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ABSTRACTS

of International Symposium on Changing Mountain Environments in Asia

7 - 9 October 2012
Kathmandu, Nepal



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Keynote Presentations

Beyond anecdotal evidence: Providing systematic and national-level evidence on multiple claims on land in the Lao PDR

*Andreas Heinimann (NCCR North-South, Switzerland
and Ministry of Natural Resource and Environment, Lao PDR)*

The Lao Peoples Democratic Republic (Lao PDR) is situated in the heart of the economically very dynamic region of mainland Southeast Asia. Related to its rich natural resource endowment and a change of course of the ruling communist party towards economic opening, Laos has emerged as a supplier of raw agricultural commodities, tree crops, minerals, as well as hydropower for the rest of the world. Thereby its large neighbouring economies of China, Thailand and Vietnam are the main driving forces of a drastic increase in the demand on land and augmented pressure on the natural resource. Until recently, there was yet no comprehensive spatial overview of the dimensions of this increased pressure on resources in Laos even though, understanding the spatial distribution of these sectors is essential for a meaningful spatial planning at different levels as well as for policymakers to make informed decisions about potential trade-offs of such developments in general. On this background CDE in collaboration its national and international development partners (e.g. SDC, World Bank, GiZ) have recently contributed in closing this wide information and knowledge gap in different sectors and studies. The compilation of all planned hydropower project (> 150 projects) revealed that far above 100,000 people (about >2.5% of Laos's rural population) would need to be resettled due to the newly inundated reservoir areas. Besides hydropower, land concessions for agricultural commodities have mushroomed (50 times increase) in the last decade. However no systemic overview was available in any Governmental agency in Laos about the dimension and context of these investments in land. Based on a concession inventory we could show that currently there are over 2,600 land concession in Laos, covering over 1.1 mio hectares which is more than the entire rice growing area of the country. Area wise mining and the agriculture and forestry sectors are by far the biggest sectors, with over 75% of the concession area based mainly on FDI. Most of the concessions were granted in relatively well accessibly area with relatively low poverty rates. This raises questions concerning the role of investment in land for poverty alleviation in marginal regions. On the other hand to get some insights into the extent and dynamics of smallholder shifting cultivation agriculture areas an assessment based on hyper-temporal remote sensing information was conducted. Within currently on-going work we are combining these elaborated different sources of information to get a more complete picture of the different claims of land in Laos and possible trade-offs in terms of services of the land.

Andreas Heinimann is a senior scientist of the Centre for Development and Environment of the University of Bern, Switzerland and the Swiss National Centre for Competence in Research (NCCR) North-South. He holds a MSC in environmental science of the Swiss Federal Institute of Technology (ETH) in Zurich and a PhD from the University of Bern, Switzerland. His main interests are in development-oriented research in the field of sustainable regional development, at the interface between knowledge production, development interventions, and policy. He is the author of numerous academic as well as policy oriented publication in this field. Andreas is among others, a member of the Scientific Steering Committee of the Global Land Project (GLP) of IHDP & IGBP. Since 2009 he has been based in Laos where he is an advisor to the Prime Minister's office as well as the Lao National Assembly and a number of multilateral organisations in issues related to pressure on land, upland development, and Integrated Spatial Planning in general.

On measuring carrying capacity of mountain regions

Hariharan Ramachandran (University of Delhi, India)

This paper argues that measurement of population carrying capacity of mountain regions is best approached through bifurcating settlements in to rural and urban. While the population carrying capacity of urban population is a function of the capacity of the state/ local governments to provide basic infrastructure to meet the demand, the rural carrying capacity needs to be measured through quantum of agricultural production to meet the demand from human and livestock population and a surplus to meet the demand from the urban population. Rural carrying capacity also has to be dealt with by monitoring agricultural density.

The urban scene is usually dominated by small and medium sized urban centres with high densities because of terrain constraints. Physical expansion of these centres lead to cutting land surface, often with steep slopes, resulting in soil erosion and landslides. A large part of the work force is in trade and service sector with a small contribution of small scale and household manufacturing activities. Larger centres with tourism as an economic base are characterised by seasonal variation in population pressure. Consequently they, experience stress and slack on their infrastructure.

Since urban centres exhibit a more noticeable divide across different economic classes of population, the perception on environmental degradation also differ. For example peak tourist season brings along with it congestion – a situation welcome by hospitality sector, but detested by high income local residents. Thus urban population carrying capacity would have to be computed not only on the basis of capacity to expand infrastructure, but also of people's perception.

Accessible urban centres also face the problem of land speculation of investors from other regions. In India this is evidenced by administrative failure and judicial activism.

This paper provides empirical analysis to support the preceding arguments with both city specific carrying capacity assessment and rural carrying capacity indices relating to Himachal and Uttaranchal (1981-2011).

Dr. H. Ramachandran is currently Professor of Geography at the Delhi School of Economics, University of Delhi. He is an alumnus of Delhi University and the Jawaharlal Nehru University and has also been trained abroad. Prof. Ramachandran has held several important teaching and administrative positions the most recent being that of Director, Institute of Applied Manpower Research, New Delhi, and Executive Founder Director, National Research and Resource Centre at the Lal Bahadur Shastri National Academy of Administration, Mussoorie. He has his credit eight books and over 40 research papers. He has guided 10 Ph.D. students and many M. Phil. candidates. He has been a Consultant with International Organizations like the World Bank, European Union, and the FAO and has travelled extensively both in India and abroad.

Demographic, economic and spatial transition in Nepal: Implications for the mountain environment

*Pitamber Sharma (Former Vice Chair of the National Planning Commission,
Government of Nepal)*

While the natural environment is undergoing changes in much of Asia's mountains in general and the Himalayas in particular, there is also a parallel process that is underway which is equally influencing the mountain environments. The purpose of this brief note is to draw attention to some of these processes by elucidating the case of Nepal, a highly mountainous country undergoing a demographic, economic and spatial transition. These changes have wide implications for mountain environment in Nepal.

Pitamber Sharma, a native of Falebas, Parbat District in the western mid hills of Nepal, is a Geographer/Regional Planner with a PhD from Cornell University, USA. He taught at Tribhuvan University for over two decades, worked as a regional planner with the International Centre for Integrated Mountain Development (ICIMOD), and is a former Vice Chair of the National Planning Commission, Government of Nepal. Among other works, he is the author of Urbanization in Nepal (1989), Tourism as Development, Case Studies from the Hindu Kush-Himalaya (2000), Market Towns in the Hindu Kush-Himalayas (2002), and Unravelling the Mosaic: Spatial Aspects of Ethnicity in Nepal (2008).

Oral Presentations

Environmental implications of farmers' adaptation to climate change

Tor H. Aase (University of Bergen, Norway)

The paper will address mutual interdependencies of human activity and the environment, here delimited to climate, landscape, and land use. Climate change can be assumed to have direct effects on the landscape, but it will also affect landscapes indirectly by transforming land use systems. Since the farmer is the most important land manager, the overarching questions are 1) to what extent and in which manners are farmers capable of changing their agricultural practices in the face of climate change, and 2) what are the probable environmental implications of those changes. Lacking reliable climate scenarios on local level where farming is carried out, the climatic situation to be faced by farmers is best described as one of uncertainty. The situation of uncertain production conditions is reinforced by fluctuating markets and, in some cases, unstable politics. The farmers who are flexible in their productive pursuits are probably best prepared to comply with such uncertainties. Thus, flexibility becomes a vital quality in the era of climate change and market fluctuations. How can we understand 'flexibility' in the context of farming?

Being inspired by the writings of Gregory Bateson (1975), an approach to the study of farming flexibility will be proposed. Defining 'flexibility' as 'uncommitted potentiality for change', that potentiality is lost when one of the variables (or units) of a system is utilized to its upper or lower threshold of tolerance. The system in question is the Farming System, and the variables translate into production factors. The theoretical approach thus developed shall be applied to several farming localities in Nepal and India Himalaya, where the challenge is to understand and evaluate farmers' flexibility and thereby their capacity to adapt to environmental change - climatic or other. Finally, implications of various adaptation strategies on the landscape will be identified.

Glacier change in Nepal Himalaya: Myth and reality

Katsuhiko Asahi (Shinshu University, Japan)

A number of reports mention that global climate change induces glacier shrinkage in the Himalayas. Himalayan glaciers play an important role as a water tower of Asia. Hundreds of millions of people rely on waters supplied from the Himalayas. Then predicted near-future glacier disappearance will threaten water shortage in the most countries of Asia. This scenario is commonly recognized, and it is mostly appeared in IPCC 4th report. It says that glaciers in the Himalayas are receding faster than in any part of the world and if, the present rate continues, the likelihood of them disappearing by the year 2035 and perhaps sooner is very high if the Earth keeps warming at the current rate.

The Nepal Himalayas locates in the strong monsoon environment, and dominant precipitation concentrates during summer. Thus, glaciers in Nepal are considered to be very sensitive to changes in the summer air temperature, because monsoon vapor brought as snowfall can be changed into rainfall during summer. Consequently, even a minor air temperature increase can accelerate the receding glacier. Reiterating field survey in Khumbu Himal reveals that all monitored small glaciers continuously retreating since the 1970s and the rate is accelerating. And the author's glacier inventory in the eastern Nepal documented that the glaciers of 59.7% has an area smaller than 0.5km². Such small maritime glaciers may have lost their capability to maintain the ice volume itself. Then such glaciers are vulnerable to even minor changes in air temperature and are facing disappearance.

However, this result cannot be concluded that Nepal's glaciers are retreating faster than other part of the world. For example, glaciers in the Alps are receding with high ratio. This tendency appears more clearly when the longer time scale is considered. Glaciers in the Alps are, commonly, retreated a few kilometers since the Little Ice Age. In contrast, those of the Nepal Himalayas retreated a few hundred meters or less. Moreover, the terminus of large valley glacier is generally stable. The glacier size can be applied to evaluate the potential for future change. As pointed out above, small-sized glacier is dominant among the total number of glaciers in the eastern Nepal, however 2.7% of large glaciers, with the area larger than 10 km², occupied almost half the area of total glaciation. It can be assumed that glaciers in eastern Nepal are under steady state.

Dominant precipitation by the SW monsoon caused the sharp declination of precipitation in the southern flank of the Himalayas. More than 2,000 mm precipitation arises at the foot of the Himalayas, whereas less than 500 mm precipitation brought to the High-Himalayan glacier area. Plenty of water supplied by rainfall in downstream. Glacier melt water is not provided for irrigation except much arid inner Himalaya. Generally, life in downstream doesnot rely on glacier. Thus, careful description and delineation in field is essential when considers global issues.

Field research and action projects: Two case studies from the Sagarmatha (Mt. Everest) National Park, Nepal

Alton C. Byers (The Mountain Institute, USA)

Today, the vast majority of high mountain research is based largely on remote sensing, geographic information systems, and computer modeling techniques. The presentation suggests that deeper understandings of contemporary landscape and climate change phenomena can be achieved by also including traditional, field-based methods from the physical and social sciences that involve the active participation of local people. Examples presented include the author's alpine disturbance research in the Sagarmatha (Mt. Everest) National Park (SNP) in Nepal between the 1980s-2000s, that in consultation with local people led to the formation of the Khumbu Alpine Conservation Council (KACC) in 2004. The KACC has since implemented a range of alpine conservation and restoration interventions that have been replicated by similar organizations in the Makalu-Barun National Park, Nepal and Huascarán National Park, Peru. A second example describes the author's climate change research in the SNP beginning in the mid-2000s, replicating photographs of glaciers and high altitude landscapes taken by the early climber-scientists in the region in the 1950s. By 2012, this initiative had led to the establishment of the USAID-funded High Mountain Glacial Watershed Program that is actively helping mountain people adapt to the impacts of climate change; works with international partners to reduce the risks of potentially dangerous glacial lakes; and promotes South-South collaboration and exchange between Andean and Asian countries. This project also contains a Climber-Scientist Small Grants Program that encourages young scientists to systematically combine the best of modern technologies with traditional, participatory, field-based research methods in remote mountain regions.

Climate change effects on water and agriculture system: A study from Upper Kali Gandaki River Basin in Mustang, Nepal

Prem S Chapagain (Tribhuvan University, Nepal)

Climate change has directly affected agro-pastoral system of the high Himalayas. Based on field survey and climate data analysis, it has tried to know this relationship in Upper Kali Gandaki basin that is bordered with China in the north. The study villages range from 3,000m to 4,000m in altitude beyond the major Himalayan range. The mean temperature of the basin has a rising trend by about 0.02°C per year. The snowfall is the major source of drinking and irrigation water that has been drastically reduced within a decade. Farmers have abandoned their one-third cultivated land due to lack of irrigation water and have faced the severe food insecurity. The decreasing rain and snowfall has decreased pasture productivity that consequently compelled to decrease herd size. The decreasing herd size reduce amount of manure to farmland and income from it. It has resulted increasing time and distance to firewood collection and increase workload to women. Farmers have adopted different strategy to adopt the climate change induced water shortage situation. They have i) gradually adopting a new farming system, ii) emphasized to grow comparatively advantages crops in terms of growing period and income, iii) adopted new system of irrigation on to a single terrace, iv) set a new community rules and regulation to use water for irrigation v) emphasized to construct new irrigation infrastructure, v) abandoned less productive land and vi) adopted seasonal migration for household income.

Impact of outmigration of population on farming system and household income in the hills of Nepal

Chhabi Lal Chidi (Tribhuvan University, Nepal)

In the last two decades Nepal has experienced a dramatic growth in internal and international migration, especially from rural areas to urban centers, hill to Tarai, and foreign countries. It has created labor shortage in rural hill agriculture on the one hand and has indicated that the changing cropping pattern of hills of Nepal due to changing situation of market access on the other. This study is based on field survey of the middle hill of western Nepal. Observation, key informants survey, and household survey are data collection methods. Observation was done using aerial photo, maps, satellite images and Google maps. Key informants survey and household survey was conducted using semi-structured questionnaire. In the study area outmigration of hill farmers (mainly active age group and children) seems very high during last two decades. Most of the active male goes to foreign countries and some of them to Tarai and urban areas. Female and children migration is mostly in urban area for quality education. Sudden release of population pressure on agriculture land has changed land use and cropping pattern. On the one hand depopulation has created land abandonment mainly at marginal cultivated land and deforestation process has been converted to forestation on the other. Improved market access has promoted on commercial crops rather than home consumption, Maize based hill agriculture has become commercial bean farming as a mixed cropping with maize. Other commercial products like ginger have not increased more due to labor shortage and unstable market price. Due to remittance for most of the household income has been improved than before. The role on household income has been mostly influenced by remittance. So, the food habit has been highly changed from maize based food to rice based in the study area. However their major production is maize but the use rice for daily consumption purchasing from the market selling their commercial beans and using foreign remittance. Foreign remittance and their commercial product have changed their livelihood but it may not be permanent so employment in own country Nepal should be provided in the future.

