to conserve biodiversity at an ecological landscape level;
- to enhance the relative values of wild resources (as a conservation incentive) by promoting their sustainable use; and
- to create a policy, legislation, and financial framework conducive to community-based conservation (locally appropriate conservation committees will be organised at the valley and district levels).

Project tasks

Project tasks include:

- developing village, valley, and conservancy level conservation plans;
- implementing a broadly-based conservation awareness programme;
- introducing sustainable use demonstration projects;
- enhancing scientific knowledge of biodiversity in conservancies;
- involving women in conservation;
- revising current wildlife laws;
- developing conservancy level trust funds; and
- enhancing the capacity of government departments to undertake sustainable development and biodiversity conservation.

Project area

The focus is on ecological landscape management at large spatial scales. MACP activities are being undertaken in four conservancies identified using a range of biological, socioeconomic, and other criteria, with two sites in the NWFP, and two in the

NA. In the NWFP, the Tirichmir and Qashgar Conservancies both lie in the Hindu Kush. In the NA, the Gojal Conservancy lies at the point of intersection of the Karakoram range with the Pamirs in Afghanistan and China. The Nanga Parbat Conservancy, also in the NA, lies in the Western Himalayas. The Tirichmir and Gojal Conservancies are characterised as cold deserts, dominated by a dry alpine environment, although alpine meadows are found at higher elevations. Much of the landscape in these areas is treeless, with permanent snowfields found above 4,000m. In contrast, the Nanga Parbat and Qashqar Conservancies harbour ecologically important tracts of dry temperate forests. The conservancies together span an area of some 163,000 sq.km.

Achievements of the project

- The impact and human capacity of community level organisations to conserve biological diversity has been strengthened. Planning and management structures are in place in the four conservancies in the NWFP and NA of Pakistan.
- Conservation values are imparted to local communities through a well-targeted conservation education and awareness drive, with avenues for the sharing of information and experiences about wild resource management among people from the four conservancies in the NWFP and NA of Pakistan.
- A system has been established for monitoring and evaluating project impacts, including ecological and socioeconomic outcomes.
- Development agencies and local communities have targeted financial and human resources towards long-term village eco-development in the four conservancies in the NWFP and NA of Pakistan.
- The knowledge base regarding the sustainable use of components of biodiversity has been enhanced and results applied to ongoing community development activities.
- Government policies and regulations have been re-moulded to support the management of the conservancies. Institutional capacities for the management of participatory conservation models have been strengthened in the NWFP and NA of Pakistan.
- A biodiversity fund is operational and contributes to the recurrent costs of conservancy management in NWFP and NA of Pakistan.

Recommendations

- To fight poverty, policy makers must focus on creating a high rate of sustainable national growth, while ensuring that the benefits of that growth are spread over all parts of society.
- Environmental services agreements are now urgently needed in the face of observable global trends towards environmental degradation in mountain areas.
- Region-specific approaches need to be developed for the valuation and contracting of upstream environmental services by downstream communities and enterprises dependent on reliable quantities of good quality water, together with disaster prevention strategies.
- Capacity building educational programmes need to be started in upstream areas.
- A systematic and regular monitoring system needs to be developed to monitor mountain environments. The system should cover the three major components of mountain environments: air, land, and water.

- An early warning information system, with respect to changes in mountain environments and their consequences, is a priority need. The target groups should not be limited to mountain communities. Messages should also reach lowland communities.
- An inventory of mitigation options and best technologies needs to be disseminated to national institutions and mountain communities.
- Capacity building of national institutions must be ensured to enable monitoring of mountain environmental issues in developing countries. This should include continual monitoring complemented by project research.

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Panel Topic – Securing Community Participation in Conservation

Professor Xu Jianchu, Programme Manager, WHEM, ICIMOD

Introduction

This paper examines the opportunities and challenges in relation to community participation in ecosystem assessment and conservation in light of contemporary political ecological perspectives. There is a growing recognition of the role of communities and indigenous people in assessing, maintaining, and nurturing the diverse landscapes and biodiversity in which they live and on which they depend. However, there is a fundamental difference between outsiders and local people in terms of knowledge systems, perspectives in relation to conservation approaches, methodological frameworks, and interests. There is also a difference in the power relationships between different actors – state, private, environmentalists, NGOs, and local people. The phrase 'community based' can mean different things to different people, making their ways of dealing with local people also quite different. In this paper, I will employ the term 'community' consistently to refer to indigenous people, place-based practices, and local knowledge, as well as to the legal and legitimate entity. Community participation does not simply mean convincing a local community to plant trees to prevent soil erosion. It is more important to have the participation of the community and local people in the production, validation, and application of scientific knowledge; in the negotiation of access rights to natural resources, markets, information, and technology; in the assessment of environmental risks and climate changes; and even in local governance and decision-making. With increasing globalisation and climate change, we should not ignore the large uncertainties that local communities face as they strive to use ecosystems and sustain the diverse landscapes in which they live. With these threats to local environments and cultures, it is essential not only to document indigenous and local knowledge and practices, but also, most importantly, to enhance the capacity of local people to strengthen their evolving technical innovations, and to improve their livelihoods and human dignity. In this paper, I will examine how to define a community; what we have learned so far from community-driven conservation; and what the pathways are for sustainable conservation and development.

