Sustainable mountain development: The Himalayan tragedy*

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Mountain systems in India, including the Himalayan region are characterized by highly complex socio-ecological systems, with rich cultural diversity linked with equally rich species of biological diversity. With a large number of ethnic societies having their own social, economic and cultural attributes placed in a highly heterogeneous mountain environment, any conservation-linked developmental initiative has to be based upon a value system that they understand, appreciate and therefore can participate. While textbook-based 'formal knowledge' has its value in this effort, the rich traditional ecological knowledge (TEK) derived through an experiential process and available with local communities forms a powerful connecting link between ecological and social systems. Converting TEK, often seen as location-specific into broad generalizations that are applicable across socio-ecological systems was the major step that was undertaken by this author to convert research results into policy formulations and developmental initiatives, as illustrated here. In the ultimate analysis, developmental initiatives that link cultural diversity with biological diversity are seen as the basis for ensuring human security in these socio-ecologically fragile mountain systems.

Keywords: Mountain systems, socio-ecological system analysis, sustainable development, traditional societies, traditional ecological knowledge.

HAVING depleted much of the biological diversity (at all scalar dimensions of biodiversity – sub-specific, species, ecosystem and landscape levels) of the larger Indian plains, much of what we are left with is now largely confined to the mountain systems of the country, with 'traditional societies' (those living close to nature and natural resources) as the custodians of this critically important natural resource base. Apart from the fact that this global resource is gaining international importance arising from its value for human well-being, through both tangible and intangible benefits that accrue to humankind[1–3]; in the India-specific context, the mountain systems, particularly the Himalayas in the north, and the Ghat systems in the south play a critical role in determining ecological benefits both in these mountains as well as in the adjoining plains of the country[4–6].

Over a period of time, there has been rapid degradation of land resources in the mountains arising from deforestation and associated depletion of biodiversity, leading to desertification of the landscape[6,7]. Issues arising from land-use dynamics and the linked human dimensions of it have been well brought out during a recent transect case study on lowland/highland interactions in Kerala, as part of a larger Tri-Academy (India, China and USA) initiative[8]. The human dimensions of issues arising therefrom form the basis for a consideration of issues that differentially impact upon different sectors of the mountain society[9]. The Tri-Academy analysis showed that external pressures arising from governmental policies and market pressures (both national and/or international) are the key drivers of large-scale land degradation. Proximal drivers of land-use change can at best be seen to be operating on the already impacted larger landscape causing further degradation; the myth surrounding land degradation that population pressure is the key driver was subsequently demolished through a detailed analysis of already existing literature on land-use/cover change[10]. The ecological implication of this is further accentuated by 'global change' as an ecological phenomenon[3] and globalization as an economic one[5].

Developmental initiatives undertaken so far and still being pursued are largely centred around a textbook knowledge-based approach with experimental models being created in the area of mountain agricultural development, or following traditional sylvicultural ways of dealing with forestry. In such efforts community participation in developmental efforts, that is so critical when dealing with these traditional mountain societies[6,11], has been ignored,

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and therefore such efforts have not been able to take-off. Wherever community participation did occur, it remained highly localized largely as part of environmental activism, which in the absence of a firmly rooted socio-ecological system framework that is based on rigorous research analysis, could not be replicated on a larger region[6]. This is evident from participatory afforestation plan linked to village self-sufficiency arising out of the now well-known 'chipko' movement[12]; or replicating the now famous 'Sukhomajri' experience in community participatory watershed management[13]. Indeed, in the area of watershed management which tends to take a holistic view of landscape management with all the attendant natural and human-managed ecosystems, a recent analysis suggests that the biophysical dimensions are better understood than issues linked with socio-economic, community participation, people's empowerment, institution-building, conflict resolution, and equity and gender considerations[14,15]. This obviously will have limited replication possibilities on agriculture-linked landscape management in the Himalayan region. Even the Joint Forest Management (JFM), what started as a 'bottom-up' approach towards conservation-linked sustainable livelihood for local communities, has become 'top-down' with foresters calling the tune. The success, therefore, tends to be somewhat patchy. This is reflected in declining forest cover in the tribal districts of Andhra Pradesh and Orissa, where a drastic decline in forest cover was seen between 1993 and 2000, arising from a lack of appreciation of the value system that traditional societies cherish[16]. Small-scale efforts by NGOs were based on community-level interactions. For replication, however, traditional ecological knowledge (TEK) has to be properly analysed and meanings put into it, so that generalizations that cut across socio-ecological systems could be arrived at, to enable regional planning efforts. Unfortunately this did not happen in these small initiatives[6]. Herein lies the Himalayan tragedy!