Land use and land cover change in the Chure (Siwalik) region, western Nepal

Kedar Dahal (Tribhuvan University, Nepal)

Chure region has a distinct geographical and bio-physical specificities lying on the foothill of Himalaya. It is the youngest mountain of the world, and suffering from mass erosion, landslides and other environmental externalities, which make the region vulnerable. Resource depletion due to natural as well as human induces factors in the Chure region has accelerated; Degradation of watershed, lowering the underground water and disturbing the ecological niche in and around the region makes the region more sensitive and fragile. The Government of Nepal, at present, has also given greater emphasis on the protection of Chure through initiation of 'Rastrapati Chure Conservation Programme' from the last years in the field of conservation and management of the resources in the Chure region. The main purpose of this study is, therefore, to analyze the land use and land cover change in the Chure region over the period between 1978 and 2010 by using maps, field observation and community interaction. The study covers Arghakhanchi district of western development region of Nepal.

Chure occupied 46.76% land of Arghakhanchi district, and about 72% land of the Chure region has covered by forest including bushes and shrubs. Ecological, geographical, bio-physical conditions of the Chure region have rapidly degrading from the last 32 years. Over the last three decades, there has been a tremendous change in land use and land cover in the Chure region. In this period, Arghakhanchi Chure forest has decreased by 31%. Conversion of dense forest into bushes-shrubs, degraded land in the Chure region has increased significantly. Illegal timber collection, open and uncontrolled grazing, extraction of riverbed deposits, rural road construction, forest fire are major causes of the decreasing forest area in the region. Dispersed settlements and increasing dwelling units in the Chure region is one of the major causes of decreasing forest area in the Chure region in Arghakhanchi. As the disperse and illegal settlements grew in Thada, Dhohote, Toribari, Pawara, ,Bikramsota ,Batheni, Gagrekhol, Bhangala, Mauwabari, Gainde Khair-Bhatti, Pattharkot and other different parts of Siddara, Simalpani, and Jaluke VDCs; forest encroachment and illegal timber export has been increased. Forest encroachment trend continued after the establishment of the multiparty democracy system. The problem has become so acute at the time of Maoist movement for both of human encroachment and illegal trade of forest products in the Arghakhanchi Chure and the Forest Office was completely paralyzed by the political instability and the area has sunk in a poor system of forest administration.

Sensitivity of precipitation on water flow simulation over the Koshi River basin, Nepal

F. Delclaux (IRD, France), L. Neppel (Univ. Montpellier 2, France), P. Chevallier (IRD, France), N. Gongaholiariliva (CNRS, France) and M. Savean (Univ. Montpellier 2, France)

In mountain basins, evaluating the respective contributions of rainfall, snow melt and ice melt is one of the key issues for estimating water resources, both in present time and for the future. In our paper, we evaluate different precipitation datasets on the Koshi River basin (approx. 58,000km²), and their impact on the results of the hydrological model HDSM on the Dudh Koshi River sub-basin at the outlet, Rabuwabazar (3,720km²). Three precipitation datasets have been considered in the study: (i) the Aphrodite grid, (ii) an interpolated precipitation grid (co-kriging) based on the DHM observations, (iii) an interpolated and snow-corrected precipitation grid. The paper presents the following main results.

Precipitations extracted from the Aphrodite dataset are unable to produce enough runoff and snow melt to reach the discharge monitored at the Dudh Koshi basin outlet. As a consequence, the runoff coefficient of the Dudh Koshi River basin (ratio discharge/precipitation) is systematically greater than 1. Moreover, for getting consistent discharges, the model must be calibrated with high values of ice melt parameters, generating ice melt volumes eight times larger than snow melt ones, which is unrealistic. Concerning the interpolated precipitation dataset, runoff coefficient is still larger than 1, but simulated snow cover is in a good agreement with Modis snow cover products. Finally, the interpolated snow-corrected precipitation dataset appears to represent more satisfactorily the precipitation volumes in terms of simulated discharges and simulated snow cover.

This study highlights i) the too sparse gauge network in an area characterized by high gradients of precipitation, ii) the underestimation of high elevation precipitation measurement due to underestimation of snow measurements, iii) the necessity to check the consistency between the precipitation and discharge before forcing hydrological model with unrealistic precipitation data.

Pastoral adaptation strategies to challenges of the post-Soviet era in the eastern Pamir and the western Tien Shan

Andrei Doerre (Free University Berlin, Germany)

The post-Soviet transformation is characterized by radical changes in the political, the legal, and the economic sphere. They induced far-reaching socioeconomic and ecological effects. For the societies of Tajikistan and Kyrgyzstan - formerly the poorest Soviet Republics - the resolution of the USSR led to a weakening of their economic integration with other successors of the Soviet Union, to the rupture of important transfer payments from the former centre as well as, finally, to a dramatic decline of their national economies. Especially for the rural population that was confronted with wage losses and unemployment natural resources gained massively in importance. In both countries, alpine meadows and high mountain deserts used as pastures constitute such an important capital.

Using the examples of two regional studies from the Eastern Pamir and the Western Tien Shan the lecture try to show systematically, which pastoral adaptation strategies matching the different post-Soviet challenges were developed by the rural population in both countries. On the one hand, changing processes of resource utilization were studied at high mountain pastures of the Murghab Rayon (district) of Tajikistan's Autonomous Oblast' (province) of Gorno-Badakhshan (GBAO). On the other hand, a regional focus was lying on the pastures of the walnut-fruit forest region of Kyrgyzstan's Zhalal-Abad Province. It becomes clear that the differences between the utilization regimes cannot be explained solely by the specific natural conditions of both regions. It is much more important, to turn one's attention on the respective legal institutions and the administrative structure, the socioeconomic situation of the people as well as their resource-related knowledge and experiences in pasture management.

Ecological dimensions of land use and land cover change in the Siwalik Hills, Nepal

Motilal Ghimire (Tribhuvan University, Nepal)

The study examined land use and land cover change in the Siwalik Hills during 1991 and 2010. Time-series satellite images that included Landsat TM and ETM+, which covered the time frame between 1990/91 and 2010, were used. Remote sensing analysis revealed a net increase in cultivated land in the Siwalik Hills and a corresponding decrease in forest area or shrub area. Increase in cultivated land was observed on the river valleys and available gentler slopes. In the last two decades, a large part of the forest area was converted to shrub (47,272 ha) and agriculture (4,243 ha) particularly on the steep slopes, i.e., above 30 percent. Similarly on such slopes in certain locations, conversion of 4,088 ha cultivated land to forest or shrub was recorded. Loss of agricultural land due to flooding and erosion in some parts and reclamation of cultivated land from the old riverbed was common tradeoff during the two decades. The increment or loss in grass/grazing land in places can be attributed to river activity. Land use and land cover change has exhibited a complex process of change in landscape in the hills, which is mainly attributed to growing demand for cultivated land, exploitation of forest resources, and the dynamic river morphology. The trend of land cover indicates a gradual degradation of ecosystem of the Siwalik Hills, which can be a threat to ecological balance and sustainable livelihood of local people.

Impacts of tourism on water quality in Khumbu region, Nepal

*Narayan Prasad Ghimire (Tribhuvan University, Nepal), Pramod Kumar Jha
(Tribhuvan University, Nepal) and G.U. Caravello (Padova University, Italy)*

Sagarmatha (Mt. Everest) National Park is a popular international eco-touristic destination, which is a unique place to study and observe diverse flora, fauna, environment and socio-culture. In the last few years tourist flow has increased tremendously generating anthropogenic pressure on the natural environment. To assess the river water quality, physical parameters (temperature, total dissolved solids, pH and conductivity), chemical parameters (nitrate-nitrogen, phosphate- phosphorous, metals (Fe, Cu, Na, Mg, Mn, Pb, Zn) and microbiological analysis were done in 2008 – 2011. Total nitrogen in water samples was lower than the WHO standard but an increase in the nitrate-nitrogen has been recorded when compared with the earlier reports. Similarly total phosphorous value was also found increased. Iron content has been found more than WHO and Nepalese standard at few sampling points. Non-scientific solid waste management (no separation of waste and construction of collection pit near water course); open defecation and poor condition of septic tanks; and direct disposal of toilet waste to water courses or on the exposed surface, are major sources of river water pollution. Some sites along the trekking routes showed fecal contamination. The river water quality in general still stands good in terms of standard for drinking water (WHO, Nepal standard) but degradation process has started.

Landslides hazard analysis of upper Madi, Nepal

Sher Bahadur Gurung (Tribhuwan University, Nepal)

Very steep slopes, high concentrated monsoon precipitations and active tectonic activities create mountain environment so vulnerable places for the people to live and travel. Among the natural disasters, landslides are the seventh ranked killer, after windstorms, floods, droughts, earthquakes, volcano and extreme temperature. Mitigation and adaptation are seen as viable options in reducing the vulnerability and risk associated with the anticipated negative impacts of landslide hazard.

The present study analyzes the landslides hazard for the reduction of disaster risk. Semi-statistical tools are used to fulfill its objectives. Further, this study explores the causes of landslides. At the end, it also deals with the knowledge gap in the disaster policies adopted by the nation.

Preliminary findings on ‘Adaptation of Local Livelihoods to Changing Ecosystem Goods and Services in the Context of Climate Change and Gender Equity in the Hindu-Kush Himalayas’

E. Valdemar Holmgren (ICIMOD, Nepal)

Not all groups in society have the same adaptive capacity (and community processes) for changes in eco-systems’ goods and services, and for improving the productivity of ecosystems to continue to generate services. Any group lacking in financial, social and political means to secure an alternative livelihood is more vulnerable to environmental degradation.

This presentation provides initial findings from an ethnographic study on livelihood adaptation to changing ecosystem goods and services in the context of climate change and gender equity. The study focused on the role of eco-system goods and services in providing livelihoods to community women and men, and how local users view ecosystem services and incorporate traditional knowledge and practices to harness these services. Within each community, different groups have different interests, livelihood strategies, demographics, networks and interactions with ecosystems, that influences the success of adaptation to change. Gender roles are an important aspect of livelihood adaptation. The different gender roles that prevail bring about different and complimentary knowledge that women and men acquire and transmit. For example: they have knowledge about different things and different knowledge about the same things that can be, or needs to be, drawn upon.

The study area is in the mid-hill region of east-central Nepal, where other assessments and surveys complement the findings. The study methodology comprises household interviews, focus-group discussions, intra-household interviews and rapid ecosystem assessment.

GPS collar tracking of argali (*Ovis ammon*) in the Sarychat-Ertash State Reserve, Kyrgyz Republic: Problems on wildlife management

Shigeyuki Izumiyama (Shinshu University, Japan), Maksat Anarbaev (National Center for Mountain Regions Development, The Kyrgyz Republic) and Teiji Watanabe (Hokkaido University, Japan)

Although argali (Marco polo sheep) symbolizes the mammals of Kyrgyzstan, its population is remarkably decreasing and facing extinction. We tracked 1 argali (adult female; age = 7) by GPS collar with GLOBALSTAR satellite communication. Her group, composed of 10 individuals, moved as far as 30 km during the winter. We assumed that the home-range size of the argali was quite large. Argali inhabit in and around the boundary of the reserve and hunting area. Since home range of argali is large, it is necessary to expand the protected zone. However, there is an ongoing project of gold mine development in the area adjacent to the protected area. Furthermore, there are plans to construct 3 dams around the Chinese border. When it is completed the concern is that if the part of the preservation zone is included in the water reservoir area. These various issues must be solved in order to protect the wildlife in this region.

Carbon stock estimation and analysis of altitudinal carbon content variation: A case study of Thulonagi Community Forest, Dolakha district, Nepal

Kendra Jyoti Khadka (Tribhuvan University, Nepal), Kedar Rijal (Tribhuvan University, Nepal) and Ramesh Prasad Sapkota (Tribhuvan University, Nepal)

Vegetation plays significant role in stabilizing the accumulated concentration of carbon dioxide in the atmosphere. It stores carbon in its biomass as well as in soil as a carbon pool. The present study aims to quantify the amount of carbon stock and also predicts the sequestration potential of Thulonagi Community Forest. The sampling plots were taken using stratified random sampling, with strata divided on the basis of elevation range from 2,300 – 3,000 masl. Allometric equations were used for determining aboveground and underground biomass. Core samples were taken for determining the soil organic carbon. The total carbon stock of Thulonagi Community Forest (including tree biomass carbon and soil organic carbon) was found to be 72,954.06 tons with the mean stock of 304.60 ton/ha. The study also showed that the carbon stored in the forest soil was almost double than the biomass carbon. It is shown that effective management of existing forest and reforestation program on the barren patches may sequester additional carbon both in vegetation biomass and soil, and which ultimately contribute to climate change mitigation strategy on the Lesser Himalayan region of Nepal.

Landscape dynamics in Chure hills and upstream - downstream linkages

Narendra Raj Khanal (Tribhuvan University, Nepal)

Chure hills, which is also known as Siwalik, rise abruptly from Indogangetic plain. It is the youngest and very weak mountain ranges in the Himalayas extending from west to east. The north-south maximum width of Chure is 55 km and the ridge elevation ranges from 300 m to 1,500 m with a maximum of 1,872 m. This paper discusses the processes of landscape change in the Chure hills and its consequences in downstream areas based on the results of four case studies made in the Chure and adjoining Terai plain in the eastern and central Nepal, i.e., Mahuli, Ratu, Lalbakaya and Pashaha watersheds. Since Chure hills are geologically very weak, large volume of hillslope materials are fed into the rivers originating from this area. The longitudinal profile of rivers originating from the southern slope of Chure range shows three distinct zones of geomorphic processes: production, transportation and deposition. Hillslope materials transported by these rivers are deposited in areas immediately after debouching from the hills, which is known as Bhabar. River channels in Bhabar zone are exceptionally very wide and riverbeds are rising. In many places, level of riverbed is equal to the bank. So, change in river course and inter-basin transfer of water is common. Such changes in river course have two implications in downstream areas: increasing flood risk along the new channels and increasing scarcity of water along old channels. Processes of river channel change by avulsion particularly in Bhabar zone were common in the past. However, it has been intensified due to increasing pressure of population in the sediment production zone, i.e., Chure hills and consequent changes in land use and land cover after eradication of malaria in the late 1950s. Large number of people from hills and mountains in-migrated in Chure hills and started to settle permanently. Similarly, people started to settle in Bhabar zone, which was covered with dense forest and used to act as safety valve to absorb excessive sediments transported from upstream area in the past. As a result, the potential risk of flood damage and drought in densely populated Terai has been increasing. So, attention should be given to conserve Chure hills and networking and training of river from its source to downstream areas in order to reduce flood and drought risk.

Eco-crisis in the Himalayas: Is it realistic or utopian?

