LUCC Research Agenda and HKH Region[a]

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Introduction

LUCC research is oriented towards the process causality analysis, where links and interactions between human behavior and biophysical attributes of land resources are focussed. The purpose is to identify the nature and functioning of human driving forces rooted in social, economic and political structures, which influence biophysical processes and in turn are affected by the latter. By way of responding to the changed situation, the human behaviour initiates the next round of affecting and being affected by changed biophysical conditions. The basic premise of our discussion is that the pace, pattern and process of this dynamics of change is primarily conditioned by the biophysical features of the focussed area as an integrated unit and its links with the external world. This we explain with the help of situation in Hindu Kush Himalayas. The discussion is based on the inferences from different studies and observations, which in turn are integrated into a framework called mountain perspective frameworks (Jodha et.al. 1992). We also believe that understanding of a process can help in designing the methods for assembling and integrating more quantitative data being sought by LUCC.

Two-way Adaptation Process

One of the simplest ways to describe and understand the changing nature-society interactions or what LUCC calls human processes influencing and being influenced by biophysical processes (finally reflected in landuse-land cover changes), is to look at the whole dynamics of change as a two-way adaptation process.

Accordingly (i) guided by a range of mechanism to satisfy survival or accumulation instincts, society adapts its needs to the imperatives (capacities) of biophysical resource and thus live within the ecological limits imposed by the latter, or (ii) adapt (or amend-or over extract) the biophysical resources to meet its rising needs/greed. Under the first type of adaptation process the biophysical limits, have the primacy, while the second part of the process is dominated by social-economic forces. The consequences of the two are quite different for land use and land cover changes.

Enquiring into these processes has to start with recognition and fuller understanding of biophysical circumstances of a given ecosystem, the next step is the juxtaposition of the imperatives of these biophysical features as objective circumstances with the attributes of human interventions directed to use or live with the biophysical resources. This can provide broad understanding of nature-society interaction processes and their consequences reflected in land use/cover changes. We illustrate this approach by focussing on situation in the mountain areas.

Mountain Specificities

Biophysical circumstances of mountain areas could be described as mountain specificities i.e., the special features, which due to their incredibly higher degree and impacts help separate mountain and hills from plains. They are inaccessibility, (or limited accessibility), fragility, marginality, diversity and niche and people's adaptation mechanisms to live with these

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circumstances. Some ecosystems such as deserts, coastal wet lands, small island habitations may also share some of these features but they differ in terms of imperatives and human response to them. Table 1 describes the mountain specificities their shared causes and imperatives in terms of objective circumstances conditioning human interventions (Jodha 1995, 1997, 1998).

However, we may briefly summarise the conditions, their imperatives and human responses and finally the changes following the increased external links or reduced isolation of mountain areas.

Inaccessibility

Imperatives: Semi-closed system, limited exchange, little external dependability, local resource.
Local: Focus of production, consumption; collective stake in resource health; demand rationing, diversified resource regeneration/conservation-production activities, low and regulated resource use etc.

Fragility

Imperatives: Vulnerability to intensification-related degradation, high risk, limited production options/opportunities.
Response: Land extensive, diversified activities covering both production and consumption; annual-perennial links, CPRs-PPR, complementarities, zero-tillage practices; harnessing natural opportunities mainly, demand regulation by various means.

Marginality

Imperatives: Associated with fragility and inaccessibility; biophysical limits and constraint to de-marginalisation ie. due to inaccessibility, under investment-led under developed and unusable potential (e.g., irrigation), high risk and limited options.
Social marginality: Product of physical marginality and inaccessibility; lack of external influence, support and replication of outside successes.
Response: Low productivity, diversified, subsistence oriented activities.

Diversity & niche:

Higher than elsewhere due to elevation, terrain conditions, topography etc. Diversity apply to all other features e.g., all areas not equally fragile, inaccessible or marginal.