On the contrary, understanding of socio-ecological system arrived at through a detailed analysis of 'knowledge systems' has opened up possibilities towards finding lasting replicable solutions to the problem of natural resource management in the mountain regions. Redevelopment of jhum (shifting agriculture) in Northeast India through an 'incremental pathway' (step-by-step building upon TEK base available with the community) through community participation, was initiated a decade ago in the northeastern hill region[6,17,18]; a developmental initiative that could not happen over the last more than 100 years. Now, there is a renewed interest in 'redeveloped' jhum in the northeastern hill region and elsewhere as part of a cultural landscape. rather than an 'alternative' to jhum on a sectoral basis and that too based on formal knowledge-based models in the backyard experimental garden divorced from local communities, that got propagated all along during the last more than 30 years by the agricultural scientific community, in one form or another[19,20].

It is in this context that the whole issue of conservation-linked sustainable mountain development through innovative approaches become significant. Recently, Singh[9] has alluded to 'fragility and vulnerability of mountain ecosystems due to the uniqueness of mountain specificities'. He further mentioned the significance of socio-cultural system perspectives whilst dealing with sustainable mountain development, without going into specific details of taking them on-board in research analysis, let alone converting research results into developmental initiatives. Hence this follow-up integrated socio-ecological system analysis of the approaches towards researching mountain systems, and the emerging developmental perspectives therefrom[6,17]. Indeed, understanding 'knowledge systems' and linking the ecological processes with social processes was seen as the key for linking developmental concerns with a value system that local communities understand and appreciate and therefore participate in the process of development, with possibilities of local initiatives taken to a regional scale, through general principles that could cut across socio-ecological systems. This forms the basis for what follows.

What is unique about the mountains?

Traditional mountain societies are characterized by the close interconnection that they maintain with nature and the natural resources. They depend upon the natural resources in general, and the biodiversity around for their sustainable livelihood[17,21,22]. This relationship extends beyond the biophysical ecology and economic concerns; social, cultural and spiritual dimensions also play a significant role[23]. They have a holistic view of the ecosystem and the social system, which results in agricultural strategies that are adapted to the natural environment and sustainable use of the natural resources. Their traditional institutional arrangements have always been geared towards ecological prudence, through a series of compromises. The objective being sustainable use of natural resources to cope with uncertainties in the environment, rather than a short-term strategy to maximize production. Their ultimate objective has always been geared to sustainable use of natural resources through compromises between environmental risks and productivity concerns. TEK generated by the community through an experiential process, and which is centred around manipulation of biodiversity, to a large degree still determines land-use dynamics in the mountains. The emphasis is on diversification rather than homogenization of the landscape. Such an approach has ensured sustainability of the fragile mountain landscape in the past. It is now even more significant in the context of global change adaptation strategies[24], because diversification will render mountain societies less vulnerable to uncertainties arising from global change[25]. In the context of changing human population dynamics, and a range of external pressures on mountain-based natural resources[8,10,26], the linkages of traditional mountain societies with nature have been weakened, resulting in economic marginalization of mountain societies, often ending up in social disruptions[5,17,25,26]. While TEK still remains a key link between ecological and social processes, for meeting with sustainable developmental concerns of the mountain societies, in this rapidly changing scenario of the socio-ecological system in the mountain context, we need to have technologies that have an appropriate mix of TEK with 'formal knowledge'.

Knowledge systems

'Formal' knowledge derived through an 'hypothetico-deductive process, arising from a biophysical understanding of ecosystem dynamicity both in space and time, and their structural and functional attributes has been well studied and elaborated over a period of time[27]. This knowledge base has been widely used to address a whole range of ecosystem management-related issues, and has often worked well in the context of the industrialized world, where a vast majority of the people are now de-linked from nature. However, such an approach is seen to be deficient in addressing resilience and adaptive capacity of socio-ecological systems under a variety of situations[28], particularly so in the context of dealing with traditional mountain societies that we have in India. Having realized these deficiencies way back in the early 1970s while dealing with a range of traditional societies living in the north-eastern hill area[17], we came to the conclusion that knowledge system in general and TEK in particular has to be the connecting link to understand the functioning of the socio-ecological system.