Hriday L Koirala (Tribhuvan University, Nepal)

The Himalaya extends from the Pamir in the west to the valley of the Brahmaputra in the east for nearly 2,500 km and passes through Pakistan, India, China, Nepal and Bhutan. The Himalayan area by virtue of its complex geologic structure, snow-capped peaks, a variety of natural landscapes, mountain peoples of unique socio-cultural diversities and adaptation mechanisms has attracted outsiders from the past. The favorable government policies and peaceful native people of the Nepal Himalaya have welcomed thousands of tourists/trekkers/researchers and others to fulfill their various aspirations and interests. However, the poor country with ignorant native people is often blamed for causing the so-called eco-crisis in the region. During the 1970s and 1980s, publishing several books and articles with attractive titles, some mountain experts showed solidarity with those who propounded a hypothetical theory of Himalayan environmental degradation on the basis of the limited samples collected from a few localities. The native people as well as the country were made scapegoat by the western experts despite their past hospitality in the area. The causes of flood and siltation within the Ganges and Meghna basins were explained with the name of highland-lowland interaction and several projects were initiated to justify it. In this context, the present study is an attempt to review the available literatures and case studies in order to evaluate the potentiality of the so-called eco-crisis/environmental degradation in the Nepal Himalaya areas. It also attempts to analyze the present scenarios in relation to the key factors within the area to judge its validity of the issues raised.

Glacial lake development of Chamlang South Glacier and its prospect to GLOF occurrence

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A number of glacial lakes have been developed in the Himalaya during the last half century as a result of the melting and retreat of glaciers. Recent studies have found 20 glacial lakes as 'potentially dangerous' in the Nepal Himalaya largely relying on remote sensing image analyses. Chamlang South Glacier Lake in the Eastern Nepal Himalaya is one among them. Field survey or detailed studies of any kind have not been carried out on Chamlang South Glacier/Glacier Lake until this study was undertaken. Nevertheless, the lake has been repeatedly cited as a potentially dangerous lake for a glacial lake outburst flood (GLOF) and also as one of the most highly prioritized critical lakes in Nepal Himalaya.

We carried out detailed surface area, bathymetric and topographic mappings around the glacier/glacial lake to examine the development of Chamlang South Glacier Lake, glacial melting and prospect of GLOF from the lake. Bathymetric survey of Chamlang south Tsho was conducted by sonar-sounding machine on a boat. The lake was 87 m deep while volume of water contained in the lake was calculated to be $\sim 35.6 \times 10^6 \text{ m}^3$. Surface areas of the Chamlang South Tsho, as revealed by satellite data, were 0.040 km², 0.125 km², 0.636 km², 0.864 km², 0.868 km², 0.865 km², 0.866 km², and 0.867 km² in 1964, 1976, 1992, 2000, 2002, 2006, 2008, and 2010, respectively. Thus the lake virtually stopped expanding since 2000. The lake has little possibility of future upward lake expansion due to the fact that the lakes already reached the bottom of the mountains, touching rock cliff/bedrock. High-resolution Corona KH-4A and Advanced Land Observing Satellite (ALOS) PRISM stereo-data taken in 1964 and 2006 were processed to generate digital terrain models (DTMs). Extensive surface lowering, as high as 156.9 m, is found in the upper glacier area. The average lowering of glaciers within the entire study for the 42-year period between 1964 and 2006 area is 37.5 m, with the average rate surface lowering being 0.9 m/year. The average surface lowering for the 45 years from the 1964 glacier surface to the 2009 lake bottom was 99.5 m at a rate of 2.2 m/year, and the minimum and maximum surface lowering during that period were 12 m and 153.8 m, respectively. The lake has a wide dead-ice area downward from the lake to produce buffer to potential flooding, all other geomorphic conditions (e.g., position and condition of hanging glacier, steep outward slope of the end moraine, low elevation difference between lake water level and dead-ice moraine topography) favor the lake to be potentially highly dangerous.

Himalayan rangeland ownership of Milke-Jalajale, eastern Nepal

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Himalayan rangeland of Milke-Jalajale extends in three districts Tehrathum, Taplejung and Sankhuwasabha from 2,700 m asl to 4,400 m asl having 585 Km² in area. It was Kipat land (communal land) of indigenous Limbu people before enforcement of land reform act 1964. There are some elements, which have triggered land use change and degraded the rangeland area. Yak and chauri have been bringing to Milke-Gupha area from high Himalaya (Tokpegola) since last 40 year since then land use change pattern of this region has been much inconsistent and degraded. Community Forest User Groups (CFUG) have been encroaching grazing land in lower belt of Milke-Jalajale rangeland. Government imposes land reform policies frequently which alter the existing land use pattern. People use horses and mules for load carrying as a means of transport these animals grazing behavior and trampling is so severe than cattle. Infrastructure of physical development, e.g. road, hydropower and water pipe installation etc. have been encouraging people to settle on the road side and rangeland converting into settlement area. Field study revealed that there were five kind of rangeland ownership such as private, public, kipat, kipat mortgage and community forest user group in Milke-Jalajale rangeland area. Mortgage kipat rangeland has represented maximum part by 66% and minimum part represented by 2.5% with community forest user group.

Assessing vegetation cover changes induced by livestock grazing in the Alai Valley, the Kyrgyz Republic in and after the Soviet time

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The Kyrgyz Republic has experienced the great changes of social and economic systems since 1991 when the Soviet Union collapsed, which also led to transformation of a grazing style especially in the high mountain areas. The aim of this study is to understand the land degradation before and after 1991 in the eastern area of the Alai valley, southern Kyrgyz Republic. Field survey was conducted on 173 grazing slopes (84 slopes without grazing terraces and 89 slopes with grazing terraces) in 2011 and 2012 to examine the degree of grazing intensity: observation of vegetation coverage, terrace measurement, and slope measurement. The grazing model of Howard and Higgins (1987) was used to understand the degree of grazing intensity on the 89 slopes with grazing terraces. The result suggested that 76 slopes were overgrazed and other 20 can accept more livestock in the future. Further, 33 local families were interviewed. The interview survey showed that eight families live in the study area all year around. Six of them have moved there before 1991, and have housed in the west part of the study area, which has plenty of water resource to support their life for whole year. Twenty-three families stay in the study area only in summer, and they are comparatively new comers from outside. Two families stay there only in winter. These 25 families are all housed in the east part of the study area. The 1965 Corona and 2009 ALOS satellite imageries were digitalized and analyzed. The analysis demonstrated that the total vegetation cover has decreased by 6.55% from 1965 to 2009. The study area was divided into eight basins (basins A – H from the west to the east). Vegetation cover in basin A decreased most and basin B; and E and H also showed some decrease. Vegetation cover in basin D increased most, but its vegetation cover had been less than 50% both in 1965 and in 2009. Slope measurement in basin D showed that nine slopes with terraces are overgrazed while only one slope has no terraces. Basins F, C and G also presented vegetation-cover increase. The slope analysis shows that the slopes with the degrees of 10 – 30° have more bare ground. The greatest decrease in the vegetation cover has occurred in basins A and B, where the house had been built first. Basin B has the largest settlement in the area. The vegetation-cover percentage had been the least in basin D both in 1965 and in 2009, where people had most easily accessed to the main road. These may suggest that settlement and road could be the major elements for vegetation-cover degradation in the area. Individual household should graze their livestock at certain periods in remote pastures in order to diverse the impacts on the slopes. It would be advisable that the government considers investing capital to construct bridges over the Kyzyl Suu to distribute livestock to the southern area with rich vegetation cover, where herders can reuse the abandoned old road-networks.

Climate change and adaptation in Sagarmatha National Park, Nepal

Gyanu Raja Maharjan (Tribhuvan University, Nepal)

The regular process is happening in the earth and atmosphere from the beginning of the universe it is true and natural process but from some decade this regular process is happening very rapidly then the people are feeling the climate change is happening. The climate change effects us all over the world but mountains are highly vulnerable to human and natural ecological imbalance. Mountains are the most sensitive area to all climate changes in the atmosphere. The Sagarmatha National Park (SNP), which is the top one national park in the world, inscribed on the World Heritage listed in July 1979 due to its superlative natural phenomena and areas of outstanding natural beauty and aesthetic importance. Due to the climate change the Sagarmatha National Park is also vulnerable to a series of locally triggered pressure, and requires active management solutions at the local level. The mountain areas people's livelihood depends upon the Himalayas. If the snow is melting rapidly in Himalayas their livelihood also finished. Adaptation can consist of a wide variety of actions by an individual, community, or organization to prepare for, or respond to, climate change impacts in the SNP area. Many of these measures are things we are already doing but could be stepped up or modified to prepare for climate change.

Soil erosion modeling for sustainability of land system in Middle mountain areas in Nepal: GI Science approach

Umesh Kumar Mandal (Tribhuvan University, Nepal)

Middle mountain areas of Nepal Himalaya is seriously suffering from ecological degradation and has been estimated over 240 million cubic meter of top soil being eroded annually from there to the Bay of Bengal. Thirteen percent of Nepal's watershed area has deteriorated seriously and 10,000 sq km are devoid of sufficient vegetation and are in danger of desertification. Topsoil loss from the mountain is resulting the riverbeds' raise in the Tarai at an estimated annual rate of 15 – 30cm and its effect on soil fertility decline has been one of ecological crisis facing Nepal. With these concern, an attempt was made to estimate the soil loss using Geographical Information (GI) Science integrated technology and its correlative interpretation with land system units and land use and cover types from Maheshkhola Watershed, a part of Trishuli river located in middle mountain region of Nepal Himalaya. Several empirical and physically-based erosion models were found applied in estimation of soil loss in different ecological condition. Revised USLE (RUSLE) using RKLSCP was used to estimate the soil loss in the present analysis.

A total of 231,155 tones of soil were estimated, annually being lost from Maheshkhola watershed. Erosion rates in the study area were found highly associated with the increasing slope of land system units. It was evident from the fact that 33.0% of the total soil loss in the watershed was mainly contributed only by each land system units, 11 and 12. Among the average soil loss from different land system units, depositional dissected alluvial fans(9cd) was found highest of 3.62t/ha/yr. Soil erosion rates were also found highly correlated with the increasing antropogenetic activities. The dominant land use, agriculture with a spatially concentrated on 61.53% in the entire watershed area, was contributing almost 90% of the total soil loss in the study area. Similarly soil cliff/landslide and river sand areas were also perceived as most influencing factor of soil erosion, which contributed 10.11 t/ha/yr and 9.38t/ha/yr on an average respectively. The land units, steeply mountainous terrain having soil loss more than 35t/ha/yr must be given higher priorities for soil conservation measures for sustainable watershed development and planning.

Importance of field work in natural disaster risk assessments in high mountains

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Increase in glacier melting leads to the formation of new glacier lakes at the snout of glaciers in high elevations. It is common to find moraine-dammed lakes and glacier lake outburst floods (GLOFs) in different glacierized regions. GLOFs can affect fragile mountain ecosystems as well as economic activities due to the large magnitude of the flow. The complexity of this problem is increased by the remoteness of the areas and the lack of data, and the majority of risk assessments are based on remote observations such as satellite imagery and aerial photography. The Dudh Koshi basin contains twelve of the twenty potentially dangerous glacial lakes of Nepal. In May 2012 ground penetrating radar surveys were completed at three glacier lakes in Nepal to measure the moraine thickness and detect the presence of ice in the moraines. The lakes were: Dudh Pokhari, considered to be high risk due to its volume; Tama Pokhari, considered to be low risk after a 1998 GLOF; and Imja Lake, considered to be high risk due to its large volume. Due to expansion in the direction of the Imja glacier instead of the moraine during the last decade and the extensive terminal moraine complex there has been a belief that Imja lake will not have a GLOF in the near future. This work highlights the idea that to have an accurate risk assessment, fieldwork needs to be one of the main sources of information, which could be mixed with remote sensing and numerical modeling. For these lakes we found: Dudh Pokhari does not show evident risk since it does not have evident triggers such as overhanging ice. Tama Pokhari was drained considerably in the 1998 GLOF; however, some risk remains since there are many hanging glaciers and the volume of the lake is not well known. Community members mentioned that twice some ice has fallen into the lake producing waves, which overtopped the moraine and generated floods downstream. At Imja Lake, extensive GPR surveys were run at the terminal moraine and indicated the presence of ice in the entire terminal moraine complex. The lake is expanding in both directions and exposed ice is visible at inner face of the south moraine. The terminal moraine is quite wide, but it is very unstable. We believe that the water is dammed by the ice instead of the moraine itself, and any change in the ice structure might lead to a collapse of the moraine, especially if an earthquake occurs, which is probably the worst scenario. Therefore, at all three lakes we found information that contradicts assessments based on remote sensing and prior site visits. For Dudh Pokhari, recent remote images indicated that it was dangerous; but after visiting, we believe it is not. At Tama Pokhari, the recent GLOF led to the assumption that it is not dangerous; but, based on our site visit, we believe it has some residual risk. For Imja Lake, people assumed it was not dangerous because it has such an extensive terminal moraine complex; but we believe in the near future it could be dangerous.

Livestock farming in Hussaini village, Gojal district, northern Pakistan: From stagnation to decline

Kazuo Mizushima (Nihon University, Japan)

The Gojal district maintained a self-sufficient lifestyle until the late 1980s by relying on traditional farming and agriculture techniques. However, this region changed significantly in 1986 with the opening of Karakoram Highway (KKH). This report focuses on the case of Hussaini village, located near the centre of Gojal district, and clarifies the factors that led to the decline of an already stagnant village livestock breeding enterprise. The Hussaini village is inhabited by the Wakhi tribal people and comprises 80 farming households with a population of 565 as of 2002. Until the late 1980s, Hussaini village maintained a self-sufficient lifestyle as did many other villages in the Gojal district. However, the opening of the KKH significantly affected this traditional lifestyle by making available large volumes of Chinese products, thereby altering the village lifestyle to dependency on nonindigenous products. Villagers, who now needed a new source of income in order to purchase these products, aggressively cultivated cash crops such as potatoes, and particularly in the case of younger villagers, sought employment in other industries. The introduction and expansion of potato cultivation resulted in a shortage of water used for farming and irrigation, which the village aggressively attempted to resolve. On the other hand, villagers who sought employment in other industries had moved to other regions, and thus, the communal lifestyle of the village faced a remarkable change, particularly in livestock breeding. Because this district is in an arid, mountainous region, villagers have strived to secure feeding grounds for their livestock. These grounds are easily obtained in summer because more precipitation enhances the glacier's rich natural vegetation. Hussaini village offers summer pastures in five locations on the right bank of Batura glacier. The farthest pasture from the village is in Meidan (3,100 m asl), approximately 25 km from the village. Traditional transhumance centres on this Meidan summer pasture, where villagers begin to move their livestock to Meidan around 20 May every year. Initially, KKH is utilized for moving the livestock to the end of Batura glacier. From there, the livestock continue on a steep moraine slope where roads are scarce. During this migration, the livestock stop at four summer pastures before finally arriving at the Meidan, where grazing continues from mid-July to mid-September. Recent trends, however, indicate a dramatic reduction in the number of grazing livestock. Until the first half of year 2000, the number of sheep and goats exceeded 1,200 (1,329 in 1999, 1,230 in 2005); however, this number dropped down to 450 in the survey of 2011. Several factors have contributed to this decline. The first factor is the penetration of market economy in this region and the reduction in tourism. This has diminished the demand for livestock products. The second factor is that the naturally grown food supply has been reduced through many years of grazing, resulting in environmental changes. The third factor is the trend of villagers seeking alternative employment options elsewhere. Because of these factors, the village has deemed livestock management in summer grazing grounds to be the communal responsibility of the entire Hussaini village, and has allocated the work to two groups: only by 15 farming households with 450 head of livestock. Interest in livestock management is gradually moving from stagnation to a state of decline, with fewer people engaging in the harsh administration tasks at the summer grazing grounds. The village currently faces a situation in which stable cash income cannot be guaranteed, and is confronted with a harsh natural environment that includes frequent natural disasters. The most important current issue for the villagers is sustainable development and maintenance.

