

Global change, natural resource management and sustainable development: an introduction

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Abstract: This introductory chapter sets the tone for what follows in the subsequent chapters on natural resource management linked sustainable development, with emphasis on biodiversity rich areas. The emphasis on mountain regions is particularly appropriate in the context of the U.N. sponsored International Year of the Mountains 2002. The basic framework for applying a socio-ecological system approach to natural resource management has been set, which forms the basis for what follows in the following chapters. This is an area which has just started receiving attention.

Resumen: Este capítulo introductorio marca la pauta para los temas que se tratan en los capítulos subsecuentes, todos ellos relacionados con el manejo de los recursos naturales ligados al desarrollo sostenible, destacando las áreas ricas en biodiversidad. El énfasis en las regiones montañosas es particularmente apropiado en el contexto del Año Internacional de las Montañas 2002, financiado por la ONU. Se ofrece un marco general para la aplicación del enfoque de sistemas socioecológicos al manejo de los recursos naturales, el cual representa la base para los capítulos subsecuentes. Ésta es un área que apenas comienza a recibir atención.

Resumo: Este capítulo introdutório marca o tom para o que se segue nos capítulos subsecuentes quanto à ligação entre a gestão dos recursos naturais e o desenvolvimento sustentado, com ênfase nas áreas ricas em biodiversidade. A ênfase nas regiões montanhosas é particularmente apropriada no contexto do Ano Internacional das Montanhas, 2002, apoiado pelas Nações Unidas. O quadro básico para se aplicar uma abordagem sistêmica sócio-ecológica à gestão dos recursos naturais é definido e constitui a base do que é desenvolvido nos capítulos subsecuentes. Esta é uma área que começou justamente a merecer atenção.

Key words: Eco-cultural landscape, mountain ecosystems, socio-ecological system concept, sustainable development.

Introduction

There is an increasing realization throughout the world, about the state of our environment, caused by over-exploitation of natural resources for economic development. Viewed in the context of developing versus developed world, over-exploitation of resources has had contrasting connotations. Resource exploitation in the developing

world has largely been geared to meet the very basic needs of food, fodder, fuelwood and shelter of a large section of deprived societies. On the other hand, developed parts of the world have largely concerned themselves in trying to maintain and accelerate the already very high levels of resource consumption that they have achieved for a much smaller segment of the world's population, based on an early initiative taken and advantage gained

through industrialization. In this scheme of things natural resource base has often viewed as limitless by the industrialized world either due to a myopic view of the future or because of their immense faith in technology being able to substitute for the natural resource capital. This faith in technological quick-fixes for world's problems linked with over-consumption is still prevalent. It is in this context that one needs to view the whole issue of natural resource management particularly in a few pockets of resource rich areas still left under-exploited in the developing tropics where 'traditional societies' live. In the Indian context, these biodiversity rich areas are located in the uplands of the country, where traditional societies live.

Global change

Global change (involving climate change, biological invasion and land use/cover changes and biodiversity depletion) is the trigger for this shift in paradigm on economic development linked to sustainable natural resource management (Bondeau *et al.* 1997; Ramakrishnan 2001; Walker *et al.* 1999). Depending upon the kind of 'global change' issues with which the society is currently trying to grapple with the problem of sustainability assumes different meanings: the issues involved are, therefore, attempted to be solved also has to be through a variety of different pathways. The pathways that are available to solve issues, such as global warming because of greenhouse gas emissions, acidification of soil and water through SO₂ and NO_x. Drastic decline in the quality of air, soil and water, reckless exploitation of natural resources stored in the soil through mining activities, drastic changes in land use and land cover through over-exploitation of natural resources leading to desertification of landscapes associated rapid depletion of biodiversity, etc., are indeed very diverse. Further, depending upon the disciplinary emphasis of the individual/organization concerned with developmental issues, sustainability assumes different meanings. In spite of the confusion that prevails, and 'sustainable development' meaning different things to different players in this field, this concept provides a useful framework to base development with concerns for conserving natural resources. In this process this issue has to be addressed differently depending upon the ecological, social, economic and cultural framework in

which one is operating. It is a difficult task to look at all the different perspectives involved in such a developmental process in a very comprehensive manner in a discussion of the nature that is attempted here; therefore, what I propose to do is to look at some of the issues in the specific context of ecosystem/landscape management with concern for biodiversity linked natural resources.