Much descriptive literature exists on the food and medicinal species used by traditional societies, which in itself is important[29–31]. On TEK, some general information can be gleaned from studies on traditional land-management practices. An aspect of TEK which needs to be addressed is how ecosystem processes are altered by societal perceptions and decision-making processes. In other words, how does the socio-ecological system function as an integrated whole, both in space and time, and what are the implications for sustainability science? It is only in recent times that ecologists have started looking at the dynamics of these relationships, operating at varied spatial (sub-specific, species, ecosystems and landscape) and temporal scales.

Our understanding of TEK is based on the economic, ecological and socio-cultural benefits, both tangible and intangible that traditional societies may derive from the surrounding landscape[6]: (a) Economic – traditional crop varieties cultivated, lesser-known plants and animals of food value, and medicinal plants harvested from the wild are of direct economic benefit for mountain societies and can buffer periods of food scarcity; (b) Socio-ecological – the way mountain societies conserve and manipulate biodiversity contributes towards ecosystem resilience, and strengthens people's ability to cope with environmental change, to conserve soil water regimes and hydrology, and to manage soil fertility through enhancement of soil biological processes[32]; (c) Socio-cultural – cultural, spiritual and religious belief systems of mountain people are centred around the concept of sacred species, sacred groves and sacred landscapes, which can play an important role in biodiversity conservation. What we are dealing with here, therefore, touches upon all disciplinary dimensions (Figure 1).

Sustainable development of human-managed ecosystems

Creating buffering mechanisms in the soil sub-system against excessive use of fertilizers in intensively managed tea plantations[6]

Soil organic matter and the linked biological activities as part of soil ecosystem processes are poorly understood and managed in most agroecosystems. As part of the international 'Tropical Soil Biology and Fertility' (TSBF) programme, the South Asian Network (SARNet) has been aiming at understanding sustainable soil fertility management centred around two basic principles: (a) that the capacity to manage soil fertility is dependent on the mechanistic understanding of the biological processes regulating nutrient flux, organic matter dynamics and soil physical properties, and (b) that the sustainable management of soil fertility must be based on ecosystem/landscape-level

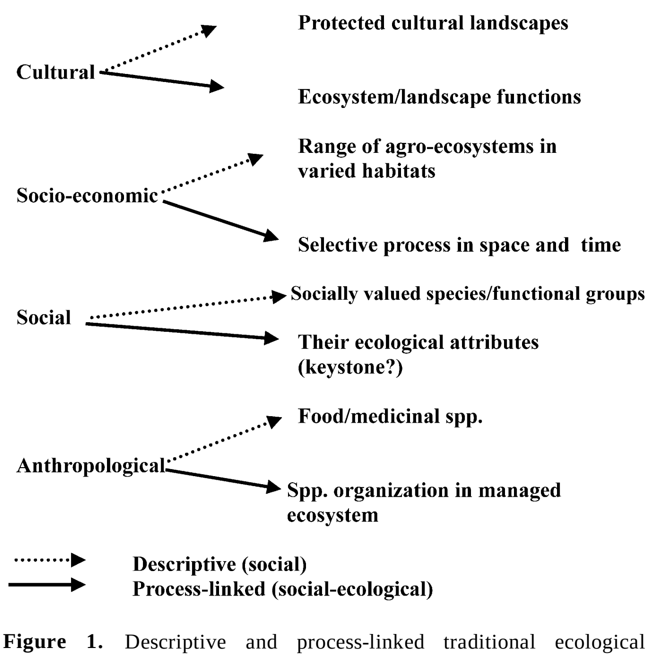

Figure 1. Descriptive and process-linked traditional ecological knowledge at the ecosystem or landscape level understanding of the different disciplinary dimensions of ecological functions[6].

understanding of processes, integrating soil-management concerns of the farmer, his objectives and decisions, in relation to all components of the agroecosystem. In recent times, in the tea-growing areas of the Western Ghats, serious problems of soil exhaustion had become evident due to intensification of land-use. Indeed, productivity from the tea gardens has been adversely affected in spite of added inorganic fertilizers, including a rapid decline in the life-span of the tea bush due to soil exhaustion.