Disaster mitigation and landscape protection in the Western Ghats Mountain region of Kerala: Challenges under a changing climate

K. Shadananan Nair (Nansen Environmental Research Centre-India, India)

Severity of natural hazards are often aggravated by human interference and changing climate in the Western Ghats Mountain region of Kerala State in India. Natural hazards result in casualties, loss in agriculture and livestock, and large-scale damage to infrastructure. They are challenges to securities in food, water and energy. The Mountains bordering the entire 580 km eastern side of Kerala produces heavy rainfall of more than 3,000mm annually. Fast runoff through steep slopes creates floods in lowlands. Deforestation and introduction of plantation crops replacing the natural vegetation has affected the topography and water holding capacity of soil and reduced summer water flow in the rivers and also the storage capacity of reservoirs. Together with this, construction of a number of dams and large-scale sand and rock quarrying in the hills result in landslides and flash floods. Debris flow considerably reduces the runoff, making some of the once perennial rivers seasonal. The State with heavy rainfall experiences seasonal water scarcity and even droughts. This paper analyses the role of human interference and climate change on changing landscape and worsening natural hazards in the Western Ghats Mountain, assesses the existing policies and strategies for hazard mitigation and explores the possibilities for the improved mitigation measures. Analysis shows that the intensity and frequency of floods and landslides are increasing because of the pressure of the increasing population on the environment. Rainfall is becoming highly seasonal and more intense. Increasing convective activity produces more thunderstorms, causing casualties associated with lightning and floods. Large raindrops erode topsoil. Sedimentation in reservoirs and rivers worsens the flood situation and adds to the severity of droughts during non-rainy months. New schemes like the river diversion may further increase the severity of hazards. The State lacks an efficient disaster management programme and an emergency task force. The rules and regulations to protect the environment are not properly implemented because of various social and political reasons. Even in rescue operations, there are regional and vested interests and attempts for political gains. Though human impact has a considerable role in inviting hazards, administrative and legal mechanisms fail to control it. The Government machinery is slow and often corrupt and there is no coordination among the various departments. Guidelines to mitigate the impact of natural hazards and suggestions for a better environment policy to face the new challenges have been provided, taking into consideration the environmental, political, social and economic situations.

Local people's perception on climate change and adaptation strategies: A case study of Bhimeshwor Municipality, Dolakha, Nepal

Pashupati Nepal (Tribhuvan University, Nepal)

Mountains are among the most fragile environments on earth. It is more difficult to understand climatic characteristics in the mountain than in the plains due to the complexity of the topography and the orographic features. In such circumstances, the study of local people's perception on climate change and adaptation strategies followed by local people to respond the changes in the study area can have better understanding of the issue. The paper also seeks answer from the local people whether they perceive any barriers to adaptation. Data and information required for this study was obtained through direct observation, key informants survey, focus group discussions and secondary information analysis. The results of the case study strongly indicate that people perceive climate change and its impact vary. Majority of the local people claimed that temperature has increased and duration of rainfalls has been decreased. Impacts were observed contributing to loss of species, outbreak of diseases and pests, rapid encroachment by invasive species, and emergence of human diseases. Local people also perceived that the changes have been occurred in flowering and fruiting of fruits and vegetables and seasonal calendar of farming. There were important differences to adapt climate change impacts among the local people. Although large numbers of people were perceived no barriers to adaptation, those that do perceive them noted poverty, lack of appropriate technology and market accessibility as major barriers. Those people who perceive climate change but fail to respond may require particular incentives or assistance to do what is ultimately in their own best interests.

Climate-smart mountain agriculture to improve food security in the HKH-region and its effects on land systems

Sarah Nischalke (ICIMOD, Nepal)

This paper focuses on the interface of human-environment interaction and land system changes by assessing the food security status and vulnerability of households to food poverty and deprivation in the changing mountain environments of the HICAP project region (river basins of Upper Indus, Koshi and Eastern Brahmaputra). The four aspects of food security (availability, access, utilization, and stability) are investigated along with impacts of current food regimes and macro-level drivers. The objective is to provide first insights into climate-smart adaptations in agriculture to show potential for improvements in community resilience and food security as well as consequences for land systems.

The food security discourse, re-evaluated through a mountain perspective, and a brief literature review will help to address further what Jhoda et al. (1992) already formulated as specificities of mountain agriculture in 1992 as issues of physiography, fragility, diversity, inaccessibility and marginality. The common denominator of identified problems across the literature are land degradation and decreasing productivity due to limited capacities of mountain populations but also the adoption of market-oriented practices without considering area specificities, which lead to loss of resource regenerative practices and diversification measures (Su 2012). Therefore, optimizing yields, product diversification, livelihood diversification (including accessibility to markets) and improvements in resource management (water management, biofortification etc.) as major solutions given will be further looked into. As Rasul (2012) showed water will be the decisive factor in mountain food security due to irrigation requirements under climate change conditions. Even though it is very likely that climate change will have adverse effects on the vulnerable food production and livelihood systems in mountain areas they widely have been left out in climate change modeling, probably because they represent the fringes of production.

In a second step these trends will be confronted by data from a conducted vulnerability assessment (VACA) to provide not only a better understanding of the current state of natural capital resources but also of endowment structure and household entitlements to food. The data shows that even though bio-physical conditions (and natural capital as dominant 'currency') are most important in mountain regions, present food regimes and their political, economic and cultural determinants and power relations within the institutional landscape affect mountain communities and can foster a state of cumulative vulnerability. Therefore, the identification of drivers of change (climate, markets, demographics, labor markets, policies, etc.) and their restructuring effect on agriculture and livelihood portfolios will be analyzed. The data reflect that farming practices in the mountains are changing already (crop varieties, cropping patterns etc.) due to changes in weather patterns or demographics (reflected in migration and new work patterns), which indicates the future path of a restructuring process in agriculture and land systems.

Mountain tourism and its impact on livelihood

Ram Sharan Pathak (Tribhuvan University, Nepal)

Mountain tourism refers to all tourism activities (mountaineering, trekking, adventure tourism, cultural tourism, resort tourism, pilgrimage tourism) for which mountain manifest comparative advantage (Sharma, 1998). Pilgrimage was perhaps the primary phase of mountain tourism (Bhardwaj, 1973). For centuries, the Himalayas have been a source of religious and spiritual inspiration for millions of Hindu and Bhuddhist devotees (Nepal, 2003). In the second phase, resorts, sanatoria and spa developed (Singh and Kaur, 1973; Robinson, 1976). A large number of resorts and sanatoria are found in the mountainous regions of the world. In the third phase, mountaineering and trekking tourism developed. Trekkers and mountaineers from developed countries aspire to see, experience, and feel the beauty and spirit of the place in an undisturbed, unpolluted natural setting that is ecologically harmonious as well as socio-cultural heritage and day to day life of the mountain (Poudel, 1998).

Mountains of Nepal, harboring eight out of the 14 eight-thousanders, have played an important role in attracting a large number of trekkers and mountaineers from abroad. Mountain tourism began in Nepal with the successful ascent of the peak Annapurna I in 1950 by a French team led by Maurice Herzog and with the successful ascent of the Mount Everest by Tenzing Norgay and Edmund Hillary in 1953. In 1965, colonel Jimmy Roberts introduced the world to trekking in Nepal. The opening of new areas for trekking provided a further boost to the trekkers visiting Nepal (Pathak, 2012).

More than 50 million people visit mountain destinations each year. In Nepal, roughly one fourth of all international tourist visits occur in mountain destinations (Nepal, 2003). Mountaineering generates 17.5 times higher per capita income to the country than the ordinary tourism (Dhakal, 2008). Mountain tourism has helped in uplifting living standard of mountain people. Mountain tourism has given young man and women the option of building a future in their home community instead of becoming part of the rural exodus to cities (<http://www.mountainpartnership.org/issues/tourism.html>). It has helped in reviving the ancient cultures and made it a commercial venture in the village (Dhakal, 2008).

Mountain tourism can also have a range of damaging effects such as degradation of fragile mountain system, deforestation, garbage generation, commercialization of art, loss of symbolism of cultural event, theft of cultural and religious objects and artifacts and a thriving black market.

Mountain people are the stewards of mountain ecosystem, so before taking any decision to develop tourism in the mountain area, people living in mountain areas should be involved in planning process and managing mountain tourism.

Community seed banking in agrobiodiversity conservation and mycoflora in stored paddy seeds

Chandra P. Pokhrel (Tribhuvan University, Nepal), Vimala Bhandari (Tribhuvan University, Nepal), Pramesh Lakhey (Tribhuvan University, Nepal) and Ram Kailash P. Yadav (Tribhuvan University, Nepal)

Community Seed Banking (CSB) is emerging as a reliable option for the conservation of agrobiodiversity and it offers the major source of seed for the local farmers. This study addresses the role of CSB in agrobiodiversity conservation and identification of associated mycoflora in stored seeds of paddy in community seed banks of Bardia, Kailali and Kanchanpur districts of western Nepal. Seventy-five varieties of paddy (*Oryza sativa*), 13 varieties of wheat (*Triticum aestivum*), 10 varieties of maize (*Zea mays*) and 8 varieties of millet (*Eleusine coracana*) were stored in Community Seed Banks. Out of those 45 paddy varieties, 4 wheat varieties, 7 maize varieties and 8 millet varieties are the local. 44% of the farmers use local and improved varieties, 56% use local, improved and hybrid varieties of seeds from seed companies. The cereal seeds are stored in plastic bags where as bean and vegetable seed are stored in plastic bottles in Community Seed Banks. Twenty different varieties of paddy were randomly collected for germination test; the study showed that germination varied from 0 – 96%. A total of 9 fungal species were isolated and identified from the seed samples of 11 paddy varieties.

Pathways of social-environmental transformation in pastoral social ecological systems in the Global South: A research proposal

Julio C. Postigo (National Socio-Environmental Synthesis Center, USA)

Pastoral social ecological systems (PSES) have responded to social environmental change over millennia. However, in the last decades, PSES have been driven into marginality, poverty, and vulnerability. PSES use 25% of Earth's land area, sustain 200 million households and almost a billion head of livestock, and produce 10% of the world's meat. Though syntheses of the general trends of social environmental change rarely address PSES, they recognize the need for a synthesis that: i) specifically assesses PSES, and ii) incorporates the interactions of social and environmental responses to change. This proposal shows a framework to respond to these needs by: i) identifying and mapping the main trends and patterns of socio-environmental change in PSES; ii) synthesizing the responses of PSES to climatic changes; iii) outline comprehensive policies (that include local responses) to improve the adaptability and resilience of PSES facing climate change. The materials used in this project are remotely sensed available data, published (peer reviewed and grey literature) materials, and expert opinion. The outcomes of this research will contribute to a global assessment of the relations between PSES and global drivers of environmental change. It also will show how social environmental changes are responded to at local, national and international levels. Finally, suggested policy will be designed in order to contribute to the science-policy interface and the international community. The basis of this contribution is the case-base evidence of PSES' transcalar and cross-level responses that combine local, national, traditional and modern responses to socio-environmental change.

Mountaineering tourism in Nepal

Padma Chandra Poudel (Tribhuvan, University, Nepal)

The profusion of the Himalaya Mountains in 28 main ranges and their subsystem and their peaks and pinnacles spread at continuous chain from East to west of the country, forming almost northern border of the country, have provided Nepal a fertile and attractive destination for mountaineering tourism. Continuous and unplanned flow of mass of mountaineers to the fragile Himalaya and their ecosystem and geology exemplifies both worst and best case scenarios in mountain tourism. The worst cases scenario is related to the extreme crowding, noise, pollution, and other negative symptoms that occur in the fragile mountain environment. The best cases scenario is related to the academic and scientific research of the mother earth, commercial interest and economic benefits to the nation and mutual understanding between hosts and the guests, and the business promoters. In the mountains laying at the boarder a single country's policy cannot control the worst cases. Therefore, there is essential of realization and understanding about the worst cases among the nations of both side of the boarder to revive the situation to the positive direction. This paper focuses on the distribution of mountain ranges and their peaks in Nepal Himalaya and analyzes the situation of the mountaineering tourism based on the published and unpublished secondary information.

Place attachment and mobility of people in Rai community of Bhojpur, eastern Nepal

Dhyanendra Bahadur Rai (Tribhuvan University, Nepal)

Place attachment is an affective bond that people establish with specific areas where they prefer to remain and where they feel comfortable and safe. It refers to the process of human-place bonding; the bonding process includes both physical and social ties formed within an environment. The research seeks to establish place attachment as a multidimensional construct consisting of affective attachment, place identity, place dependence, social bonds and relations, which directly influences to the mobility nature of people. A structured questionnaire survey and in-depth interview have been conducted for this study. The findings demonstrate that the mobility process of Rai community in Bhojpur is strongly affected by place attachment and sense of place.

Landslide hazard in mountain areas of Nepal

Balaram Raya (Tribhuvan University, Nepal)

Nepal is a mountainous country with 77 percent of hill and Himalayas areas. Rugged and fragile geomorphology is our landform's characteristics. Such physical condition is being the various types of movement occur for human hazard in our country. Both natural and anthropogenic causes are significant role to trigger the landslide vulnerability in the settlement areas. The main causes are slope, rock structure or type, weathering, soil, rainfall and unplanned settlement as well as developmental activities. This study has found that 4,327 human life and around 555,607 people have affected from landslide hazard between 1971 and 2010 period. Similarly, out of 55 hills and mountain districts, 8 districts (Makawanpur, Dhading, Kaski, Sindhupalchock, Taplejung, Khotang, Syangja and Myagdi) have identified very extremely vulnerable districts. Likewise, numbers of human deaths of landslides is increasing trend in each decade over forty year. The maximum numbers of deaths (455 people) is in 2002 and the minimum death is in 2005 (17 people) in same period. Finally, landslide hazard is increasing year by year that may risk human lives and infrastructures in the future.