Mountains: Biodiversity hot-spots!

Much of the biodiversity in the Indian context are concentrated in the mountains (Ramakrishnan *et al.* 2000). Mountain regions are of global importance. This is reflected in the recognition given to the mountains by the United Nations by declaring 2002 as the 'International Year of the Mountains'. About one tenth of the global population lives in them. They provide resources to at least half of humankind; including water, energy, food, food products and places for tourism. They are global centres of ecosystem complexity (biodiversity defined ecologically in its broadest sense). Their steep slopes and sharp gradients render their ecosystems very fragile. In a developing country context, these fragile mountain ecosystems are being constantly exploited for the rich natural resources contained there in - resources such as timber, the rich biodiversity that they harbour such as medicinal plants from the wild, mineral resources, water resources for hydroelectric power generation etc. Consequently, the threat to the integrity of mountain ecosystems is often due to policy decisions taken to meet with a whole variety of demands external to the system.

In many developing countries, because of an exploitative approach from the rest of the society, economic development of mountain societies has not received the kind of attention from the developmental agencies that it deserves. Where some efforts have gone in, the developmental pathways chosen are alien to the socio-ecological situation prevailing in the mountains (Ramakrishnan 2001). Natural resource exploitation has only resulted in rapid depletion of the rich biodiversity that the mountains harbour, a resource on which mountain societies depend for their livelihood needs. Mountain societies directly depend upon forests around them for a variety of their daily needs through non-timber forest products such as food, fodder, fuelwood, medicine etc. They indirectly depend

upon forest resources for sustaining a variety of complex agroecosystems. With developmental efforts so far being largely based upon text-book based knowledge of land use development and being completely divorced from the socio-ecological context in which these societies operate. The societies have not been able to relate themselves with a value system that they understand and appreciate and, therefore, participate in the developmental process. Now, the economic well being of the mountain societies are increasingly influenced by and further threatened by economic globalization. This is the context in which the eco-sociological characteristics of the mountain regions in the developing tropics should be viewed.

Socio-ecological system concept

Contrary to the traditional ecologist's view point (Odum 1971), if we take a view that humans in 'traditional societies' form an integral component of the ecosystem function (Ramakrishnan 1992a; Berkes & Folke 1997), a view point which is even more obvious at a landscape level, then the role of biodiversity in ecosystem function would take a different dimension. Indeed, this is the way in which many traditional societies perceive the immediate environment around them. The concept of village as an ecosystem, with all its ramifications involving agriculture, animal husbandry and the domestic sector enmeshed with the forest and forest-related activities such as hunting and gathering of food, fodder, fuelwood and medicine and forest farming as done under shifting agriculture is an example of integrating humans within the ecosystem boundaries. Such a view of the functioning of the ecosystem changes the whole perspective of the role of biodiversity within with considerable implications for management of natural resources and sustainable development of the traditional societies. The implication is that conserving the biodiversity is crucial for the livelihood of these traditional societies. It is not only the mere presence of biodiversity and the functional role it has for the tribal humans that is significant here. The manner in which the tribals manipulate this biodiversity for ecosystem functional integrity, and through that for their own functions within the landscape is interesting. Therefore, any discussion on sustainability issues, when dealing with conservation of biodiversity and management of natural resources in biodiversity rich areas, should take into

account the sustainable livelihood concerns of the traditional societies as part of a short-term strategy and sustainable development of the region as part of a long-term planning process. This implies that we need to address issues centred around sustainable agriculture, sustainable forestry, sustainable management of common property resources and the interconnections between the different ecosystem types as part of landscape management.