Earthworm species, as ecosystem engineers, directly or indirectly control the availability of resources to other organisms by causing changes in the physical state of the biotic and/or abiotic materials. At the heart of this concept lies their ability to move through the soil and build organo-mineral structures as macroaggregates. Because of the diversity of interactions between the mineral soil on the one hand, and organic matter and other soil organisms on the other, under conditions of adequate soil moisture level, earthworms bring about fundamental transformations of the work already done by the soil microbes and other soil organisms.

Traditional vermiculture technology that simply uses mostly epigeic (surface-living) earthworms or garbage worms to prepare compost from high-quality organic matter like animal dung or from an amendment of waste biomass, is vermicomposting or 'off-soil' technology, as it is done outside the system under *ex situ* condition. This technology allows quick transformation of high quality substrate into mineral-rich compost that could readily be used in the field. However, the end results are not often satisfactory under field situations because: (a) being low in C : N ratio, the system demands repeated inputs; (b) creates limited niches not suitable for organisms that have major activities in the soil profile at different depths, particularly closer to plant roots; (c) one-time application of nutrients is more susceptible to be volatilized, washed out or leached; (d) surface application may decrease plant resistance for pest attack if not managed properly; (e) earthworms often are not able to thrive in agricultural systems under conditions of intense surface activities, with limited capacity to penetrate deeper into the soil. However, vermicomposting being readily available is good for systems that cannot be managed with sufficient quantities of localized organic residues.

It is in this context that the macrofauna network coordinated by Patrick Lavelle, Laboratoire d' Ecologie des sols Tropicaux, IRD, Bondy, France with support from EEC (European Economic Community) using the leadership provided by B. K. Senapati, School of Life Sciences, Sambalpur University, Orissa, along with the Parry Agro Industries Ltd, succeeded in evaluating the role and potential for manipulation of soil invertebrates, particularly earthworms, as part of SARNet activities. The whole effort was directed towards rehabilitation of degraded soils under intensive tea cultivation in the Western Ghats, South India.

The result of this synergistic interaction between academic institutions at the national and international levels with agro-industries, was the development of a patent entitled 'Bio-organic fertilization for plantations' or in short as 'FBO', as part of the South Asian Regional Network of the international TSBF programme. This opens up possibilities for sustainable land-use-linked sustainable soil-fertility management under a variety of ecosystems, both natural and human-managed[33]. Using selected organic residues that are locally available and through *in situ* management of locally available earthworm species of keystone value, the technology was designed to ensure the associated soil biodiversity. The studies suggested that the overall biological status of the soil improved by more than 200% along with about 60% improvement of physico-chemical characteristics of the soil, over the control plots under conventional management. Maintaining a minimal functional diversity, this technology does not favour exaggerated development of a single species that accumulates large biogenic structures and results in severe problems of soil compaction. The impact of this technology was felt in: drastic reduction in the use of inorganic fertilizers, with a decline between 30 and 50%; enhancement of processed tea production between 33 and 80% compared with conventional inorganic fertilizer input-based management practices[34,35]; and above all improved long-term sustainability of the soil ecosystem.

This approach to issues of sustainability could have a cascading impact from a plot level right up to ecosystem/ landscape levels, since soil fertility often is a critical limiting factor for land-use development[6]. What was developed for sustainable soil fertility in the tea plantations, has relevance for a whole range of traditional mountain agroecosystem typologies.

Redeveloping shifting agriculture (jhum) system: Building upon TEK incrementally

There still exist in the mountain systems of the country, a wide range of complex agroecosystem typologies (Figure 2), many of them with biodiversity comparable to that of the natural ecosystems[36]. Broadly speaking, one could have causally managed shifting agricultural system as we have in the northeastern hills on the one extreme[17], and intensely managed agriculture/plantation systems of the type one often comes across in the Western Ghats region on the other, with a whole range of sedentary agroforestry system typologies managed at intermediate levels that one comes across in the Central Himalayan region[37].