What we have learned about coupled human-environment systems

There are many examples of successful conservation initiatives by local people, adapted to the changing interaction between humans and ecosystems, and the power relations between the local community and external state, and non-state, institutions. These examples include sacred groves in India, Tibetan sacred mountains in China, forest user groups in Nepal, and initiatives by agro-pastoralist peoples in the Himalayas, Western Ghats, and on the Tibetan plateau. However, much of the thinking on biodiversity conservation and ecosystem management is still based on separating nature from culture. This is reflected in the history of ecosystem research and conservation practices over the past century. That people are a threat to nature, was a widely framed concept in conservation until the 1970s (Jeanrenaud 2002). People's activities, such as shifting cultivation and the collection of forest products, were viewed as the principal threat to stable plant succession, climax vegetation, and even the functioning of ecosystems and ecosystem development (Odum 1969). The transformation of landscapes has been, and will continue to be, influenced by predominantly cultural perceptions of nature as well as by sociopolitical and economic demands and aspirations. Entire land covers have been introduced, or removed, in order to 'domesticate' the land, or recreate wilderness (Crumley 1994). On the other hand, states, in dealing with diverse natural and social environments, attempt to make these environments comprehensible by creating 'thin simplifications', or 'legible' landscapes as described by Scott (1998). Since the end of the 1970s, the international conservation movement has adopted various 'conservation with development' narratives, promoting the idea of an integrated conservation and development programme (Kremen et al.1994; Worah 2002). The very concept of ecosystems reflects changes in thinking about human-environment interactions, or humans as part of ecosystems, rejecting the idea of a fixed equilibrium, closed systems, and static nature (Moran 1990). Proactive human management might contribute to maintaining biological diversity in ecosystems. Building a vision for the new millennium on conservation requires overcoming the dichotomy of nature versus culture. The high cost, inadequate protection, and ineffective management of public protected areas have led to thoughts of an alternative conservation approach. More attention has been paid to community-driven conservation, outside public protected areas, in community owned forestlands as well as agricultural landscapes (Molnar et al. 2004).

However, coupled human-environment systems have been influenced by the interactions in globalisation and market-economic policies, as these systems are interrelated because the flow of resources, goods, and services increasingly transcends national and regional boundaries. State policies, market pressure, and technological changes have a great impact on both production and consumption. These impacts include land use intensification and transformation; population dynamics and migration; off-farm opportunities and urbanisation; substitution of local technologies; and changes to indigenous cultures. These impacts affect local livelihoods, institutions, the power relations between different actors, and the relationship between people and nature (Granfelt 1999).

Defining 'Community'

The heterogeneity of communities

The notion of 'community', in the sense of a homogeneous entity with similar needs and challenges, should be treated with caution in resource management. Within communities, there is much variation in terms of knowledge, interests, livelihood strategies, demographics, the networks with which they interact, and the nature of their interaction with ecosystems. Members of the Hani (Akha) ethnic group have the same cultural and historical background but have developed totally different land use practices after migrating into different ecosystems (Xu et al. 1999). Some of the Hani moved to the Honghe (Red River) Basin in southeast Yunnan and now engage in terraced paddy agriculture. Other Hani people settled in Xishuangbanna in Yunnan, including those who later migrated to Laos, Myanmar, and Northern Thailand, and practice shifting cultivation. The outside perception of indigenous communities is also shaped by political discourse. The Hani shifting cultivators are more environmentally-friendly in China and more destructive to nature and forest ecosystems in Thailand (Sturgeon 2000). The political interpretation and identification of community, land use, and cultural identity also determines relations between people and nature. Local communities do not live in a vacuum. Their knowledge, practices, and innovations are influenced by the policies, markets, and other sociocultural networks surrounding them. Within communities, conflict exists between different resource users, such as old and young, or birdwatchers and hunters, or tourism developers and conservationists. Conflict has increased between certain Tibetan communities over matsutake mushroom harvesting due to the increase in the market value of this product in southwest China (Yeh 2000). This conflict has arisen even though all of these communities are conceivably part of the same ethnic group. For many rural households in the HKH region, off-farm work, wage labour, and the remittance economy have replaced agriculture as the main source of income. The perception and attitude of different family members, particularly young people, towards nature and the ecosystem has been changing. However, most family members still maintain a link to the ecosystem by owning some livestock, cultivating crops, harvesting fodder and fuelwood, and collecting non-timber forest products (NTFPs) for their livelihood. In the HKH region, there is considerable variation in people's interactions with, and connectedness to, ecosystems. This variation is determined by their geographical location, household economy, social networks, and institutional affiliations, as well as their power relations with state and non-state actors, such as NGOs and the private sector. For example, although the Hani shifting cultivators are from the same ethnic group, their way of interacting with forest ecosystems can be quite different. They may do more damage in Thailand because of lack of land tenure security without citizenship. Differentiation in livelihood strategies is more complex than ethnicity, gender, or age grouping. The challenge in securing community participation in conservation is to resolve these contradictions between the diverse functions of ecosystems and the multiple needs of people, within and among communities, as well as between locals and outsiders. Therefore the vernacular meaning of 'community' is a collective identity that arises from, and helps to reproduce, particular patterns within the political economy of the coupled human-environment system in a specific place.