Imperative: Source of specific niche (high value options or activities with comparative advantage) though restricted by inaccessibility and marginality.

Response:

People harness the opportunities by location specific diversification and sustainable production systems.

Human Adaptations Strategies:

Human adaptation mechanism are not only generic but are quite unique because they represent response to specific conditions of mountains. Folk agronomy, folk engineering etc. are the known categories of responses. The adaptations relate to resource management, resource use, production practices etc., which could be put under two way adaptation process i.e. adapting needs to resource availability/ capacity/features and adapting/amending resources to fit

to the changing needs. Besides production and resource use practices, adaptation include formal/informal institutional arrangements.

Their implication from the view point of land cover/land use can be summed up in terms of environment/ecology friendly social system – ecosystem links. Maintaining land cover through well adapted resource harnessing methods, conservation and protection measures etc. are ensured because of the collective stake in the health of resources, access and proximity based knowledge of resources, and regulation of pressure on resources by different means (institutional regulation, migration diversified and rotational production systems) (Jodha 1998).

Gradual Change: The Major Turning Points and New Driving Forces

As mentioned earlier, the above situation was very closely linked to the relatively isolated, low-population and subsistence oriented societies, who had limited demands (mainly to meet substance needs rather than for external trade), and limited capacities/means to extract resources. However, the situation changed with decline of the above features. The changes took place mainly during the current century-when mountain became major source of timber, hydropower, minerals and of late entertainment (eg., through tourism). The mountain areas got physically, administratively as well as economically linked with the production and marketing systems in the plains. The process got accentuated during the last 5-6 decades, when development and welfare became the formal state responsibility. With this change the mountains' external links and their impacts became more effective.

Following the improved infrastructure, mountain produce and resource flows to plains led to higher pressure of demand on mountain resource. Exposure to external world and even rudimentary medical facilities led to health revolution leading to rapid growth of population. State run relief and welfare activities killed the local (demand) rationing measures. State's own focus on enhancing supplies rather than management of demand led to the programmes directed to increased resource extraction for local food supplies as well as exportable niche products (timber, herbs, fruits, water, hydropower) for the plains.

This account reveals a generalised picture of key driving forces namely, state intervention, market forces and population (both in quantitative and in qualitative terms (see Table 2). Which gave primacy of human factor in place of ecology in the use and management of mountain land resources. The consequences are reflected in terms of changed land uses, decline in land cover and biophysical degradation of resources, inducing people to initiate next round of resource extraction. The both needs and capacities to extract resources leading to further resource degradation are much higher now than before Table 3, summarises the major changes and their consequences by comparing the traditional and present day situation of nature-society interactions in mountain areas.

Relevance for LUCC

The above description of the situation in mountain areas as indicated under Table 1 to 3 is supported by several micro-level studies and qualitative observations. They help describe the process of nature-society interactions in diverse mountain situations. In fact in some cases, they have helped in designing interventions to arrest or reverse these trends of resource degradation and in the process help alter landuse and land cover. But all these may appear to be marginal concerns to LUCC research at this stage, because it seem to focus on the need quantified information on land use/cover at more aggregate levels.

Table 1: Mountain Resource Characteristics, their Imperatives, Objective Circumstances and Driving Forces Behind Human Response (under low population, semi-closed situation)