Traditional societies manipulate sub-specific and species-level crop biodiversity in order to optimize production under a given ecological situation, but at the same time cope with predictable and unpredictable environmental uncertainties, as we have under traditional agroecoystems of the northeastern hills[17]. They also effectively manage the associated biodiversity (weed biodiversity), rather than resorting to weed control as is done under modern agriculture, so as to conserve moisture and nutrients within the soil ecosystem. We have shown that the socially/culturally valued species that they have in their agroforestry systems right across the Himalayan region and elsewhere in the world where traditional agriculture is practised, are invariably ecological keystone species within the ecosystem. Thus, *Alnus nepalensis* and many bamboo species conserved during the cropping and fallow phases in the jhum system of the northeastern hills, are species which conserve NPK within the system, thus playing a keystone role in an ecological sense. Such a rich knowledge base available with local mountain communities, that connects social values with ecological keystone value was seen as the basis for designing strategies for re-developing shifting agriculture (jhum) system in Northeast India that is rapidly breaking down[17]. It may be noted here that the local communities have time and again rejected textbook knowledge-based models of land-use development, in spite of the fact that there is no viable alternative system available to them to replace the jhum system that is rapidly breaking down. This is the same story for agricultural development in the Central Himalayan region of Kumaon and Garhwal too[37].

In any case, such TEK-related considerations formed the basis for a decentralized village development plan in one of the northeastern hill states of India. The entire basis for this incremental build-up is the rich TEK base of these hill societies, based on the community participatory research by Ramakrishnan and his co-workers[17]. In developing such an incremental model, 'formal knowledge' was brought in to the extent required, with suitable location-specific adaptations. Such an approach formed the basis for a similar

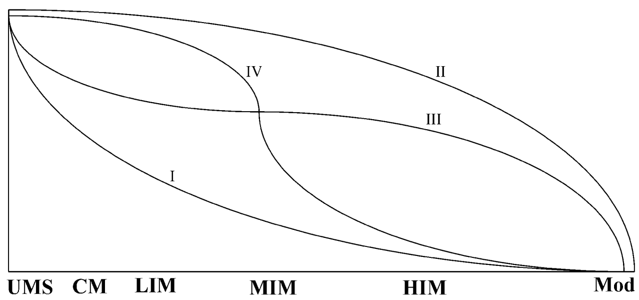

Figure 2. Biodiversity (along the *x*-axis) changes (four patterns) as related to agroecosystem type and intensity of management (*y*-axis). Curves I and II represent two extreme possibilities that seem to be unlikely. Curve II is a version of the ecologist's expectations, while curve IV seems to be more likely and interesting from the point of view of biodiversity conservation[36]. UMS, Unmanaged ecosystems (forest, grasslands, etc.); CM, Casually managed (shifting agriculture, nomadic pastoralism, homegardens); LIM, Low intensity management (traditional compound farm, rotational fallow systems, traditional agroforestry); MIM, Middle intensity management (horticulture, pasture mixed farming, traditional cash cropping); HIM, High intensity management (crop rotation, multi-cropping, alley cropping, inter-cropping systems); Mod, plantations, orchards, intensive cereal and vegetable production systems.

developmental initiative for the hill areas of Tripura (proposal just completed) and Arunachal Pradesh[11,18].

Over a thousand villages in Nagaland have been organized into Village Development Boards (VDBs), with the specific purpose of rural development. The VDBs were established taking into consideration the traditional village organization of the given cultural group. However, all of the VDBs had the same function, namely rural development. Using this institutional mechanism, the highly distorted shifting agricultural system, which indeed is basically an agroforestry system, but presently operating at subsistence or below subsistence level, is now being redeveloped by strengthening the tree component that has been weakened due to extreme deforestation in the region. The Nepalese alder-based agroforestry system, with planting of trees done both in space and time (during the cropping and fallow phases of shifting agriculture) and maintained for hundreds of years, by some of the local tribes like the 'Angamis' formed the impetus for this initiative[6,11,17]. Having shown that socially valued species are invariably ecological keystone species within any given natural or human-managed system[23], the selection of tree species is expected to be scientifically correct for the fallow management being done on a participatory mode. Such an approach is necessary because proving the keystone value through research analysis could be time-consuming.