Socio-cultural networks: How are communities connected?

One of the contestable myths about mountain 'communities' in the HKH region is their isolation or inaccessibility (Jodha 1997). Places and people are often not connected in expected ways, as conceived by the state or outsiders, with paved roads, a telecommunications network, post office, and central marketplace. However, communities are connected and linked to these places in their own ways, both visible and invisible. These 'peripheral' people and communities, as referred to by Harrell (1995), live on the edges of places that are linked to centres, that are distant and difficult to reach, but are not necessarily isolated and unconnected. For example,

Table 1: Summary of the people-nature relationship in international conservation

Variable	1960+	1980+	1990+	2004, IUCN congress
Perception of nature	Wilderness	Ecosystems; biodiversity; ecoregions	Culture in nature and nature in culture	People and nature – only one world
Environmental values	Theocentric and anthropocentric	Anthropocentric and cosmocentric	Anthropocentric and cosmocentric	Anthropocentric and cosmocentric
Problem diagnosis	Overpopulation; exceeding carrying capacity	Poverty; overpopulation	Power relations; north - south inequalities; what counts as a problem, and to whom?	Population dynamics; consumption patterns; market failures; policy distortions; poverty and inequity
Representations of local people	People are the threat	People can't be ignored; people are a resource	Support to rural people	Many voices
Solutions and technologies	Exclusionary protected areas	Buffer zones; integrated conservation and development programmes; sustainable use	Alternative protected areas; participatory management, human rights	Community driven and community conserved areas
Power relations	Alliances with elites	Technocratic alliances	Alliances with grass -roots	Proactive of indigenous people
Key influences	Colonial conservation; elitist interests	Sustainable development debates; growing concern for livelihoods	Democracy/human rights movement; participatory development; post - modern influence on natural and social sciences	Civil rights; cultural diversity; private sectors; questioning 'sciences'

Source: Modified from Jeanrenaud (2002)

caravans served extensively as market structures and formed a socio-cultural network among mountain, lowland, and even city places in the region for hundreds of years, as studied by Ann Maxwell Hill (1998). Here is her description of the long distance caravan trade based in Yunnan:

> "Before the advent of colonialism in Southeast Asia, roughly around 1850, the caravan trade as a market structure might best be described as a dendritic, or treelike, system branching out from Kunming and Dali into ever more remote areas until the difficulties of terrain and low levels of commodity production [largely tea, cotton and opium] made further expansion of the system unprofitable. ...They traversed an area that included Upper Burma to the west, Tibet to the north, the provinces of Guizhou and Guangxi to the east and upland Southeast Asia to the south."

Thus, rather than being isolated and detached, most upland communities were connected in their own cultural ways. Another example is the practice of genealogy by many ethnic groups in the region. Two people from the same ethnic group may be able to sit together, and trace their genealogy back to a shared ancestor, even though they might live at a distance from each other and practise different production techniques. These social networks play an important role in the sharing of knowledge, information, technology, and environmental risks. For example, the Yi people have a long history of migration, and genealogy is very important to them. When Yi people pass away, they believe that their souls travel back to their origins for peace. Their genealogy is cited during funeral rituals and each generation links to particular places and times on the historical migration route. The singing and reciting of the genealogical trees also mentions the forests, land, rivers, animals, and other environmental features, at each place or stop where their ancestors lived. The soul of the dead has to pass each place to return to the origin of the Yi people (Xu et al. 2005).

Assigning the myth of isolation to others often carries with it implicit assumptions about ignorance, parochialism, resistance to change, and other deficiencies that require correction. It is better to start with the assumption that mountain communities are peripheral but connected, and then ask how, and with what consequences (Coward 2003).

The democratised community and its legal personality

The democratisation of community decision-making is essential in order to ensure efficient resource management and equitable benefit distribution locally and to adapt to changing markets, policies, and climate, as well as accommodate the diversity of needs and interests within a community (Ribot 2002). Customary institutions are not always accountable to local people. State induced institutions often do not work, for example, the failure of collectivisation in socialist countries. Good governance, at the community level, calls for a new set of place-based and culturally embedded rules, made in a dynamic and democratic fashion, which address environmental sustainability and human well-being.