Resource Feature and Objective Circumstances	Imperatives-driving forces	Responses, resource use Practices
Inaccessibility (caused by physical, terrain factors); imposing his degree of isolation, poor mobility, and limited external linkages, semi-closed	Survival strategies with direct and total dependence on local resources and high stake in their protection, regulated use and regeneration; local control of local resources, culture of self-management, evolution of systems from below based on closer proximity and knowledge of resource base	Ecology-driven resource management, using conservation and protection technologies, and institutional arrangements, evolved with closer feel of the resources and enforced through local autonomy and control of local resources; rationing of demand pressure on resources, and restricting extraction levels in keeping with subsistence needs
Fragility (caused by bio-physical, topographic, edaphic characteristics); vulnerable to irreversible degradation with small disturbance, restricting usage options, intensity levels	High risk of rapid resource depletion due to intensification inducing measures to balance extraction and conservation of production base; narrow range of production options (only land extensive uses)	Technologies and usage practices combining intensive and extensive uses of natural resources; provision of institutional arrangements (e.g., common-property resources) against overextraction of fragile/marginal resources, spatially and temporally differentiated resource use systems rationing; knowledge and capacity-based resource upgrading (e.g. by terracing, agroforestry, etc.)
Diversity (created by huge variations in bio-physical features and elevations at shorter distances); creating opportunities for diversified interlinked production/consumption activities	Local knowledge, skill and capacity-based diversification of resource use as a key element of survival strategies; sustainable productivity; health of natural resource base	Spatially and temporarily diversified and interlinked activities with varying levels of intensification; diversification of demands to match the diversity of products and supplies, especially in a semi-closed situation
Niche (created by unique agro-climatic, bio-physical situations), imparts compara-tive advantage to mountain areas in some activities and products (forests, horticulture, herbs, hydropower, etc).	Potential for trade-based external linkages restricted by levels of knowledge, capacities to harness, etc.	A limited range of diversified activities directed to petty trading to supplement subsistence activities: local niche, demand and extraction facilities/capacities as key factors governing the exploitation of niche
Implication	Adherence to two-way adaptation process	Ecology-driven systems of resource use conducive to sustainability (under low pressure of population and external demand)

Note:

- The table is based on a synthesis of accounts of concrete situations described in over 45 studies in mountain areas covering Nepal (18), China (15), India (7), Pakistan (3), Bhutan, Bangladesh and Myanmar (1 each) as synthesized by Jodha and Shrestha (1994).

Table 2 Interactions and implications of rapidly changing socio-economic circumstances in mountain areas

Socio-economic changes interacting with biophysical factors, i.e. increased human interventions in mountain areas	*Limited accessibility Semi-closedness: limited dependability of external support: local resource focus of activities*	*Fragility and marginality Incompatibility with high intensity uses, focus on diversified, low cost, low risk activities*	*Diversity High potential for diversified, interlinked activities: location specificity*	*'Niche' Products: activities with comparative advantage, including human adaptation measures*
Population growth changed expectation levels/altitudes; per capita increased activities guided by profit motive or forced by poverty	Excess pressure on local resources with limited outlets; resource-use intensification, over-extraction, degradation (croplands, pasture, forest)	Indiscriminate resource-use intensification; disrehgard of resource-extensive, diversified cropping practices; dependence on external subsidy; discard of usage regulations; group action	Pressure of food needs; reduced diversification of cropping; reduced resource regeneration; diversity of food systems replaced by limited grain types	Pressure of food needs; disregard or misuse of natural potential for diversified and better suited activities and their complementarities
Market forces trade links; pressure of external demand; changes in people's attitudes, expectation	Integration with mainstream market situation despite low physical accessibility; additional pressure on resources; market driven corridors of changes; intra-regional disparities	Distant demand induced over use of resources; backlash of selective commercialisation of agriculture; decline of environment-sensitive agronomic practices; poverty of ethnic minorities and women with decline of common lands	Market-driven, narrow crop specialisation, reduced diversification; marginalisation of traditional knowledge, and practices supporting interlinked diverisfied land uses, favouring accessible areas	External demand-induced over-exploitation of major niche, e.g. hydropower, horticulture, marginalisation of petty 'niche' local concerns, traditional small scale activities, biodiveristy
Public Interventions a) Imposition of generalised development intervdentions, including investment priorities, technology choices, macro-economic policies-price, tax, trade, resource extraction	Reduced isolation, increased integration and level of activities, leading to unmanaged increase in pressure on land resources-crop land, forest, pasture	Promotion of increased use intensity; degradation of fargile/marginal resources; public relief, subsidy encouraging pressure on land without upgrading resource base	Subsidies, incentives for intensification, reduced diversification of crops, access-determined narrow specialisation (e.g. horticulture) with backlash on food supplies, food systems; widening gaps between areas with different accessibility	Over-exploitation of areas with high potential (e.g. horticulture, high value crops); disregard of side effects of local concerns; emergence of a dual sector economy (accessible-inaccessible areas)
b) Infrastructure for accessibility, integration, market-driven harnessing of 'niche'	Application for improved mobility, integration; priority to areas with high potential; regional inequities, emergence of dual systems	Priority to production over conservation; indifference to resource limitations and local community concerns; increased intensity of fragile resource use	High cost, external input-based, narrow specialisation; focus on limited crops and attributes; disregard of traditional knowhow, and institutional arrangements for diversification of land use, cropping	Market-driven over-extraction of 'niche', disregard of side effects on environment and people's survival strategies; traditional know-how; limited local participation/benefits
c) Technology and institutional support: narrow focus, directed to short-term needs, sectoral orientatio, external origin/orientation, non-participatory	Inaccessibility-induced invisibility of problems/opportunities making development measures as inappropriate impositions	Focus on current production, high use-intensity; disregard of resource limitations and logn-term consequences; sustained through subsidies, e.g. cropping on steep slopes; disregard of traditional know-how	Narrow specialisation, through incentives and support systems, technologies/R & D disregarding organic linkages and performance of total cropping systems; marginalisation of traditional farming systems; increased dependency on subsidisation	Focus on revenue generation: meeting external demand; extraction levels disregarding the side effects; locally useful area-specific potential given low priorities