The project implementation by the Nagaland Government officials through VDBs created by the Government of Nagaland aims at augmenting the traditional system of agriculture, rather than attempting to radically change it[6]. Reliance being placed on participatory testing rather than being transplanted into the field site by the extension agents, about a dozen tree species have been tested in over 200 test plots. Currently, it is estimated that the agroforestry technology is being tested in 5500 ha of replicated test plots. Farmers have adopted this for local-based testing in 870 villages, covering a total area of 33,000 ha (38 ha per village × 870 villages)[36]. In these plots, local adaptations and innovations for activities such as soil and water management are emphasized. Water being a critical trigger for sustainable management of land resources under a monsoonic climate where water scarcity is acute for a major part of the year[6,11,17], TEK combined with appropriate water management could be a major factor for sustainable management of natural and human-managed ecosystems as was initially shown for the northeast[17], and subsequently demonstrated on a larger scale for the other parts of the Himalayas[37].

Some of the other important outputs arising from the jhum re-development initiative are: mixed tree plantations in the jhum plots were superior to monocultures; people were willing to go for some of the suggested non-traditional crops; home garden systems prevalent in the region were used as a window for cash income crops; communities were willing to view biodiversity management and carbon sequestration within the system as incidental outputs. The major weakness is centred around lack of rigorous scientific monitoring and documentation of socio-ecological impacts at regular intervals by a team of scientists.

There exist in the Indian mountains, many highly traditional agricultural systems that initially need to be developed through a TEK-based 'incremental pathway', or through agroforestry system models that are fitted to diverse ecological conditions of the landscape – being built around the ecological contours, these agroforestry models have been put under what is termed as the 'contour pathway'[36]. These two pathways stand apart from the external energy-subsidized modern agricultural system/s that are inappropriate for the mountain systems.

In this context, it is also worth noting that appropriate institutional arrangements play a key role in involving community participation. Thus, VDBs in Nagaland as agents for transformation were created following the traditional ways of village-level institution building that has been always a part of each one of the more than 35 different tribes who are participating in the Nagaland initiative. In other words, though VDB formulation varies from one tribe to another, all of them have the same function of redeveloping jhum in the region. This approach has ensured community participation based on a value system that the different communities understand and appreciate and therefore can participate in the developmental process. Another powerful message that comes out from the Nagaland experience is that institutional arrangements play a key role in ensuring community participation, and that formulation of village-level institutions has to be in the given socio-cultural context.

Sustainable management of natural ecosystems

Textbook-based sylvicultural knowledge has so far been the exclusive basis for forestry practices. However, in recent times, involving communities in forest management is being seen as more and more critical for sustainable forestry[6,17]. Indeed, the International Union of Forest Research Organizations (IUFRO) has now a major international initiative on traditional forest knowledge (TFK), with a view to have community participatory forest management.

From the earlier discussion it follows that socially valued species have to be the basis for community participatory forest management, if sustainability is to be ensured from the point of view of forest-dwellers, who need to be involved to address sustainability concerns, particularly when one realizes that these communities are dependent upon forests for a range of tangible and intangible benefits[23]. As indicated earlier, socially valued Nepalese Alder (*Alnus nepalensis*) and bamboo species as early successional species in the Northeast Indian context, determine forest ecosystem structure and functioning, in space and time[17]. We have also shown in the Central Himalayan context that a few species of Oak (*Quercus* spp.), locally known as 'Bhanj', are socio-culturally valued (with music, folk dance forms, poetry and folk tales woven around them). They also play a critical rose in landscape management. Indeed, these species are critical for sustainable soil fertility management, water availability in the soil profile during the extended dry season (Figure 3), for fodder and fuelwood, with implications for sustainability of their agroecosystems, as well as for ensuring associated biodiversity (what is known and that is not yet documented by the scientific community), including a whole range of non-timber forest products that they harvest from the wild[23,37]. Such a large-scale and persistent conversion of mixed oak forests into pine plantations by the foresters right from the colonial period has now been implicated as the key causative factor for the 'chipko' movement that shook the region in recent times[11,37].

What does all this imply? We need to take a broader perspective of our forestry practices and conservation issues, wherein we effectively integrate sylvicultural issues with ecological and socio-cultural considerations[38], for sustainable forestry (Figure 4).