After the implementation of the 1998 Village Organic Law in China, village chiefs and village committees received new responsibilities and rights relating to local natural resource management. The local people democratically elect their village chief. However not all locally elected authorities are perfectly accountable to the local people. A number of problems are associated with these processes. Firstly, evidence suggests that there is inadequate external monitoring and evaluation of the performance of local authorities. Village assembly meetings, which provide internal monitoring, are ineffective for this purpose because village chiefs can easily manipulate the assembly. Secondly, the election process is often poorly executed due to low literacy and/or cultural barriers, and the process of candidate selection, voting, and vote counting is often riddled with errors. Thirdly, one of the major tasks of the local authority or administrative village is to collect taxes from villagers. However, as villagers receive no services and cannot influence decision making at higher levels of government, this taxation has created mistrust between the local government and the villagers and has undermined the credibility of elected village leaders. Nobody expects the awareness and capacity of villagers for self-government to develop overnight. It takes time to empower a local community. However, with the present constraints, electoral accountability has essentially become a wasted opportunity (Xu and Ribot 2004).

Another unsolved issue is the legal persona of the 'community'. Do local communities have legal status or power? Both natural individuals and corporations have legal status, but not communities. This lack of legal status has put communities at a disadvantage in disputes. The state is comfortable in decentralising power to the lowest level of government, in the case of China the township level. However, this level of government is not systematically accountable to the local community and instead is often upwardly accountable to higher authorities. Communities have received either no power at all, or limited power. Further, communities have extremely limited financial resources to exercise this power. Privatisation is not a form of decentralisation. It is neither democratic nor representative of the collective interests or actions. Therefore, it is not a solution, particularly for the management of common property resources, such as forestlands.

Negotiating between community, state, and non-state institutions

For most of last century, the state, in the pursuit of state building and modernisation, has accepted a technocratic and managerial view of ecological and social systems. It is a view in which the power elites and their experts are in control of knowledge, and are seen as having the skills and responsibility to do everything, from land use planning to institutional arrangement. Under the 'state knows best' or 'scientist knows best' system, the environment and forest ecosystems have typically been degraded, for example by unsustainable logging practices and mono-cultural plantations, that provide only a small subset of the original set of goods and services to a much smaller group of beneficiaries (Lebel et al. 2004). At the same time, conservation areas have been set aside without recognition or adequate compensation to indigenous communities. Such traditional command and state control management are proving ineffective, inefficient, and inequitable, as well as favouring corruption and ultimately hurting communities. A 'market knows best' perspective has its own limitations, due to its underlying principle of maximisation of yields and profits, without reference to who the benefits flow to, or who pays for long-term environmental services. A strong counter-reaction to state and corporate-centred views of how natural resources should be managed, is the emergence of community participation in such areas as community forestry and community-driven conservation. In essence, they argue that 'local communities or locals know best', emphasising local knowledge. However, this approach also has its limitations due to global environmental change (e.g., climate change) and global governance systems (e.g., the World Trade Organization for free trade). The great challenges presented by climate change and the globalisation of the economy call for a new institutional arrangement – a power relationship and partnership between local communities and state and non-state actors, particularly the private sector, as well as NGOs. Regulatory pluralism applies not only to communities, but also to the state, NGOs, and private corporations in order to secure community participation in conservation. An effective system must provide sufficient incentives and enabling conditions for communities to manage their resource base and blend conservation and use goals. There is a growing awareness in the private sector of the biodiversity spin-off for off-site environmental services. An enabling environment for community-driven conservation includes i) appreciating local knowledge, ii) strengthening common property rights and collective actions, iii) rewarding the community, and iv) representation of the community in decision-making.

Appreciating local knowledge

Indigenous people, who have lived in mountain habitats for hundreds of years, have developed, and continued to practise, ways of living and belief systems based on their intimate relationship with the mountain environment. These ways of living and belief systems have generated, and draw on, a deep knowledge of plants, wildlife, vegetation, and ecosystems, as well as soil, water, and microenvironments. Understanding the complexities of different cultural perceptions of land use, landscapes, management of resources, and local institutional arrangements contributes to alternative and more effective strategies for conservation and ecosystem management. Local knowledge systems are not static, but ever changing and evolving, because human-ecosystem interactions are process-oriented and dynamic. Therefore, the drivers of knowledge, the ecological system, and local responses co-evolve and are difficult to separate. No community is immune to changes occurring in their environment. Among the most powerful forces that influence local cultures, knowledge, and ecological systems are various government policies and the expansion of regional, national, and international markets. These forces stimulate the privatisation of land and natural resources, as well as aiming to 'fix' populations and property in space, leading to loss of traditional lifestyles, mobility, and flexibility (for example limiting of shifting cultivation, and sedentarisation of pastoralist, and nomadic peoples).

On the other hand, there are an increasing number of projects and programmes, which have put local knowledge, practices, and innovation at the centre of conservation and development. For example, a recent development in nature conservation tries to link traditional practices in sacred areas to conservation when creating protected areas, and going even further by translating the sacred into conservation legislation to grant land and cultural rights. Article 8(j) of the Convention on Biological Diversity specifically addresses local indigenous peoples and their knowledge. The Working Group on Intellectual Property Rights was established in 1990 by the Global Coalition for Bio-Cultural Diversity to unite indigenous peoples, scientific organisations, and environmental groups to develop a strategy for the use of traditional knowledge and alternative approaches using people-centred conservation models (Posey and Dutfield 1996).