Investigation of the Seti River disaster (May 5, 2012) and assessment of past and future mountain hazards facing Pokhara, Nepal and upstream communities

Dhananjay Regmi (Himalayan Research Expeditions, Nepal)
and Jeffrey Kargel (University of Arizona, USA)

On May 5, 2012 Setiriver outburst has not only resulted to the loss of life and property, but also has left terror of similar catastrophic event any time in Pokhara in near future. Local people and government agencies are looking for a scientific explanation of this catastrophic event, but in the absence of detail scientific study, different speculations are made by the scientist.

Instead of making just speculations following key questions needed to be addresses as soon as possible. 1. What was the cause of the Seti river disaster on May 5, 2012? 2. Is another similar flood likely? 2. What role might imprudent habitation have played in raising the death toll? 3. What other types and magnitudes (e.g., peak flows) of floods are possible in coming years and decades? 4. How large a population remains vulnerable to such floods and mass flows?

In this context the major objective of this paper is to share some of the hypothesis comes out from preliminarily field observation made from helicopter flyover in May, and to discuss and share the ideas of the scientific community presence during the conference.

Hypotheses for the causes of the Seti river flood disaster are: *a. Not a normal GLOF!* It could not have been a usual type of GLOF, because no such precursor lake existed in the drainage basin. *b. Rockfall-impounded lake: not that, either!* It was observed from satellite repeat imaging, that a modest rockfall occurred into the Seti gorge between 2002 and 2008, and was reactivated a few weeks prior to the disaster. However, quantitatively this explanation also falls short. *c. Working hypothesis #1: The karst model.* The rockfall dam outburst model was soon modified, and includes the possibility that not only the gorge could contain a lake, but possibly karst caverns in those same rocks could be water filled and may have been dammed and then undammed by the rockfall. The presence of karst is unknown in that rock formation. *d. The rock avalanche/landslide trigger.* During the disaster, another wrinkle and clue to the mystery of its causes emerged. A tour plane operator observed visually and captured on wing-tip cameras a huge brown avalanche cloud several kilometers up the Seti valley from where he was flying. In blog postings and to us personally during a visit to his hangar, Mr. Maximov stated that the brown cloud was both vastly larger and much dirtier/browner than any snow avalanche he had ever witnessed. *e. Working hypothesis #2: All-of-the-above approach with multiple water sources.* A composite model might work best. For example, supraglacial water, englacial water, water stored in wet snow, water produced by melting of snow caused by release of gravitational potential energy, and water stored in the rockfall-dammed gorge lake and perhaps in karst each contributed to the flood. The whole process-chain of mass movements then was triggered by the large avalanche/landslide.

Role of large cardamom on environment and livelihoods: A case of Panchthar district

Shiba Prasad Rijal (Tribhuvan University, Nepal)

This study aims at analyzing the role of large cardamom (*Amomum subulatum* Roxb) on environment and livelihoods focusing the case of Panchthar district. The study is based on both primary and secondary data/information. Large cardamom popularly known as 'Alainchi' is a newly introduced perennial cash crop typically cultivated in shaded areas with irrigation facilities within an altitude 700 – 2,000 meter above sea level in Nepal. It is largely concentrated in the eastern Nepal especially in the hill and mountain areas and gradually being expanded towards western parts. Though area coverage and production is limited compared to the other crops, being high market value, its contribution on national economy is significant.

Panchthar district, located in the eastern hill, is one of the main cardamom producing districts of Nepal. In terms of area coverage and production, it ranks fourth among 38 cardamom producing districts in Nepal. The role of large cardamom is significant in maintaining environment and enhancing livelihoods in Panchthar district. Increase in biodiversity with the increase in forest cover, reduction of soil erosion/landslides and improvement in water sources are the major environmental benefits felt by locals. Likewise, employment generation, and increase in household income are socioeconomic benefits. In addition, it has indirect contributions in reducing climate change impacts. In recent years, livelihoods based on cardamom are being vulnerable with the decline in productivity as caused by increase in diseases and pests. However, the extent of impacts cannot be quantified. This needs further investigations.

Hydrological assessment of significant lakes in Broghil and Qurumber valleys, Pakistan

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and Samiullah Khan (Pakistan Wetlands Programme/WWF-Pakistan)*

Speculated information was available about significant lakes of Broghil and Qurumber valleys and therefore was scanty for maintaining the country's database. Pakistan Wetlands Programme's scientific team expanded their technical expertise to Broghil and Qurumber valleys. Vital hydrological investigations were made, which mainly comprises bathymetric, water quality, aquatic flora and micro-fauna. These were the first intensive and technical assessment ever made for wetlands of the area and its buffer zones. The major explorations include; maximum, average depths, lake volume and surface to volume ratio and discharge. Apart from bathymetric investigations, the water quality of lakes was also being monitored in correlation with lakes morphometry, and topography was developed to envisage their status of vulnerability to landuse change and climate change. The hydrological parameters were mostly observed as habitat for waterfowls and their extent of biological aquatic productivity. Qurumbar Lake is one of the highest biologically active water bodies present on earth and there have been sightings of a broad spectrum of biological life, from phyto- and zoo-plankton to important migratory water fowl species, but, enigmatically, no fish.

The investigation revealed that the valley has been bestowed with very unique ecosystems, which still up to some extent are virgin and needs attention from conservation agencies. The information being gathered is preliminary and therefore for constructing management plans and conservation Strategies further detailed investigations are required. The future projects have been proposed, which are not limited to but include acquisition of high-resolution hydrological and ecological data over a longer period of time.

Changing pastures in the Himalaya

Lila Nath Sharma (Tribhuvan University, Nepal)

Anthropogenic grasslands- an integral part of cultural landscape- are shaped and maintained by fire and grazing; and changes in either have great implications for the vegetation cover and composition. In this context, we qualitatively examined 18 grasslands used by transhumance agro-pastoralists in western Gorkha to show that pastoral landscape is undergoing change due to shrub and tree encroachment; understand the role of change in grazing- and fire-regimes in shrub encroachment dynamics; and discuss policy implication of shrub control. Our results revealed that Berberis shrub encroachments started approximately three decades ago and attained a problematic cover approximately 15 to 20 years ago. In this region, grassland abandonment and livestock population decline have been the overall land-use change trend over the last four decades. Shrub encroachment started following livestock population decline as consequence of land abandonment brought by out-migration of local people from these marginal areas. Fire doesnot seem to be a plausible trigger as fire was not a practice in the encroached grasslands. Abundant cover of Berberis species has changed the landscape, and is a significant constraint for the herders that still relay on these landscape unites to sustain their livelihood. Several attempts to solve this problem by means of fire and up-rooting Berberis species have failed. Therefore, we underscore the necessity of action to maintain services of this unique landscape; and suggest synergistic application of burning, weeding and grazing rather than their sporadic treatment, for the better results.

Impacts of land use change in the Koshi Hills, eastern Nepal

*Puspa Sharma (Tribhuvan University, Nepal)
and Pushkar Kumar Pradhan (Tribhuvan University, Nepal)*

This paper intends to analyse land use change over time and its impacts on cultural landscapes in the Koshi Hills (KH) including four districts, viz. Bhojpur, Dhankuta, Sankhuwasabha, and Terhathum of eastern Nepal. While so doing, it has drawn analogue and digital data from three different sources, including LRMP (1986), toposheet (1996), and Landsat imagery (2010), complemented it from the field verification and district consultation workshop being held in the field. Attempt has also been made to identify possible factors responsible behind land use change. Five broad categories of land uses such as arable land, forest, shrubland, grassland, and others (water bodies, snowland, bareland, rock and ice, settlement built-ups, and roads) have been determined, based on the 1996 toposheets. The interpretation of the results of land use indicates dynamic in land use. Significant changes have occurred in overall land use. For instance, forest increased by 18.4 percent over the past 24 years. The inter-culture of amreso and large cardamom in the shrublands and private forests has also been practiced by the farmers in the areas linked by roads. Use of land for agricultural purposes increased by 10 percent during 1986-1996, but decreased from 1996 onwards. However, the traditional subsistence cereals crops have been replaced not only with commercial vegetables, but their cultivated areas have also increased substantially, particularly along the sides of roads. During 1986-2010, there has been decreased in shrubland and grassland to a substantial amount at 81 and 39 percent respectively, while forestland has been increased consuming mostly the shrubland, grassland and arable land. So, a considerable internal trading found to have occurred between categories, especially forest and shrub or grassland, demonstrating a fluidity of land use across the KHs. Government initiatives through adopting policies and programmes appear to be crucial towards impacting on land use change. In the KH there were two specific activities to maintain and conserve the forest coverage. The Makalu-Barun National Park and its buffer zone and the Community Forestry Programme were contributed to increase in forest coverage after 1996. The Community forestry activities have possibly contributed to a significant improvement in availability of fodder, fuelwood, and fruit tree resources, as well as they are having a beneficial effect on the balance of land use as part of a broader process of agrarian change. Shrublands and grasslands are being converted to more productive categories of forestland, reflecting the care of communities in managing and conserving their own forest resources. An increase in the arable land during 1986 – 1996 could be attributed to the building of Dharan-Dhankuta road in 1985 and the introduction of improved agriculture development programmes that initiated growing of the off-season vegetables, seeds, large cardamom, ginger, fruits and livestock rearing in the early 1980s. The spatial digital database being established provides benchmark of spatial development conditions at three map points-years: 1986, 1996 and 2010. If the database is updated in the future, comparison of the impacts of development activities on land use is possible in places and on people over time.

The transhumance of cattle by Tibetans in the northwestern part of Yunnan Province, Southwest China

Shigeru Shirasaka (Teikyo University, Japan) and Guo-Quing Du (St. Paul's University, Japan)

Transhumance is a typical subsistence of livestock industry that uses the climatic difference between lowlands and highlands. There are so many types of transhumance in the world. This study discusses the connection between mountains and human activities through the transhumance by Tibetan people in the Northern Part of Yunnan, where Tibetan people keep the ascending transhumance, and domestic cattle; Yak (*Bos grunniens*) and *pien* (local name, hybrid of yak and local yellow cattle) are their livestock for transhumance. Wunongding-goma (a spontaneous village) in Deqin County of the northern part of Yunnan Province is close to the Tibet Autonomous Region and located at the foot of Meili Snow Mountain (6,740 m, an untrodden peak). And most villages are on the slope of the mountainous district about 3,000 m above sea level. Deqin, 3,260 m above sea level, is the capital town of this area and Tibetans are the majority of the local population. Wunongding-goma, which is a village, is located in 9.2 km to the south from Deqin and 3,540 m above sea level. The village has 22 households with a population of approximately 100. Maximum snow depth is around 30 – 60 cm in Wunongding-goma, and the farming is seen during eight months from March to October. They used to cultivate mainly hulless barley (*qingke* in the local name; a kind of rye), wheat, turnip (Latin name; *Brassica rap*) that is a feed of domestic cattle for winter season. They cannot cultivate Indian corn and fruit trees under the severe natural environments. However, they cannot maintain their life only by farming because this village is near to the cultivation limit. Therefore, they do the transhumance of cattle to the alpine pasture of highlands in the summer, more than 4,500 m that exceed the timberline. The basic form of the subsistence of Tibetans living in the place of high altitudes of this neighborhood is “transhumance + farming.” The relations of these two factors are mutually complimentary, and their life does not make if either of them is missing. In the middle of June every year, they bring their cattle to their alpine pasture around 4,300 m above sea level over timberline, and produce their butter and cheese. Then they return to their village at the end of September. According to our research of 1993, 18 of 22 households in Wunongding-goma did transhumance at the time but they decreased to seven houses in August 2009. This is because this area also has been affected by the economic development, and a large number of the young population flowed out to the urban areas from the countryside like Wunongding-goma. Also, transhumance as traditional subsistence has been decreased because of local economic development, infrastructure establishment, and tourism business development that absorbed the local work force.

Land use change and its impact on livelihoods: A case from Upper Bhotokoshi Area

Uttam Sagar Shrestha (Tribhuvan University, Nepal)

The land resources are integral part of the livelihoods of residents of Upper Bhotokoshi River (UBR) and they depend on the land resources for their livelihood despite narrow gorge with, limited agricultural land, forest and grass. The development interventions after the 1950's for tourism, infrastructure, and hydropower has changed the strategy of livelihood options and majority of them have adopted more than one livelihoods strategy like agriculture with other activities as production from their own farm was barely sufficient for six months. The series of proposed hydropower developments, road alignment in the river basin and its surrounding area are responsible for changing land use pattern. Now instead of formal association with land their livelihood has operated through services, business, tourism and other activities. The present paper tries to discuss the relationship between land use changes and their implication in the livelihood of UBR within the last two decades. The methods and materials applied in the paper were observation, transect walk along the river, focus group discussion and key informant interview and consultation of literature available in Tribhuvan University, Central Department of Geography. The findings of the work are based on fieldwork carried out between 1995 and 2011.

Results: Land Resources was basis for livelihood opportunity of many people of the river basin. The existing land system is changing due to land developed for development activities. The major livelihood strategy in the basin depends on agriculture and livestock and other strategy are, services wage labour, fuel wood collection, and selling, tourism activities, small cottage and business. Wheat and barley are the main staple food in the upper part and maize and paddy in the lower part of the UBR. Agricultural and vegetable market improved by easy access of road and development of hydropower projects in riverside has change the former scenario. Changes have found towards using less number of local products and more people from surrounding sides have come into roadside for easy money earning. Diversification has emerged and life status of the people has increased following intervention of the development activities in the river area.

Discussion: Additional studies in TRB are essential to improve the understanding of land use and livelihood of the communities. Therefore, the challenges of the UBR basin are proper utilization of proper land use in fragile area and proper livelihood options to local people. The issues are raised due to over concentration of development interventions erosions, settlements in the fragile region. It is recognized that in the basin, which is important from land resources are slowly getting lost. The land use point of view the existing studies in the basin are insufficient to proper utilization of land and livelihood options.

Joint forest management: Community response and local governance in drylands: A case of Alwar, Rajasthan, India

*R.B. Singh (University of Dehli, India), Ajay Kumar (University of Dehli, India)
and K. Kimoto (Hiroshima Jogakuin University, Japan)*

The forest was considered the property of state and was under complete management of state until recently. Due to the conflicts related to forest rights between state and local community and also the inability of the state to control the further degradation of forest, policy makers decided to rethink over the forest policy of India. The importance of community participation in forest management was recognised during forest policy resolution of 1988. After that the participation of local government bodies like panchayatiraj institutions in forest management has been endorsed. The forests in drylands have distinct characteristics and their importance to local inhabitants also differ as compared to humid or sub-humid regions. The study area lies in proximity to Aravali range, having a semi-arid climate. The JFM programme has been implemented in the study area under co-management of Forest Department and Village Forest Protection Committees. The implementation of participatory forest management programme in drylands face problems like choice of species to be planted, unavailability of land, scarcity of water, imbecilic local people about uses of forest etc. The root cause of the problem is the inability to identify the main stakeholders and lack of people's participation in decision making about forest rights and uses. There is a need to make the functioning of forest department and VFC's more collaborative. The communication gap between forest department and village forest committees can be minimised by assigning greater role to local governments.