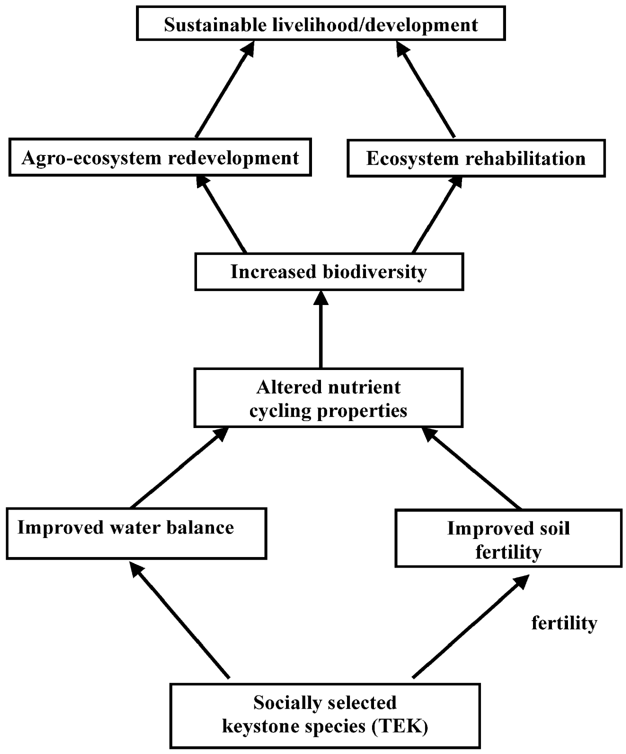

Figure 3. Traditional ecological knowledge centred around socially selected keystone *Quercus* spp. acting as a trigger for restoration of fractured mountain landscape in the Central Himalayas, with cascading impacts on land-use development leading to sustainable livelihood/development of traditional mountain societies[6].

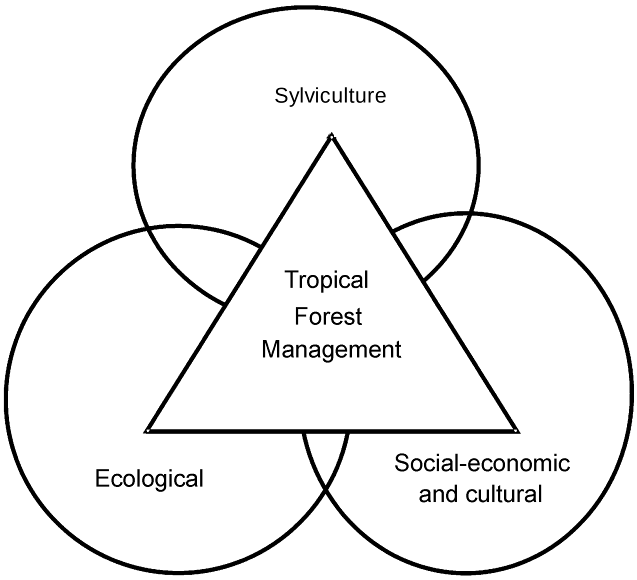

Figure 4. Interdisciplinary interations called for tropical forest management and conservation[6,40].

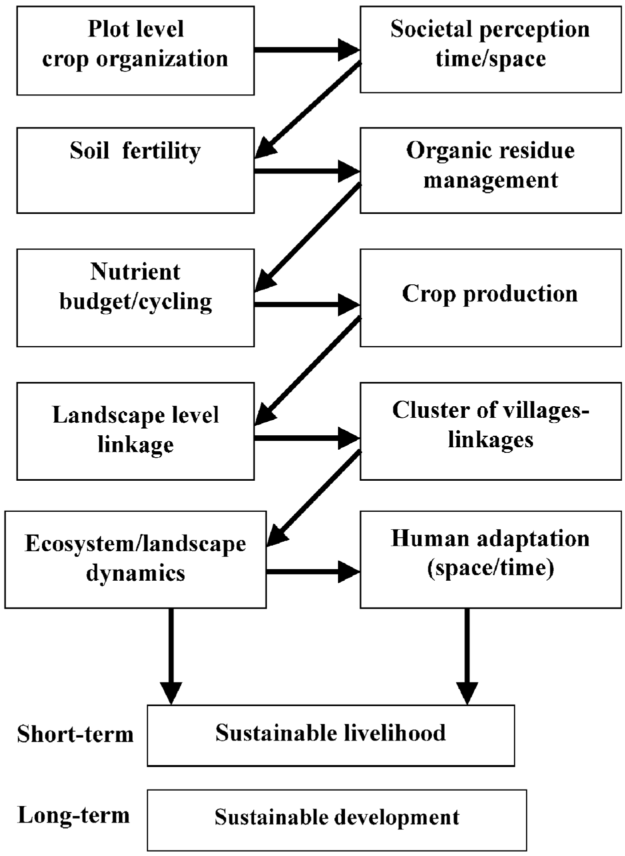

Figure 5. An interactive process for building linkages between ecological and social processes, and analysing land-use dynamics from plot level to landscape level, leading to sustainable management of natural resources and the linked sustainable livelihood concerns of traditional mountain societies[6,40].