Language is also crucial to locating biodiversity. There is an increasing concern that when languages disappear, knowledge may also disappear (Cox 2000). UNESCO's 'Safeguarding of the Endangered Languages' programme (UNESCO 1993) is a global initiative to protect indigenous languages and intangible cultural heritages. Some initiatives are also concerned with local knowledge systems and their associated landscapes and agrobiodiversity. An example is the FAO programme 'Globally Important Indigenous Agricultural Heritage Systems', which aims to conserve place-specific sites in-situ, that represent different production systems and their associated landscapes.

Strengthening common property rights and collective actions

Over the past several decades, it has become increasingly accepted that the formal protected areas system alone, cannot save the world's biodiversity. Managing public-owned protected areas is a heavy burden for governments. Despite the creative promotion of ecotourism, private concessions, and the leveraging of complementary rural development funds, few protected area sites can capture or generate the resources needed to manage their biodiversity adequately. Land tenure conflict and population pressure make it extremely difficult to extend or reconfigure the protected area system to include under-represented areas. Simply shifting land tenure from the state to the individual does not work in forest resource management. In China, 60% of the total forest area is owned by local communities (Miao et al. 2004). In the past 15 years, the amount of forest area under community ownership or management has doubled in developing countries. Currently 22% of forests in the tropics are community-administered, and projections estimate that the area will at least double again over the next 15 years (White and Martin 2002). Global estimates state that 50% of the protected areas established in the last 80 years, overlap with indigenous customary lands and resources (86% in Latin America) (Borrini-Feyerabend 2003). As part of the tenure shift, or reality of overlap with customary boundaries, conservation strategies should emphasis the strengthening of community institutions, including the strengthening of common property rights and collective actions, in resource management. Diverse tenure arrangements and flexibility in relation to common property is the guiding principle, rather than rigid control as in state property, or a simple transfer as for private ownership. Privatisation is not community-based natural resource management.

Towards rewarding community conservation and sustainable management

The great majority of the world's population, including most of both lowland and upland people in the HKH region, depend upon mountain ecosystems for environmental goods and services. River basins originating in the mountains provide vital watershed services for lowland people living in the rice bowls of Bangladesh and India for production, fishing, irrigation, and transportation. Connectivity in the coupled human-environment system demonstrates the linkage between cultural and biological diversity, and ecosystem goods and services, in upland and lowland interactions. Rewarding local communities for environmental services, including water, biodiversity, and carbon becomes a new political and economic paradox, but is also a complicated response. Rewards can be direct payments such as funds, or indirect compensation such as the provision of technical and development support. Payment for environmental services is a means by which downstream users of resources (e.g., water) can pay, in cash or kind, the upstream guardians of those resources for their protective services. A simple example of payment for environmental services is the downstream hydropower corporations and industries that pay a percentage of their profits to upstream communities in return for the conservation or protection of the resource – such as reforestation of logged forests by forest management groups, the release of water in drier winter months, and the replanting of degraded areas. Rewards can also be the certification of particular products (including forest products and agriculture) and their means of extraction. The criteria to take into account are the biological and ecological components of production areas and ecosystems. 'Fair trade' is another example of rewarding community conservation. Fair trade was initiated to help disadvantaged communities by paying better prices and providing better trading conditions, together with raising consumer awareness about their role as buyers.

Representation of community in decision making

One of the most difficult challenges for conservation and ecosystem management on a large scale is to represent local world views in higher-scale decisions. The importance of integrating local views into higher-scale decisions is multiple. It allows policy makers to design policies that enable local people to optimise their uses of ecosystems, while at the same time allowing higher-scale understanding to inform policy making. It also creates the space for local people to engage in conservation and resource management and therefore work with, rather than against, the objectives of those operating and making policy at higher-scales.

Representation channels are multiple. Some systems of communication already exist in the party system. Local views are communicated by researchers who understand and can translate this local understanding into language accessible to policy makers. Local people are also represented through locally elected officials at the administrative village level. The challenge for the forestry service is to design a system that enables local knowledge and local aspirations to be represented in decision making. The trick is to design a system that is consistent with the new decentralised approach to development and to forestry and conservation. Representation matters if local knowledge and local labour are to be mobilised for local good and for the good of all higher levels of the political-administrative organisation in which they are nested. If local people are able to make decisions, then their world view will be included in the decisions that they make.

Conclusions

For a long time, a dichotomous approach to nature-culture relations has been dominant in debates and strategies on conservation and the management of natural resources. Certain cultural perceptions of landscapes have become dominant or imposed through economic and political forces, often to the detriment of local knowledge, practices, and innovations. The state-building process and scientific knowledge development have served to justify simplified landscape and local institutional changes, which, in many cases, have led to high levels of environmental degradation, poverty, and food insecurity. Understanding the complexities of different cultural perceptions of landscapes, the interactions between humans and nature, local knowledge systems, and institutional arrangements contributes to the development of alternative strategies for ecosystem management and socioeconomic development. The key to community-driven conservation is to develop community-based science. This calls for the participation of research professionals, development practitioners, and local NGOs to support local communities in developing their own knowledge, practices, and innovations to adopt and adapt global influences to foster their own livelihoods, on the basis of their own cultural repertoires and identities. Community-driven conservation cannot be achieved without a transfer of power, and accountable and representative local institutions. The road to community-driven conservation and science has moved, and continues to move, back and forth between exclusion and inclusion of the community.