Institutional dimensions and changing role of forest management governance in Dehradun Valley

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The forest policies are evolving at various stages and at various levels, but they need further strengthening and legal support. The forest policy should guide development of the forest sector and provide a clear indication of the state's goals for community forestry. The settlement process and expropriation of forest is a significant factor contributing to the deep resentment among forest dwellers and the people who are fully dependent on these resources. The concept of JFM is a central feature of the National Policy of 1988. It has been endorsed and initiated by all the states but there have been no accompanying changes in the national legal framework to implement it. It is operational through administrative orders and circulars, although it has been linked to state legislation in Uttarakhand. Moreover many programmes, so many policies make people more confused with the whole administrative structure.

Traditional community institution like van panchayat can break down in the face of economic change, and external pressure on forest. In villages in which traditional system of management is still prevalent, they are often reluctant to share the management of forest resources with the forest department. Although JFM on many counts has been successful in fostering forest conservation but it is rigid in terms of addressing social and institutional conditions across different communities.

Ecotourism through the traditional and local practices –A case study of Langtang National Park in Nepal–

*Kazuko Tatsumi (Yamaguchi University, Japan)
and Phurpa Tamang (Rural Development and Social Research Centre, Nepal)*

The concepts of environment protection and biodiversity conservation have been included in development policies of some donor agencies and governments. However, the deforestation, pollutions, declining of animal and plant species can be seen in Nepal. As one of the reasons, there are awareness gaps between the policy makers and the people of grass roots level, the rich and the poor, the tourists and the local peoples. The Langtang National Park is the third major trekking rout of Nepal after Sagarmatha and Annapurna. Many foreign tourists visit every year in Langtang valley and Gosaikunda lakes for natural attraction as well as cultural religious pilgrims' importance (Buddhists/Bonpos and Hindus). In this area the most people are Tamang (ethnic group) and Buddhists/Bonpos. To preserve the natural resources they have the traditional and local skills, knowledge and practices. For example, they recognize the mountains, water, soil, forest and air as God. They need some plants to be preserve for the pray or ritual works. While doing the ritual works and pray, the local grains is require. The hybrid grains or foods are not allowed. It will promote the organic and local things. These days Nepal tourism board has implemented the tourism campaign of the Tamang heritage trail in this area. Therefore the local people have to explain to foreign tourists that traditional and local skill, knowledge and practice are importance for environment protection and biodiversity conservation and their life. This is a good chance for them to understand their own culture and to consider how they would like to develop the park that is going to protect the land they live in. Moreover the gaps between the foreign tourist and the local people will be filled. They have engaged to tourism businesses for a long time, but now an alternative way of their tourism will be needed. They tried to integrate their traditional system with new styles. Ecotourism may be one of the alternative ways that the cultural heritages of the specific area are respected and conserved. The aim of this study is to analysis this process in their ecotourism. The analysis of the outcome is based on data and information collected during fieldwork from 2000 in Nepal. This study finds that it is important to consider community management at the grass roots level and the way it is linked with local governance.

Lessons learnt from Participatory Watershed Management Project in Nepal

Koji Terakawa (Tribhuvan University, Nepal)

Nepal is one of the most beautiful mountainous countries of the world and more than 70% of population are living in rural area with highly dependent on natural resources such as forest, water and soil. Due to the fragile topography, Nepal has been always facing soil conservation and watershed management challenges.

Soil erosion has become crucial problem in Nepal where more than 80% of the land area is mountainous and still tectonically active. Improper management of the forest due to the rapid depopulation by increase of migrant workers and decrease of collaborative activity, resulting in increase of abandoned land, decrease of land productivity and soil erosion in hilly areas.

Since 2009, the Department of Soil Conservation and Watershed Management (DSCWM) has been implementing the Project named as “Participatory Watershed Management and Local Governance” with the key concept of “SABIHAA (SA:Samuhik=Community, BI:Bikas=Development, HA:Hariyali=Greenery, A:Aayojana=Project)” was supported of JICA (Japan International Cooperation Agency) in Nepal till now. SABIHAA Model was developed through JICA’s 15 years’ technical cooperation for effective watershed management has been utilized for some areas in hill areas of Nepal. On the other hand, coordination system development among local government bodies and line agencies to correspond various needs of community members has been still in progress. Therefore, it is necessary to establish the effective system for the implement of regional development activities combined with soil conservation activities under the collaboration and coordination among local government body, line agencies and community members by the facilitation of DSCO (District Soil Conservation Office).

The main purpose of the Project is to improve the existing SABIHAA model. There are two lines of operation. 1) Local government body such as ward level community members (WCC: Ward Coordination Committee), Village Development Committee (VDC)/District Development Committee (DDC) and 2) DSCO and DSCWM that deals with administration of soil conservation and watershed management. The Objective of the Project is to develop a capacity to implement effective watershed management plan that corresponds to medium-long term Plan. In implementation, two-administration lines should work together in an integrated way and develop a mechanism of collaboration. Project purpose and overall goal is shown below. Project Purpose: Improved participatory watershed management in better collaboration with DSCO and local bodies is implemented in the target area.

Overall Goal: Improved participatory watershed management in better collaboration with DSCO and local bodies is applied in other districts by the initiative of MoFSC (Ministry of Forest and Soil Conservation) and MoLD (Ministry of Local Development).

Impact of climate change in snow and glaciers

Bhabana Thapa (Tribhuvan University, Nepal)

Climate change studies in Himalayan regions have focused mainly on glacier melting, retreating, Glacial Lake Outburst Flood (GLOF). But somehow the impact of climate change and adaptation strategies of local peoples have not been studied in detailed in Langtang valley. Hence, this research has been carried out to investigate the vulnerability of climate change and adaptation strategies taken by the people's, living in the areas vulnerable to climate change. This research papers deals with various time series satellite imagery, temperature data, precipitation data, water discharge data and social survey. The results shows that the temperature is increasing at the rate of approximately $0.119^{\circ}\text{C}/\text{year}$ and the total snow coverage area was continuously decreased in Langtang valley. The total snow covered area was 43.16 percent in 1988, 42.67 percent in 2000 and 38.72 percent in 2009. Total snow covered area was decreased by 2196.5 ha between year 2000 to 2009. Snow melting rate was calculated as 0.21 percent per year between years 1988 to 2009. Result suggested that the glaciers are retreating rapidly and people are facing several problems due to the hydro-ecological changes in Langtang valley and trying their best to tackle with the changing environments. Rapid glacier melting disrupted rural livelihoods by posing a threat to agriculture, biodiversity and health. Change in rainfall and temperature resulted in changes in plant behavior like early flowering, shift in vegetation line and loss of some valuable species. Extreme climate events are destroying crops, depleting water resources, causing losses in livestock, cropland, and agricultural productivity. These changes indicate that unpredictable climate variability will be a major obstacle for subsistence-based livelihoods in Langtang valley.

Spatiotemporal modeling of urban growth dynamics in Kathmandu, Nepal

Rajesh Bahadur Thapa (Japan Aerospace Exploration Agency, Japan)

Agglomeration of dispersed population centers in cities with the expense of natural landscape to urban landscape has become a major trend in developing countries. The complexity of urban system requires integrated tools and techniques to understand the spatial process of urban development and project the future scenarios. This research aims to examine the urban development process and optimize spatial patterns of future urban growth allocation to provide a basis for urban environmental management in the Kathmandu Valley, Nepal. The increasing availability of time series satellite images and improving mapping techniques have allowed mapping and detecting landscape change in the valley since the 1960s. An artificial neural network urban growth allocation model is developed. This predictive model optimizes spatial patterns of future urban growth allocation under the three scenarios, i.e., spontaneous, environment-protecting, and resources-saving. The predicted spatial patterns mirrors where and how the urban development in the valley is likely heading by 2050 and provides time-series information on land availability for future land development projects. The results suggest that the current urban development process is in critical stage where urban and peri-urban areas will face unprecedented stress on land resources costing river and forest ecosystems and other environmentally sensitive areas by the next decade. Rural vicinities will face regional imbalance on urban growth allocations. However, there are still possibilities to improve urban environment and manage the potential land demands in the valley by enforcing the urban growth policies strictly and altering the current growth trend as revealed in the environment-protecting and resources-saving scenarios.

Hydrological regime of the Brahmaputra river basin: Preliminary assessment using two model platforms

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The Himalayan River Basins have great socioeconomic, cultural and environmental importance in South Asia. Yet their hydrological regimes - modulated by steepness of the mountain terrain, geological and soil properties, vegetation, snow and glacier melt and monsoon circulation - is less understood to support informed decision-making. This paper presents improved understanding of hydrological regime of the Brahmaputra river basin based on its fully distributed hydrological description within MIKE-Basin and SWAT modelling platforms. The model description utilized data and information related to: topography (GTOPO30, SRTM and ASTER-G DEM), land use (USGS) and soil (FAO). The model is calibrated for 2002-12 period. It is observed that, in general, river flow is calibrated better in MIKE BASIN platform than in SWAT. Availability of additional precipitation data from Assam and Arunachal states of India during 2011-2012 considerably improved model calibration in both the modelling platforms. The experience of detail hydrological modelling exercise will be utilized to improve understanding of climate change impact on hydrological regimes of Himalayan river basins to support science based adaptation planning.

Changing use of pastures: A case study of the sheep herders of East Nepal

Kazuyuki Watanabe (Ritsumeikan University, Japan)

Pastoralism is a way of life, which keeps herd of livestock for using the livestock products. There are so much people engaged in pastoralism among the world, however, in case of the Himalayan region, transhumance is well known for its vertical migration as a type of adaptation to mountain environments. While so many studies have reported types of migration, over classification is bare. Because of its flexibility of the herder's communities, a group, which is categorized A type could be changed into B type in next year. This paper aims to report about dynamic process of pasture use by a case study of Nepalese sheep herders, who migrate vertical and horizontal considerably. Fieldworks were carried out in 1996-98, 2006, and 2011. And, I try to examine why the herders changes their pastures, and as the consequence, how the types of the migration could change for more than 10 years.

Bacterial population on the phyllosphere of woody species in subtropical environment at Shivapuri-Nagarjun National Park, central Nepal

Ram Kailash P. Yadav (Tribhuvan University, Nepal), Sushila Shrestha (Tribhuvan University, Nepal), Chandra P. Pokhrel (Tribhuvan University, Nepal) and Pramod Kumar Jha (Tribhuvan University, Nepal)

The phyllosphere represents the habitat provided by the aboveground parts of plants, and on a global scale supports a large and complex microbial community. Microbial interactions in the phyllosphere can affect the fitness of plants in natural communities, the productivity of agricultural crops, and the safety of horticultural produce for human consumption. Seasonal variation of phyllospheric bacterial population and their leaf traits of four woody species were studied at Shivapuri-Nagarjun National Park that represents a subtropical-temperate environment. The four species examined were *Alnus nepalensis*, *Schima wallichii*, *Rhododendron arboreum* and *Gaultheria fragrantissima*; they belong to deciduous, semi-evergreen and evergreen species. The leaf samples were collected during summer and winter seasons in 2010. The phyllosphere bacterial population estimation was done by the serial dilution plating method. The leaf traits such as leaf water content, nitrogen content, phosphorous content, sugar content and specific leaf mass were also estimated. The average bacterial population of four woody species ranges from 7.41×10^2 to 3.01×10^5 CFU g⁻¹ f.w. (2.87 to 5.48 log CFU g⁻¹ f.w.). The bacterial populations greatly varied among seasons and species. Leaf phosphorous content was found to limit the abundance of epiphytic bacterial population in the phyllosphere of studied species in this environment. The deciduous species were clearly separated from the evergreens on the basis of their leaf traits such as water content, nitrogen content, phosphorous content and specific leaf mass.

NDVI-based vegetation change trend and its response to climate changes in Koshi Basin in middle Himalaya Mountain on the world's Third Pole

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Monitoring changes in vegetation growth has been the subject of considerable research during the past several decades, because of the important role of vegetation in regulating the terrestrial carbon cycle and the climate system. In this study, we combined datasets of satellite-derived Normalized Difference Vegetation Index (NDVI) and climatic factors to analyze spatio-temporal patterns of changes in vegetation growth and their linkage with changes in Koshi River Basin in middle Himalaya Mountain from 1982 to 2006. At the region scale, although a statistically significant positive trend of average growing season NDVI is observed (0.0008 yr^{-1} , $P = 0.03$) during the entire study period, there are three distinct periods with opposite trends in growing season NDVI. Growing season NDVI has first significantly increased from 1982 to 1994 (0.0019 yr^{-1} , $P = 0.03$), and then decreased from 1994 to 2000 (-0.0058 yr^{-1} , $P < 0.001$), finally increasing from 2000 to 2006 (0.0049 yr^{-1} , $P < 0.001$) or from 2000 to 2011 (0.0034 yr^{-1} , $P < 0.001$). This fluctuation in the growing season NDVI trends over KRB are largely contributed by sudden drop in NDVI from 1994 to 2000 during the three periods. Spring, summer and autumn NDVI significantly decreased from 1994 to 2000 (-0.0099 yr^{-1} , $P < 0.001$; -0.0045 yr^{-1} , $P < 0.0014$ and -0.0102 yr^{-1} , $P < 0.001$, respectively). Further spatial analyses supports the idea that there was a sudden decreasing trend of in spring and autumn vegetation that occurred during the study period from 1994 to 2000.

Poster Presentations

Status of wetland in Nepal - A case study of Beesh Hazari Lake

Pabitra Aryal (Tribhuvan University, Nepal)

Wetland in Nepal are playing vital role as wintering areas and seepage for a wide variety of migrant birds. Of the recognized 27 global freshwater wetland types, 2 are present in Nepal. Nepal became signatory of Ramsar convention in 1967. There are 9 wetland sites are enlisted in Ramsar list of wetlands of international importance (Ramsar Convention on Wetlands 2009). Beesh Hazari Lake is one of the largest wetland enlisted in Ramsar site in Chitwan district of Nepal. This lake is an ox-bow lake and is very sensitive to water pollution. Beesh Hazari Lake is of great ecological significance and can be regarded as the biological supermarket for its rich biodiversity. In recent year conflicts over natural resource management in Nepal are increasing just like in Beesh Hazari Lake. In the field, by asking people from local and some government sector, it is found that Beesh Hazari Lake is suffering from the conflict between buffer zone management committee and local people and the conflict is due to presence of valuable resources. The conflict over the lake can be solved if the people dependent on resources of the lake are provided with some alternative facilities.

The water quality of Beesh Hazari Lake is decreasing due to pollution because of the unmanaged cleaning and the direct contact with khageri channel over there. To find out the water quality of this lake, altogether 8 physico-chemical parameters were studied. By comparing its result with the National and WHO guideline it was found that most of the parameters were within the limit of the guidelines. DO, BOD and chloride level of the lake water are good for aquatic life but the high concentration of Nitrogen and Phosphorus indicates the hyper eutrophication in the lake.