Source: adapted from Jodha and Shrestha (1994), based on synthesis of evidence and inferences from more than 30 studies and documents (some of them cited in Table 14.1) covering mountain areas in Asia, Latin America, and Africa

Table 3 : **Factors and Processes Associated with the Nature-Society Interactions under Traditional and Present-day Systems of Resource Use in Mountain Areas**

Situation under Traditional Systems	Situation under the Present-day Systems
A. Basic Objective Circumstances	
(i) Greater degree of inaccessibility, isolation and semi-closeness of systems; poor mobility and external linkages, etc. creating total and exclusive dependence on local resource base and high concern for its health and sustainable use	(i) Greater physical, administrative and market integration of traditionally isolated areas/communities with the dominant, mainstream systems, reducing critical dependence of the former on local resources and hence the degree of their stake in the conservation of local resources External linkages-based diversification of sources of sustenance, welfare and development, reducing the extent of critical stake in local resource maintenance
B. Key driving forces/factors generated by (A)	
(i) Social survival/welfare strategies totally focused on local, diverse, fragile resources	
(ii) High collective stake in protection and regeneration of local natural resources	(ii) Role of functional resource knowledge marginalised due to imposition of generalised approaches from above for local resource management; wider gap between resource users and decision makers
(iii) Functional knowledge and closer understanding of limitations and potential of resources due to closer proximity and access to resources, little gap between resource user and resource itself	(iii) Erosion of local resource control, autonomy following the extension of mainstream, legal, administrative, fiscal arrangements to formerly isolated areas
(iv) Autonomy, local control over local resources (due to absence of external impositions)	(iv) Rapid demographic changes
(v) Low population pressure as permitted by bio-physical constraints	
C. Social Responses (concerns and adaptations) dictated or facilitated by (B)	
(i) Adoption and enforcement of production/extraction systems adapted to natural resource features through diversified usage, controlled usage-intensive; regenerating, upgrading, developing the resources, depending on capacities and needs	(i) Greater role of demand-driven measures leading to resource use intensification, overexploitation with greater extractive capacities and technologies
(ii) Controlling or rationing the demand pressure on resources through social and institutional sanctions, collective sharing, recycling, out-migration, etc.	(ii) Increased role of (unregulated) external demands, which are insensitive to local resource limitation
	(iii) Resource upgrading measures more generalised and less location specific
D. Mechanisms and means to execute social responses:	
	(i) Largely externally evolved generalised rules guiding resource use, framed by legal and technical experts with little concern for local resource users' perspectives and limited knowledge of site-specific situations
(i) Collective evolved site-and seasons-specific norms of resource use facilitated by direct access and proximity to resources and little gap between decision makers and resource users	(ii) High science-based modern R & D as a source of technologies, ignoring rationale of traditional practices; ignore local resource perspectives
(ii) Site, season, product and resource component-specific folk-technologies evolved over the generations facilitated by functional knowledge and close proximity to resource base	(iii) Institutional interventions evolved and designed for incomparable situations extended to these areas as a part of agricultural, rural development, etc.
(iii) Formal/informal institutional arrangements guiding broad approach to resource management, access and usage regulation, facilitated by group action or community participation, and autonomy and local control over local resources	Resource usage system driven by uncontrolled pressure of demand: (i) developed by experts without local participation (ii) enforced (rather un-enforced) by formal state machinery
E. Consequence	
Ecology-driven natural resource management systems:	
(i) evolved by the communities having high stake in sustaina-bility of the resource base;	
(ii) facilitated by functional knowledge of resources, close proximity to resources, and community control over the local resources	