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Panel Topic – Geographic Information for Sustainable Mountain Development in the Hindu Kush-Himalayan Region

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Introduction

The Hindu Kush-Himalayas (HKH) extend from Afghanistan to Myanmar and are the world's highest mountain ecosystem. They have the youngest geological formations and contain lands with diverse human cultures, religions, indigenous traditional systems, and socioeconomic conditions. The majority of the region's population live in poverty and depend upon fragile natural resources for their livelihood. The HKH range offers important ecosystem services for life support, such as a wide range of biodiversity, medicinal plants, fresh water reserves, hydropower, minerals, and spectacular pristine views with a potential for ecotourism. However, rapid population growth, the development of infrastructure, and the exploitation of the natural resource base, combined with global warming, are creating pressure on mountain ecosystems. Mountain ecosystems are experiencing unsustainable human practices leading to the depletion of natural resource bases and environmental degradation.

ICIMOD is the only regional centre working for the sustainable livelihood of the mountain people and promoting economically and environmentally sound development of mountain ecosystems in the HKH region. ICIMOD has been working to facilitate the generation and sharing of mountain specific information and knowledge.

Many issues in relation to mountain development, such as environmental degradation, deforestation, soil erosion, poverty, migration, floods, and the sharing of water resources, have a strong geographic component. Geographic information plays a significant role in sustainable decision making.

The role of geographic information in sustainable mountain development

Sustainable mountain development poses enormous challenges due to a lack of scientific understanding of mountain ecosystems and their important function in providing ecosystem services that support livelihoods in mountain communities, as well as in communities downstream. There is a lack of credible data and information, and local and national institutions have inadequate capacity to integrate multi-sectoral analysis for use in problem-oriented analysis of mountain areas. The problem is further aggravated by a lack of coordination between national agencies, together with limited regional cooperation in terms of data and information sharing and exchange. Finally, mountain areas are often marginalised or neglected by the development mainstream in countries which lack mountain-friendly policies.

Decisions about sustainable and equitable development have to be based on accurate and reliable information. Over the last decade or so, geographic information and related technologies have made remarkable advancements, adding a new dimension to the integration and analysis of divergent sources of information. At the same time, the cost of hardware and software has decreased. With the significant growth in public domain geographic datasets, there has been widespread adoption of geographic information systems (GIS). GIS are evolving in ways that will increase their prominence in decision-making processes by integrating many disciplines and by adding value to our decisions. The increasing use of decision support systems based on geographic information, and the information thus processed through these simple yet sophisticated tools, can render information and knowledge useful for sustainable decision making. Hence, access to geographic information is crucial, and there is a need to bridge the geographic information and knowledge gap in the region.

Building an infrastructure for geographic information is becoming as important as building other kinds of infrastructure, such as roads or telecommunications. Geographic information infrastructure has been conceived as an environment where the basic geographic datasets are readily available; existing geographic information is well documented; available geographic information conforms to accepted standards; there are policies to encourage the sharing and exchange of geographic information; and there are adequate human and technical resources to maintain and manage geographic information. Geographic information infrastructure can be seen as the broad policy, organisational, technical, and financial arrangements necessary to support access to geographic information. The concept is gaining importance at the local, national, regional, and global levels, and many nations and regional and international organisations are embracing such a framework.

The MENRIS programme at ICIMOD

Agenda 21 of Chapter 40 of the UN Conference on Environment and Development in Rio de Janeiro in 1992 emphasises the need for data and information for decision making at all levels. This was further reiterated and emphasised at the Bishkek Global Mountain Summit of the UN's International Year of the Mountains 2002, and in the international partnership in mountain development at the World Summit on Sustainable Development (WSSD). Realising the potential of geographic information for sustainable mountain development, ICIMOD, through its Mountain Environment and Natural Resources Information Systems (MENRIS) programme, has been working on promoting the use of geographic information for the management of natural resources and environmental monitoring in the HKH region, through a decentralised network of partner institutions in its regional member countries. MENRIS is operationalising its strategy by providing access to geographic information and knowledge through four programmatic components, namely, capacity building and networking; integrated GIS data management; applications and spatial decision support systems; and a metadata clearing house. These are the essential elements, or founding blocks, of a regional geographic information infrastructure for the HKH region.

Partnerships between national and regional institutions, and the capacity building of these institutions, are MENRIS's major strategies for the development of a regional geographic information infrastructure. The partnership initiative was designed to extend the fully functional capabilities of national institutions by developing mutually supportive relationships with a focus on training and the dissemination of geo-information technology and its applications.

ICIMOD has developed a strategy to establish a framework for a regional geographic information infrastructure in the HKH region and through this continue its efforts to increase the availability and accessibility of organised geographic information to contribute to local, national, and regional decision making needs in relation to sustainable mountain development. The conceptual framework for utilising geographic information for sustainable mountain development is shown in Figure 1.