Conclusion

What does this all add up to? We encounter a whole set of highly heterogeneous socio-ecological systems while dealing with conservation-linked sustainable development of mountain societies. In terms of land-use and land-management practices, these mountain societies are working at varied intensity levels of land-use management, ranging from casually managed jhum (shifting agriculture systems) in many places, going up to energy intensive 'modern' management systems. Each one demands diverse approaches that link TEK appropriately with the formal knowledge to arrive at technologies that contribute towards agroecosystem sustainability[11]. Apart from the human-managed agroecoystems, we also need to go for conserving and sustainably managing the rich natural forest resources in the mountains. For this, we need to have a new breed of scientists to work in the mountains in an interphase area that addresses issues not merely ecological, nor social alone, but one that also deals with integrated socio-ecological systems[27,28]. In such an effort, knowledge systems, particularly that which is available (TEK) with the communities form a critical link connecting the ecological boxes with social boxes at all scalar dimensions (Figure 5). We need innovative methodologies to deal with mountain issues.

One is talking of innovative approaches to understand the linkages between the biophysical and the social systems but also deals with traditional knowledge not merely as 'local knowledge' as often studied by social anthropologists, but have evaluated TEK using appropriate 'scientific' tools to arrive at conclusions that could be generalized across socio-ecological systems. Such an approach towards linking knowledge systems is critical for a regional planning process for conservation-linked sustainable mountain development[41]. In more specific terms, one is also considering sustainable soil fertility[33] and water management during the long dry spell outside the monsoon season[6,11] as triggers for sustainable land-use development of the mountain societies, amongst other sustainable developmental possibilities. Also to be recognized is that sustainable development is a series of compromises[42]. In the context of increasing environmental uncertainties arising from global change[43], the aim should be to restore/reconstruct cultural landscapes[11] and at the same time taking care of the immediate short-term developmental possibilities. Such an empowered society can take care of its long-term developmental concerns. Such a planning process that conserves cultural diversity and the linked biological diversity of the mountain societies will, to a large measure, contribute towards human security.

We have a long way to go in this direction, since we from outside have always tried to inculcate a value system to the mountain people, that we consider is important for them, without even trying to understand their traditional values. There is an urgent need to have a change in the mindset of the scientific community at large. We have to create a new breed of scientists who will be able to work in the interphase of natural and social sciences, linking knowledge systems[11,40]. Arising from these considerations, there is greater urgency to make educational curricula mountain-relevant, at least in those institutions located in the mountain regions of the country. This is the root cause for the Himalayan tragedy!

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MEETINGS/SYMPOSIA/SEMINARS

DST-Sponsored Contact Programme On Shear Zones

Date: 15–30 May 2007
Venue: Varanasi

The purpose of the contact programme is to acquaint young Earth scientists with the recent developments in the field of structural geology, mainly in Shear Zones, and analysing various structural features in the shear zones. Last date for receipt of application is 20 March 2007.

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International Symposium on Advances in Neurosciences and Silver Jubilee Conference of Indian Academy of Neurosciences

Date: 23–25 November 2007
Place: Varanasi, India

The symposium will focus on relevant theme with an objective to have deliberations in the emerging areas of neuroscience. This will also provide a platform to young neuroscientists to present their work and interact with experts in the area attending this symposium.

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The Himalayan eco system is vulnerable and susceptible to the impacts and consequences of a) changes on account of natural causes, b) climate change resulting from anthropogenic emissions and c) developmental paradigms of the modern society.Â Primary objective of the mission is to develop in a time bound manner a sustainable National capacity to continuously assess the health status of the Himalayan Ecosystem and enable policy bodies in their policy-formulation functions and assist States in the Indian Himalayan Region with their implementation of actions selected for sustainable development.Â The Himalayan ranges are the youngest and loftiest among the mountain systems of the world.