Note: The table is based on a synthesis of accounts of concrete situations described in over 45 studies in mountain areas covering Nepal (18), China (15), India (7), Pakistan (3), Bhutan, Bangladesh and Myanmar (1 each) as synthesised by Jodha and Shrestha (1994)

However, as mentioned earlier we feel that an understanding of the process through a conceptual frame work should precede the efforts focussed on detailed pure numbers. In the light of the above, the main contribution of the above discussion would be an advocacy for evolving a framework e.g. Mountain Perspective Frame Work, which could help in understanding the interactions between biophysical processes and socio-economic processes in mountain areas. This can also help in predicting the consequences of globalisation and related changes on the above processes in mountain areas (Jodha 1997). The **mountain perspective**, put in simple terms, means understanding and incorporating the imperatives of mountain specificities (such as inaccessibility, fragility, diversity, etc.) in designing and implementing interventions in mountain areas to facilitate environmentally and socially sustainable use of mountain land resources.

The Required Framework

(i) Once the framework of enquiry is accepted, through LUCC efforts, more quantified information too can be assembled. The ways to aggregate the same can also be developed. The framework has already been used for development plans in many cases in the HKH region such as development strategy under Agenda 21 for Tibet (China), formulation of Agricultural Perspective Plan (APP) for Nepal and Action Plan for Himalayan region by the Indian Planning Commission.

As already mentioned above, the availability of a framework (with possible amendments) offers a first opportunity to shape LUCC research effort in Mountain areas.

(ii) This framework or parts of thereof can be validated using RS data as Mountain Farming Systems Division and MENRIS at ICIMOD are currently doing.

(iii) The framework can help identify past and present constraints obstructing building of data base for mountain areas, as discussed below.

Mountain Perspective and Data Question

Through indirectly alluded to, the implications of mountain specificities in the context of data and information as required by LUCC can be briefly commented on.

Despite ethnographic studies, micro-level economic investigations travelers' observation, and formal records by state agencies, mountain in the present day formal statistical sense are least researched in terms of building data base and records. There are several reasons for the same:

a) Invisibility of mountains for the mainstream statistical systems caused by physical inaccessibility and communities' lack of external exposure or marginal status, obstructed the systematic data collection in mountain areas on larger scale except for prospecting niche-products for use by the mainstream economy.

b) Diversity, frangility and marginality also restricted the applicability of standardised norms/yard sticks/methods for collection and assessment of information in mountain areas.

c) Hence development and welfare interventions, planning for harnessing niche or controlling resource degradation have taken place in vacuums as far as the precise data are concerned. Most of the initiatives have taken place on the basis of broad understanding of qualitative description/ understanding of the process rather than

quantified facts. However, of late some needs and compulsions are beginning to emerge which can act as catalytic forces to initiate some action on data front in mountain areas.

d) Furthermore, due to diversity of land scapes and its usage, several data sets through correct in their respective location contexts, at times proved contradictory when aggregated.