Framework for using geographic information for sustainable mountain development

The framework describes the utilisation and management of geographic information in partnership with national and regional organisations in the region. Use of GIS technology is in the early stages in the region and especially for the mountain areas, thus considerable emphasis has been placed on capacity building and the creation of a mountain GIS network. The framework provides a mechanism for the assimilation of both biophysical and socioeconomic information through an organised information network consisting of national partner institutions and other regional/international partners. The geographic information framework defines the aggregation of this data

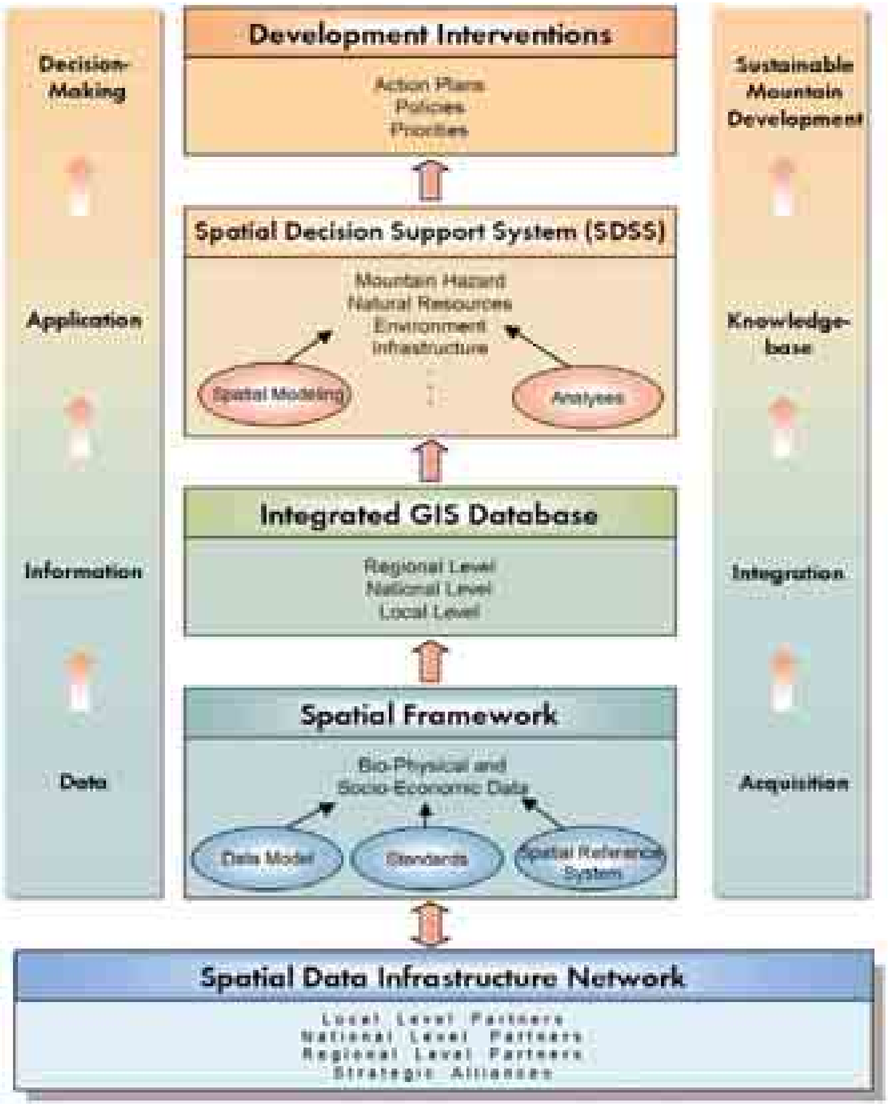

Figure 1: Conceptual framework for using geographic information to support sustainable mountain development

and information with accepted standards at different levels (local, national, and regional) to generate integrated databases for the HKH region. These integrated databases then serve as a foundation for many geographic information applications. The spatial modelling tools, combined with the knowledge of thematic experts, will help to model key components of mountain environments in the region, such as biodiversity, climate change, snow and glaciers, land use/land cover, infrastructure development, and many more. Ultimately, this framework will contribute to increasing the information and knowledge base for a decision support system to meet our prime concerns in solving the complex problems of mountain environments.

Geographic information applications for mountain areas

ICIMOD has adopted a strategic approach to assist its Regional Member Countries to capture the opportunities provided by geographic information, and its related technologies, for organised information networking and improved decision making. Through its close contacts and collaboration with research institutions, space and software agencies, and especially its strategic alliance with key GIS partners around the world, ICIMOD has fostered the establishment of a strong GIS network (of more than 120 institutions) to serve this vast and diverse region (Figure 2). Through these efforts, GIS technology has made significant inroads in the HKH region, and has been used effectively to support policy formulation, planning, and the management of natural and human resources for sustainable mountain development. Many applications, covering a diverse range of uses and decision support systems suitable for mountain areas, have been developed at local, national, and regional levels. Some of the important applications of GIS, undertaken by ICIMOD together with partner organisations in the HKH region, are as follow:

- land use/land cover mapping at the regional level;
- vegetation monitoring using remote sensing data;
- sustainable development indicators;
- inventory of glaciers, glacial lakes and potential impact of GLOFs due to global warming;
- urban and municipal planning;
- biodiversity mapping and assessment using remote sensing data;
- water resources management applications;
- decision support system for national park management; and
- ecoregional agricultural and land use planning for mountain ecosystems.