Climate change perception study: A case study of Pakjarbas VDCs of Ramechap district, eastern Nepal

Suresh Bhandari (Tribhuvan University, Nepal)

Climate change has been seemed tangibly in the world, ending the doubts on the matter. The Intergovernmental Panel on Climate Change (IPCC), a scientific consultative body formed by the World Meteorological Organization (WMO) and United Nations Environmental Programme (UNEP), is now very confident that the Earth has warmed overall since 1750 A.D. due to human activities. According to the latest, Fourth Assessment Report of IPCC, the global mean temperature of the Earth has been rising by 0.76°C over the past 100 years. Even temperature of Nepal is in increasing trend at the rate of 0.06°C/year. Study on climate change is mostly focused on mountain regions. It is probably because there are clear evidences on the matter, may be also because mountain ecosystems and communities are considered to be affected severely. The study was carried out in Pakharbash VDC of Ramechap district and is much known as a drought prone area of Nepal. Focus group discussion and visual observation methods were used to study climatic pattern of Pakharbash. This case study tries to investigate the issue on microclimate level study of climate change perception in Ramechap district. The study concluded that there is changing in climatic pattern as compare to before.

Assessment of carbon stock in Lake Nagadaha and its adjacent agriculture land, Dhapakhel, Lalitpur

Mamta Bhatta (Tribhuvan University, Nepal)

The potential relevance of lakes to the global carbon (C) has received attention recently with the realization that lakes form an important source of the terrestrial carbon cycle. Estimates of global C burial by lakes suggest burial rates ranging from 0.03-0.07 Pg C yr⁻¹. Realizing this, a case study of Nagdhaha Lake was carried out to determine water quality and comparative study of carbon stock in the lake and adjoining agricultural area. Study was carried out in Nagdaha Lake located in Dhapakhel VDC-8, 5km away from Kathmandu. Water quality was determined by following APHA (1998). Soil Organic Carbon (SOC) was determined by Walkey and Black (1934) Titration Method. N-nitrate and P-phosphate was found as 0.256 mg/L and 0.123 mg/L respectively. SOC was found as 71.39 ± 42.58 gkg⁻¹ in Nagdaha Lake and 14.36 ± 8.38 gkg⁻¹ in agricultural land. T-value was found as 9.18 for lake and 7.66 for agricultural land (p-value < 0.0001 by SAS). Lake area was 52 ropani in 1964 and 42 ropani now. This shows that its area is decreasing with the time. Comparatively, lake has stored more carbon than agricultural land. Conversion of lake area into agricultural land could emit large amount of carbon into atmosphere.

Lichen species richness pattern along land use and elevational gradients in Kanchenjunga, Nepal

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and Chitra Bahadur Baniya (Tribhuvan University, Nepal)*

Lichens are one of the least studied plant groups not only in Nepal but also elsewhere. Thus a total of 525 species have been reported till now so far from Nepal. They are highly economical to human as well as other life. Structurally, lichens are sensitive towards any changes in the environment. Many of them already vanished before knowing by us because of present rapid changes in the environmental composition. Thus lichen study is must urgent from anywhere. I selected to study lichen from Kanchenjunga Conservation Area, East Nepal along different land use types and altitudinal gradient. This is unexplored and highly diverse area for lichen. A total of 80 transects on 20 land used gradients and 5 different altitudinal gradients were sampled. All forms of lichens present inside each transect and substrate were recorded. Lichen sample could not be identified in the field. Thus voucher specimen for each lichen sample together with field notes about substratum type, land use type and altitude were recorded. Altogether 578 specimens collected during this study. Spot test, anatomy and morphology study were applying to each sample for identification of genus as well as species level. Final determination has yet to be done. The preliminary result showed that the foliose form is the most dominant form. Among different land use type crop fields was the least preferred land use for most lichens. This study also reveals that lichens are highly correlated to land use types as well as altitudes.

Study of agricultural productivity and food security in response to climate change of Nepal: A case study of Manaslu Conservation Area

Bunu Gauli (Tribhuvan University, Nepal)

Climate change is an inevitable global challenge. It poses severe threat to biodiversity and livelihood of the developing countries with low adapting capacity, of which Nepal is not an exception. Agriculture is the major source of income of farmers' in Nepal, which is highly dependent on climatic factors. The prevailing climate change affects agriculture and livelihoods of agriculture dependent farmers' in Nepal, especially those of mountain region with marginal agricultural system. Only few studies have been done in agriculture and climate change in Nepal and even less at farmer's level. A study was performed at the mountain region of Nepal, at the Sirdibas VDC of Manaslu Conservation Area, Gorkha district. It has revealed the local perceptions, witnesses & experiences on impacts of climate change on agriculture, the status of food security in the VDC and adaptations followed by farmers' as strong evidences to support the scientific knowledge of climate change. Information was collected from both primary & secondary data sources and was scientifically verified by trend analysis of climate data. Climate change is posing severe threat in agriculture of mountain region reducing the crop yield, especially maize and potato. The slight change in the climatic pattern highly fluctuates the productivity. The local innovation to cope with the change is helpful to some extent to conserve the natural resource. This micro level study helps to identify community level vulnerability in agricultural production and food security in response to climate change and helps to address better adaptation policy.

A case study on climate change vulnerability of Lalu VDC of Kalikot district

Rupendra Ghale (Tribhuvan University, Nepal)

Climate change results from internal variations of climatic system as well as from influences of external factors that either natural or anthropogenic. Nepal has experienced an average maximum annual temperature increase of 0.060 °C. This rate of increase is higher in the mountains than in other regions. Despite having only 0.4 percent of the total global population and being responsible for only 0.025 percent of total GHG emissions in the world, Nepal will be affected disproportionately, especially from increasing atmospheric temperature. The main purpose of this survey is to study vulnerability scenario of Karnali community. The study was carried out in Lalu VDC of Kalikot district in Karnali zone, which is located at 1,000 m to 3,000 m above sea level. This VDC is extended about 2511.86 ha land area with rocky structure. Primary data and secondary data were collected. Primary data include observation and measurement in the field, questionnaire survey, and key informant interview. A questionnaire including 27 questions was prepared for a VDC. Three questionnaires were filled up by three households of each ward. An interview was taken with social mobilize representative, former VDC chairman and secretary of that VDC. Gateway system analysis, analysis of climate change sensitivity and analysis of climate change exposure were conducted to find vulnerability index of each ward. Core system, Secondary system and Tertiary system were analyzed under gateway system. The secondary data was collected from different literatures, VDC records and institutions. It was found that most of wards are more vulnerable to the probable climate change induced disasters. Understanding lever of local community toward climate change is found to be stumpy. Ward no 1, 4 and 6 are more vulnerable wards of Lalu VDC. Lesser vulnerability ward is observed in ward no 3 and 9. That community falls on high vulnerable group, most of them are indigenous and dalit communities who have the lowest adaptive capacity to cope with climate induced disaster as well as no access to the basic goods and services.

Tourism and development in Khadbari area

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Tourism is the compound of four components: attraction, accessibility, accommodation and amenities. It is the world's largest and dynamic industry both in terms of scale and change. Diversified landscape with remarkable scenic beauty, biodiversity, habitat and socio-cultural life world of the people have created tourismagnetic atmosphere in Khandbari area. The opening of different hill and mountain areas of the country after the revolution of 1950, trekking has been increasing demand of tourists who have arrived in Nepal. Because of concentration of several Himalayan peaks, higher than 8,000m with uniquely distinct geography and harmoniously developed socio-cultural life world, the eastern region of Nepal has been one of the very demanding areas to the international tourists not only for mountaineering but also for trekking purposes. In the eastern region, the trekking route that heads to Makalu base camp is also increasing popularity because of the road accessibility up to Num and uncertain air flight from Kathmandu to Tumlingtar. This paper attempts to appraise the natural socio-cultural resources of tourism with the preparation of GIS-based distributional map of the resources and facilities.

Biophysical and socio-economic impacts of downstream area of Kulekhani dam for inter-basin transfer of water from Kulekhani to Rapti river

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This paper tries to assess the changes in river morphology and socio-economic conditions in dewatered downstream area from Kulekhani dam for inter basin transfer of water to Rapti river since 1982. Increase in channel width, rise in riverbed, decrease in the availability of aquatic life including fish are some of the biophysical impacts in the area. Similarly, the change in cropping pattern due to decline in water availability for irrigation particularly during winter season, increasing problems for grinding crops due to non-functioning of water mills are some of the socio-economic consequences.

Change in surface area of non-debris covered glaciers in Hinku and Hongu valleys in the eastern Nepal Himalaya between 1964 and 2008

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Recent studies have indicated that non-debris covered glaciers (clean-type glaciers) in the Himalaya are shrinking more rapidly than such glaciers in other regions of the world, in regard to their mass balance amplitude. An understanding of glacial shrinkage is indispensable to the estimation of the glacier mass balance for water resource management elsewhere. Multi-date glacier surface mappings with high-resolution satellite data over a longer span of time gap can produce reliable information on glacial recession (e.g., quantity and trend). Nevertheless, a little is known in this regard in the Nepal Himalaya. This paper documents change in surface area of non-debris covered glaciers in Hinku and Hongu valleys in the eastern Nepal Himalaya over 44 years. Non-debris covered glaciers were mapped using orthorectified Corona KH-4A stereo-images for 1964 and using orthorectified ALOS ANVIR-2 imagery for 2008 with spatial resolution of 2.70 – 7.60 m and 10 m, respectively. The resulting glacier maps for 1964 and 2008 provide an overview of the glacier surface coverage and their change over the period. Large glacier loss is observed especially at lower elevation. Two glaciers with surface area of 39,270 and 90,540 m² in 1964 were completely lost by 2008. All other glaciers are also retreating and moving to the upper mountain slope. Surface area of glaciers in 1964 and 2008 were 140.6, and 118.1 km², respectively: 22.5 km² glacial area decrease, which amounts to a 16% loss. Thus, regardless of size, all glaciers are retreating; however, small glaciers at low elevation are more severely impacted. Glacier change ranged from ~5% (minimum surface area change/loss) to 100% (complete loss); dominant areal retreat/loss of glaciers was from ~10% to 25%.

Rapid assessment of trail degradation in Shei-Pa National Park, Taiwan

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The rapid trail-condition assessment method was developed for the 10.9 km long trail in Shei-Pa National Park, Taiwan. The results revealed that the total length of 4,808 m of the problems exists: root exposure, multiple trail, gully erosion, wet/muddy tread, trail expansion, sheet erosion, and running water. This study clarified the spatial characteristics of the problems, identifying root exposure to be the greatest problem (in total, root exposure of 2,630 m long occurs; 52.85% or 1,390 m occurred in the 7.8 – 9.6 km section). The trail was classified into four types to identify the priority sections to the future management treatment and monitoring based on the combination of the existing measures and problems. The type 3 sections (2,000 m in total; 18.35% of the entire trail), which are defined to be sections with great problems but no measures, are given the first priority to be treated and monitored. This method allows different researchers and park managers repeatability through time.

Environmental and economic cost of Yarsagumba collection in Majhphal VDC of Dolpa district, Nepal

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and Bharat Babu Shrestha (Tribhuvan University, Nepal)*

This research examines the environmental and economic cost of Yarsagumba collection and its effects on the decline of Yarsagumba, based on the case of Majhphal VDC of Dolpa district in Nepal. Research on the environmental and economic cost of Yarsagumba collection, which causes the decline in the environment and production of Yarsagumba, has not been done. This research aims to fulfill this gap. This study is based on qualitative and quantitative methods, which include questionnaires, collection of waste, and measurement of wood used by the collectors for various purposes. On average, 15 kg of wood as fuel is used by each house or hut per day, whereas 1.5 kg of waste was collected from each house or hut per week. An increasing number of collectors and their daily life-style in the study area has resulted in the pollution of water sources. Moreover, collection of firewood (almost 6,000 kg/day) has lowered the tree line by 200 m in the last five to ten years. The trend of the total number of collectors is increasing, whereas the quantity of Yarsagumba collection per person per day is decreasing. This study finds that unmanaged and unsustainable harvesting and various environmental pollutants emitted by the collectors cause the decrease in the rate of Yarsagumba production. Given the increasing number of collectors and the decline in production rates of Yarsagumba, the economic benefits to individual collectors is declining.

Response of *Pinus wallichiana* to climate change: A case study from Manaslu Conservation Area, western Nepal

Sangita Pant (Tribhuvan University, Nepal)

This study mainly focuses ecology and dendroclimatology response of *Pinus wallichiana* to Climate Change. It was studied in two community-managed forest of Prok VDC under MCA, western Nepal. Thangming and Chhak forest of Prok VDC was selected as the Northern and Southern Aspect forest respectively. Vegetation sampling was done by quadrat method, and the sample quadrates were located by systematic random sampling method. Four vertical transects were laid along the elevation gradient running parallel to each other with 200m difference (2,100 – 2,700 m). Twenty-seven quadrat (20 m × 20 m) were laid between 2,100 and 2,700 masl on both north- and south-facing slopes (18 on north and 9 on south facing slopes). DBH, basal DBH, height of each *Pinus wallichiana* were recorded. Tree core from two species of each quadrat were taken from DBH of each tree species by using Japanese Haglof increment borer. Habit, ground cover, canopy cover, moisture condition, stoniness, bare soil exposure, light cover and sign of disturbance in each quadrat were determined by visual estimation. Slope, altitude, latitude and longitude were also recorded. Both aspect forests were *Pinus wallichiana* dominated and *Cedrus deodara*, *Rhododendron arboreum*, *Castanopsis indica* were associated species. The north-facing slopes in the study area have denser forests than the south-facing slopes (average density 1743.75/hectar in Northern and 937.5/hectar in Southern). Tree density of *pinus wallichiana* decreases with increase in altitude (2,100 – 2,700 m) in southern aspect. While this shows fluctuation in northern aspect, it increases in 2,300 m, decreases in 2,500 m and again increases in 2,700 m. This trend is the indication of maximum disturbance in easily assessable areas. Due to the trampling, grazing, fire the regeneration of the seedling is found in least number. Tree ring analysis shows the sampled oldest tree as 106 years. The ring pattern shows the fluctuation in the ring width. This indicates that the existing environmental condition was not favorable for the growth and development of the tree species.

Seed germination behaviour of *Gaultheria fragrantissima* and *Gaultheria nummularioides*

Anju Poudel (Tribhuvan University, Nepal)

The effect of several environmental factors as well as different pretreatments on seed germination of a medicinal shrub *Gaultheria fragrantissima* and a small prostrate shrub *Gaultheria nummularioides* were investigated. The seeds of *Gaultheria fragrantissima* were collected from three different altitudes whereas that of *Gaultheria nummularioides* from two different altitudes for the investigation. Pretreatments of 10 ppm GA₃ and 10% HNO₃ for 2 minutes exhibited maximum germination in *Gaultheria nummularioides* whereas scarification treatment by 10% H₂SO₄ for 6 minutes showed maximum germination in *Gaultheria fragrantissima*. Germination was higher in red light and white than blue and far red light in both the species. In addition, germination of both the species was sensitive towards the salt stress and was fully inhibited at 6,500 ppm NaCl.