Opportunities for LUCC Data

To reiterate, despite crucial dependence of plains and their vast population on relatively low populated mountain areas, mountains except for extraction of major niche resources have remained unknown in terms of basic information on resource availability, usage, potentialities, constraints. The circumstances such as inaccessibility causing semi-closeness and marginality (specially voiceless-ness) of population caused the invisibility of mountains for the information and statistical systems. However, of late following the increased integration of mountain economies in the mainstream economies and increased concern and awareness of mountains, several (need based and concern driven) opportunities have emerged, which may help in gathering more information on mountains. Similarly more means and mechanism to accomplish this task have also become available now. They range from soft options such as PRA (participatory rural appraisal/participatory environmental appraisal) to high tech options such as GIS and RS (see Table 4).

Research Strategies

To harness the above opportunities for data collection the following steps could be considered.

(i) Build upon and strengthen the emerging trends i.e., opportunities and compulsions to gather and integrate information on mountains resources and their usage.
(ii) Integration and synthesis of scattered data using the mountain perspective framework indicated above.
(iii) Focus on process, which generate understanding of land use/cover changes and their consequences rather than concentration on pure numbers without a framework.
(iv) Focus on simultaneous use of data and understanding of the processes (i.e., involve local stakeholders) to enhance their awareness and ownership.
(v) Focus on diversification and diversities to identify typologies for user data rather than emphasizing aggregate situations.
(vi) Institutionalise the efforts by organising relelvant institutions and their frequent interactions and exchanges on LUCC initiatives.
(vii) Most of these suggestions match well with the ideas presented in the LUCC implementation plan.

Table 4 Data Opportunities in HKH region: Emerging Trends and their Implications

Emerging Trends	Compulsion/facilities/needs for data
Improved accessibility; and recognition of concerns for mountain areas and people	Reduced extent of "inaccessibility and marginality-led invisibility" of mountain areas and people conducive to information gathering
Emerging global awareness and concern for mountains as source of biodiversity, fresh water, nutrient and moisture flows	Required strong data base and emerging support For the same, to plan for conservation, protection and management of mountain ecosystems and their global contributions
Increased focus on development and welfare interventions in mountain areas and recognised unsuitability of externally evolved development measures	Due to various mountain specificities (e.g. diversity, marginality, etc.) high information intensity of designing and implementation of development interventions can serve as a compulsion for building area specific data base
Seriousness of resource degradation in mountain areas and its off site impacts (eg. Floods, silting of down stream dams, etc.)	Integrated upland-low land resource management constrained by lack of usable data on erosion etc. on requisite scale
Emerging comflicts between development and environment in mountain areas	Data needs of evolving environment friendly development options
Emergence of multiple agencies (stake holders) e.g. NGOs, donors, communities and government agencies to address specific problems/issues in mountain area, unusability of routine records	Scattered large volume of purpose-specific data collected by multiple agencies requiring their integration and synthesis to serve as a source of strong data base
New developments on information prospecting and synthesis	New methods and tools ranging from PRA (Participatory Rural Appraisal) for household and community level information gathering to GIS and Remote Sensing to get specific information at landscape/watershed or regional levels; framework based on mountain perspective for purpose specific synthesise of scattered information/data.
Existing data base and its enhancement	ICIMOD's collaborative initiatives with national agencies in HKH producing or accumulating data on diverse aspects; GIS-RS applications for data collection, and Mountain Perspective Framework to synthesise data

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