Figure 2: The HKH region and its river basins (Source: ESRI data and maps MENRIS)

Further, a mountain GIS portal has been developed to encourage the sharing of geographic information-based resources and to strengthen the existing geographic information network in the region. The GIS portal serves as both a 'user' and 'provider' of geographic based information and as a virtual platform for addressing issues related to sustainable mountain development in the HKH region (Figure 3).

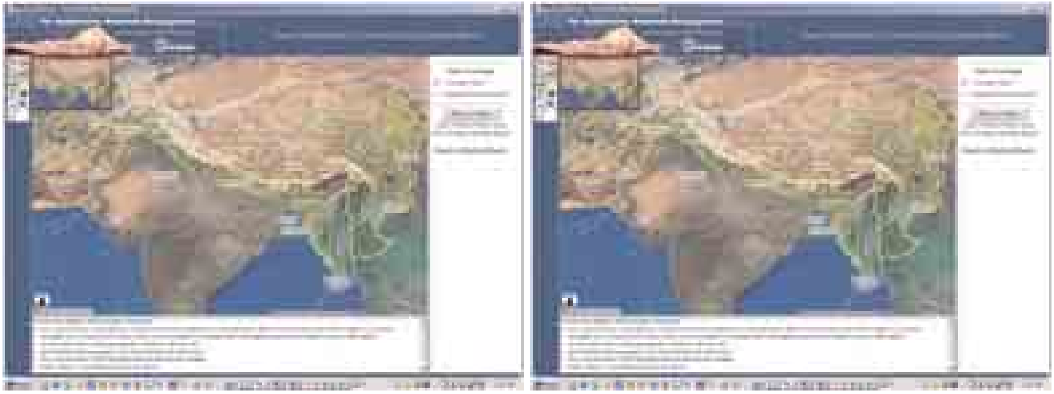

Figure 3: The Mountain GIS portal with its biodiversity theme

Conclusion

Mountains have very distinct spatial and temporal expressions and many of the planning and decision-making processes in mountain areas are influenced by geographic information. Given the dynamic character of natural resources, which undergo rapid changes in mountain regions, there is a constant need to update information and review dynamic linkages. Geographic information infrastructure provides a unifying framework for the integration of many different kinds of information so that we can better understand mountain ecosystems and support their functioning and management. Moreover, many problems that we face in the region are transboundary in nature. Using such a technology and framework can promote regional cooperation among the participating Regional Member Countries.

In the recent past, geographic information and related technologies have improved our capability to handle geographic information. This has made it necessary for different stakeholders to re-examine their role with respect to the use and supply of such information. Using geographic information based decision support systems, the information products can be used to help indicate alternative strategies to mountain development practitioners and policy/decision makers. Such a framework has proven to be a viable technological and institutional option for sustainable mountain development. ICIMOD, with its institutional foundation and active networks of national partners and key GIS organisations around the world, can leapfrog national efforts in the HKH region to attain higher stages of sustainable development using geographic information infrastructure.

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Discussion and Recommendations: Working Session I

The plenary discussions after the presentations in Working Session I focused on two key issues:

- upstream-downstream relationships, and
- use of knowledge thus far accumulated.

Participants emphasised that upstream problems tend to be neglected in the existing social and economic systems and that upstream environmental services are not well compensated, although there are some recent efforts focused more towards development in upstream areas.

With respect to knowledge management, concerns were raised about how the knowledge generated is being put into practice, and what constraints there are to policy/decision makers using this knowledge.

At the end of each presentation and discussion, recommendations were also made that would help set the future direction of ICIMOD. Some of the most important made during Working Session I are listed below.

- In relation to advanced technology: To avoid misinterpretation of data and technological errors, use of technology must foresee the involvement of experts, while reaching out to as wide a user community as possible.
- In relation to climate change: It was suggested that ICIMOD persuade GEF and others to fund related projects and to take on joint studies of Indian mountain ecosystems.

- In relation to environmental services: It was suggested that a systematic mountain environment monitoring system be developed together with associated capacity building of national institutions. Other recommendations included environmental services agreements and region specific approaches to the valuation and contracting of upstream environmental services. There is also a need for policy makers to focus on creating a high rate of sustainable national growth.
- In relation to community participation in ecosystem assessment: It was suggested that a participatory approach to learning be developed by sharing and creating space for local communities in terms of representation, resilience, and re-adaptation, and by creating a level playing field. A call was made for community-based science.
- It was also recommended that communities be involved in addressing sustainable development issues. It was pointed out that given proper training, increased population could be turned into a valuable asset.