Trekking tourism and development: A study along Manebhanjang to Namche Bazaar trekking route

*Subash Rai (Tribhuvan University, Nepal)
and Padma C. Poudel (Tribhuvan University, Nepal)*

Trekking means a journey to be undertaken on foot for sightseeing in areas where normally modern transportation system is not available. Because of increasing modernization and urban complexity tourist are increasingly diverted to the trekking areas of the mountains. The study area Manebhanjang to Namche Bazar Trekking Route passes through the three Himalayan districts (Solukhumbu, Bhojpur and Sankhawasabha) of the Eastern Development of Nepal. The unique mix and diversified natural and socio-cultural tourist resource in mountain environment of Himalayan region have been increasing demand for international tourists in Nepal. Arrivals of trekkers to the mountain trekking destination are highly reflexive to the facilities. The Khumbu region receives thousands of trekkers annually. The trekking route from Manebhanjang to Namche Bazar has not been able to receive tourists as its prospects. However, changes in socio-economic aspects of people living along the trekking route have been remarkable scenes in recent time. This paper attempts to discuss 4 'A' of the areas based on field works supported with GIS based map focused on the distribution of attraction and facilities along the trekking route.

Climate change vulnerability assessment: A case study of Raha VDC, Dolpa

Deepak Rajbanshi (Tribhuvan University, Nepal)

Main objective of the study was to identify the level of vulnerability of a mountain community of Karnali zone of Nepal to the possible impacts of climate change in quantitative way using the gateway system analysis approach. The adaptive capacity, exposure and sensitivity of individual ward of Raha VDC, Dolpa were calculated based on the different indicators of human, natural, social, financial and physical capitals. All wards of the VDC were selected for the study and data were collected through group discussion to each ward separately. Different PRA tools (participatory rural appraisal) were used to gather the information from a community by. Hazard mapping, historical timeline, hazard prioritization, crop calendar, seasonal calendar, identification of livelihoods sources, impacts analysis of climate induced disaster on livelihoods sources, impacts identification table, were the tools used at community level to collect information on assessing climate change vulnerability and local adaptation practice and future adaptation strategies.

This study computes IPCC vulnerability index to look over the vulnerability of a community. Study depicted IPCC-VI of wards of Raha VDC; Dolpa 2.24 to 2.75, which indicates the vulnerability of a community is high to the adverse impacts of climate change. Results suggest that the Raha VDC is highly vulnerable to climate-induced disasters. Drought, landslides, floods are the main climate induced hazards of the study area. These hazards severely affected on agriculture, forest, infrastructure and hence the livelihoods of the local people. Regarding the experience of local inhabitants, almost all people (respondents) have experienced increasing temperature and uneven rainfall pattern. Local adaptive capacity was found to be poor.

Allelopathic effects of aqueous extract of leaves of *Mikania micrantha* on seed germination and seedling growth of some herbaceous plants

Anita Sahu (Tribhuvan University, Nepal)
and Anjana Devkota (Tribhuvan University, Nepal)

Mikania micrantha is one of the worst and most aggressive, invasive weeds in Nepal. The successful invasion of *M. micrantha*, is not only due to its high reproduction and wide eco-physiological tolerance, but also its allelopathic effects on neighboring native plants. The aqueous extract of *Mikania micrantha* was obtained by soaking 26 gm of dried ground leaves in 380 ml of distilled water, for 24 hours. The allelopathic effect of *M. micrantha* has been tested on *Raphanus sativum* and *Oryza sativa* in different concentrations (2, 4, 6, 8, and 10%) referring to the control. Five Petri dishes were used for each concentration with 10 seeds in each Petri-dish. The germination behaviour or root and shoot length were obtained after 7 days showing that *Mikania micrantha* inhibits the growth of seeds of the tested plants. The root growth was inhibited more than the shoot growth in both *Raphanus sativum* as well as *Oryza sativa* with the increase in the concentration. Least or no germination was observed in 10% concentration. The highest percent of root and shoot growth in *Raphanus sativum* with extract was found in 2% (4.52% and 7.03%) respectively while 0.004% shoot growth but no root growth in 10%. Similarly in the case of *Oryza sativa* 2.74% root and 2.878% shoot length was found in 2% while 0.008% root length and 0.118% shoot length in 10% concentration. This shows that *Mikania micratha* has strong allelopathic effect more on the root than the shoot of the plants.

Application of a glacier flow model in the reconstruction of past glacier ELA – Combination of geomorphological interpretation and glacier dynamics –

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The equilibrium line altitude (ELA) varies in response to climate change. Consequently, ELA of past glaciers (paleo-ELA) are important indexes for understanding the paleoenvironment. Most studies have reconstructed paleo-ELA using the accumulation area ratio (AAR) method in which flat glacial outlines based on glacial landform are considered. However, actual glaciers have a three-dimensional form, and thus, the reconstructed paleo-ELA obtained using the AAR method may have several errors because the AAR value is determined by the flat glacier form. Moreover, the reconstructed paleo-ELA depends on the selected AAR value, which varies with glacier forms and climate conditions. In this study, we tried to develop a new method to reconstruct paleo-ELA without the concept of AAR. The new method, called glacier snapshot model (GS model), involves a combination of geomorphological interpretation and a glacier flow model that is based on the concept of the relationship between surface mass balance and flux divergence at each grid.

To validate the GS model, we carried out ELA reconstruction tests with different calculation conditions. The results obtained for the current glaciers showed that the values of the reconstructed ELAs agree with those of the observed ELA, even when flow parameters were changed (i.e., different ice deformation ratios, presence or absence of basal sliding, etc.). These results indicate that the GS model can reconstruct the ELA well and that thus the reconstructed ELA does not depend on the selection of flow parameter values. The results obtained for past glaciers showed that calculated paleo-ELA depend on the surface topography of the past glacier; that is, the position of the reconstructed paleo-ELA varied with the method of reconstructing surface topography. Moreover, some of the calculation results for glaciers with large variations in ice thickness showed multiple paleo-ELA. These results indicate that method to reconstruct the surface topography of the past glacier is the key to paleo-ELA reconstruction.

The results of our study also implied that the reconstructed glacier surface topography based on geomorphological interpretation should be improved by considering its flux distribution using the GS model. Furthermore, the GS model has the potential to be a good tool for reconstructing the mass balance of the past glacier if we can determine its flow features.

Changing transhumance in Sary Tash, southern Kyrgyzstan

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and Shigeru Shirasaka (Teikyo University, Japan)

This study examined characteristics of grazing of sheep and goats in Sary Tash village, southern Kyrgyzstan. Sary Tash village is located near the national border to Tajikistan to the south and China to the east. The village has played an important role in communication and transportation since the Soviet time. Field survey was conducted in the summer of 2011 and 2012.

Before 1991, no private grazing had been practiced in Sary Tash: all grazing had been controlled by the government in the form of *sovkhoz* or state-owned farms. In summer time, approximately 1 million livestock had been taken from Fergana and Andijan, Uzbekistan, to the *jailoo* (summer pastures) of Sary Tash village for grazing: about 80% of them were sheep.

After the 1991 independence, local people began to graze privately owned livestock. Current grazing of sheep and goats in Sary Tash is characterized by (1) co-existence of daily grazing and transhumance; and (2) dominance of transhumance by outsiders. Sary Tash has about 5,550 registered heads of sheep and goats as of 2011. Among them, 1,981 heads are grazed in the form of *kezuu* (daily group grazing), and the rest is grazed in the form of transhumance.

Daily grazing in and around the village is conducted in the system called *kezuu*. *Kezuu* is a group of families who own small number of sheep and goats. We placed micro-GPS to 20 sheep and goats and 10 shepherds in 2012 to understand the daily grazing areas in summer. Four *kezuu* are operating in Sary Tash. Each *kezuu* owns its name: Kamchatka composed of 15 families grazed 347 heads of sheep and goats in Kok Bulak *jailoo*, Kara-Döbö composed of 21 families grazed 609 heads in Kara- Döbö *jailoo*, Odongku Maala composed of 12 families grazed 250 heads in Atjol *jailoo*, and Erkeshtam composed of 14 families grazed 712 heads in Tumanchy *jailoo* as of August 2012. Sheep and goats of each *kezuu* gather in a certain meeting place in the morning, and move to the designated grazing slopes (*jailoo*) during daytime. They come back to the village in the evening, and stay overnight in the shelter of individual families.

There are currently 14 *jailoo* in Sary Tash. Interestingly, more number of sheep and goats are transhumanced by outsiders. The families using Demei *jailoo* have their houses in Korul, Uch-Töbö, Kara-Suu, Söpu Korgon, and Terek villages, all located to the north of Sary Tash, and only 3 Sary Tash families use the *jailoo*. Most families visit Kara-Kindik *jailoo* from Kara-Suu and Söpu Korgon, as well as the villages in Jagy Aryk A.O. (district), near Osh: no Sary Tash families use the *jailoo*.

Impacts of inter-basin transfer of water: A case study of Rapti Basin, central Nepal

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Inter-basin transfer of river for different purposes such as drinking water, irrigation, hydro-electricity and flood controls has been increasing in recent years. Such inter-basin transfer of water has several consequences in river channel morphology and water availability and consequently on socio-economic condition. This study attempts to assess the changes in river morphology and socio economic condition along Rapti river due to inter basin transfer of water from Kulekhani since 1982. There has been increase in river discharge and channel width. Channel bed has been raised up to 2.5 m. However, the causes for such increase in channel bed differ with channel section. In upper reaches it is due to diversion of river water for hydroelectricity production and in lower reaches it is due to increased sediment load and consequent increase in riverbed. As a result there is increase in stream power due to the increased volume of water transfer from Kulekhani river. Closing of water mills due to transfer of water for hydropower development in the upper reaches and problem in crossing river even in winter season together with increase in magnitude of flood hazards are some of the socio-economic impacts in downstream area.

Elevational species richness pattern in Manaslu Conservation Area, Nepal

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and Chitra Bahadur Baniya (Tribhuvan University, Nepal)*

The Himalayas is special by its higher habitat diversity at a short spatial scale. Higher number of species might have been expected if more diverse habitats are congenial to lives at any spatial scale. Thus species richness has a pattern, which indicates the health and heterogeneity of each habitat. Manaslu is one of the least explored conservation areas situated at Central-North border between Nepal and Tibet of China. Different forest types expanding between 2,200 m above sea level (m asl) to 4,000 masl situated in Manaslu Conservation Area (MCA) have been sampled by using standard quadrat method of $50 \times 20 \text{ m}^2$ size. Each quadrat has been sampled after subdividing it into 10 equal subplots of $10 \times 10 \text{ m}^2$ area each. There was 200 m altitudinal difference vertically between two quadrats each. Another quadrat at same altitudinal level was laid into another available forest type. Horizontal distance was varied between few hundred meters to almost kilometer. A total of 21 quadrat (2.1 ha) and 210 subplots were sampled during this study. All vascular (angiosperm, pteridophytes and gymnosperm) and nonvascular plants (lichens, bryophytes) enrooted each subplot have been recorded. Vaucher specimens were prepared for each difficult, unknown and unidentified plant species for later identification. Canopy cover of tree, shrub and herb layers from each quadrat has been estimated. Composite soil sample from four corners of each quadrat below 10 cm depth was taken for later estimation of N, P, K and pH. So far until now a total of 698 plant species have been entered and some of them yet to confirmed. There found a significant relationship between altitude and species richness and varies with plant group and their functional type.

Author Index

A		K		Ramachandran, H.		4
Aase, T.H.	9	Kargel, J.	41	Raya, B.		40
Abe, Y.	77	Karki, K.	67	Regmi, D.		41
Anarbaev, M.	21	Khadka, K.J.	22	Rijal, K.		22
Aryal, P.	61	Khan, S.	43	Rijal, S.P.		42
Asahi, K.	10	Khanal, N.R.	23, 68, 79	S		
B		Kimoto, K.	48, 49	Sahu, A.		76
Baniya, C.B.	64, 80	Koirala, H.L.	24, 68, 79	Said, A.		43
Bhandari, B.P.	79	Koirala, M.	26	Sapkota, R.P.		22
Bhandari, S.	62	Kumar, A.	48	Savean, M.		15
Bhandari, V.	36	Kumria, P.	49	Sawagaki, T.		25, 77
Bhatta, M.	63	Kutu, B.	68	Shah, S. M.		54
Byers, A.C.	11, 30	Kutu, J.	68	Sharma, L.N.		44
C		L		Sharma, P.		5
Caravello, G.U.	18	Lakhey, P.	36	Sharma, P.		45, 68, 79
Chapagain, P.S.	12	Lamsal, D.	25, 69	Shirasaka, S.		27, 46, 78
Chevallier, P.	15	Lee, Y.	70	Shrestha, A.B.		54
Chidi, C.L.	13	Limbu, D.	26	Shrestha, B.B.		71
Chongbang, T.B.	64	Liu, J.	27	Shrestha, S.		56
D		Liu, L.	57	Shrestha, U.S.		47
Dahal, K.	14	M		Singh, R.B.		48, 49
Delclaux, F.	15	Maharjan, G.R.	28	Somos-Valenzuela, M.		30
Devkota, A.	76	Mandal, U.K.	29	Song, F.		78
Ding, M.	57	McKinney, D.	30	T		
Doerre, A.	16	Miyahara, I.	27	Tamang, B.K.		79
Du, G.	46	Mizushima, K.	31	Tamang, P.		50
G		N		Tatsumi, K.		50
Gao, J.	57	Nair, K.S.	32	Terakawa, K.		51
Gauli, B.	65	Nepal, P.	33	Thakali, A.		80
Ghale, R.	66	Nepali, K.B.	71	Thapa, B.		52
Ghimire, M.	17	Neppel, L.	15	Thapa, R.B.		53
Ghimire, N.P.	18	Nischalke, S.	34	W		
Gonga-Saholiariliva, N.	15	P		Wahid, S.M.		54
Gurung, S.B.	19, 68, 79	Pant, S.	72	Wang, Z.		57
H		Pathak, R.S.	35	Watanabe, K.		55
Heinimann, A.	3	Pokhrel, C.P.	36, 56	Watanabe, T.		21, 25, 27, 69, 70, 78
Holmgren, E. V.	20	Postigo, J.C.	37	Y		
I		Poudel, A.	73	Yadav, R.K.P.		36, 56
Izumiyama, S.	21	Poudel, P.C.	38, 67, 74	Yamaguchi, S.		77
J		Pradhan, P.K.	45	Yang, X.		57
Jha, P. K.	18, 56	R		Z		
		Rai, D.B.	39	Zhang, Y.		57
		Rai, S.	74	Zhanhuan, S.		26
		Rajbanshi, D.	75			

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