On the biophysical side, natural and human-managed ecological systems are linked with the interactive rural-urban systems. Use/misuse of biological resources have linkages with biodiversity, land use management practices, which leads to ecological-social interactions. In a developing country context, traditional ecological knowledge (TEK) base of human societies living in biodiversity rich areas has always been a key consideration for sustainable management of natural resources and societal development. Therefore, in the contemporary context of variously impacted natural resources, the role of TEK for natural resource management cannot be ignored. Indeed, TEK acts as a key driver for sustainable livelihood of traditional societies in the short-run and sustainable development as part of the long-term action plan.

Traditional agroecosystems

There exists in the mountain regions of the developing tropics, a wide variety of traditional agroforestry systems, ranging from the casually managed shifting agricultural systems on the one extreme, to sedentary systems with varied levels of ecological and economic efficiencies. All the mountain agroecosystems are closely linked with forests, depending upon the role of forests in maintaining a good soil profile with adequate moisture retention during the dry season and soil fertility through recycling of forest-based organic residues. However, in recent times, these systems have undergone a whole variety of distortions, often at the point of a total break-down due to a variety of external and local pressures upon the natural forest resources in the mountains. Our ingenuity, therefore, lies in designing agroecosystem models to fit into socio-ecological contours, combining sustainability with high production levels (Ramakrishnan 1992a; Swift *et al.* 1996). The ultimate objective here is to conserve agroecosystem biodiversity and thereby providing resilience and sustainability to these systems, which are under

these systems, which are under threat from 'global change' and 'globalization'.

Forest ecosystem

Traditional mountain societies in the developing tropics are dependent upon biodiversity for meeting their livelihood concerns. Therefore, one of the underlying principles of sustainable development is to conserve biodiversity with peoples' participation so that this biodiversity could be used for societal welfare, both locally and globally. For conservation of forest biodiversity and the management of forest resources through community participation to be effective, TEK will play an important role. Silvicultural and tree biology has to be combined with ecological, social and cultural dimensions of forestry, whilst dealing with these traditional societies (Ramakrishnan 1992b). Many socially selected species are also ecologically significant keystone species, such as Nepalese alder (*Alnus nepalensis*) which conserves nitrogen, Bamboo species (*Dendrocalamus hamiltoni*, *Bambusa tulda* and *B. khasiana*) with ability to conserve nitrogen, phosphorus and potassium as in the forest ecosystems of north-east Indian hill areas. This offers a foothold to relate forest management with a value system that local communities have thus ensuring their participation in forest management. Arising from TEK are a variety of traditional technologies such as the *in situ* manipulation of earthworms for soil fertility management, traditional water harvesting systems for societal needs etc. These two are powerful tools for ecological rehabilitation of mountain regions with community participation. Such an interphase study between ecological and social processes are critical for natural resource management with community participation; biodiversity conservation and enhancement through adaptation of traditional technologies in the context of 'global change' are research areas which have only just started receiving attention.

Sustainability: The guiding principles

The guiding principles of sustainability cut across ecological, economic, social and cultural dimensions (Ramakrishnan 1993, 1995), and there are obvious trade-offs. Whilst ecological dimen-

sions in a biophysical sense are relatively easy to comprehend, the social dimensions are extremely complex. The obvious questions are: sustainable development for whom, in what context, and with what objectives? Then there is a problem of scaling, both in a temporal and spatial sense. Are we considering sustainability over an infinite time-scale? If not, can we do it over a more easily foreseeable 50-100 years? Would such a consideration conflict with short-term demands during the more immediate 5-10 years which is the range for normal planning process in a local setting? To what extent, sustainability concerns are constrained by the social, cultural and economic developmental status of the societies concerned? Can such concerns be incorporated into a short-term planning strategy? How does one reconcile a short-term strategy with long-term perceptions linking local/national goals with regional/global objectives?

Temporal dimension of sustainability also becomes obvious when we try to relate it to attributes that characterize ecosystems. A miniature ecosystem of microorganisms created in a culture flask may have a brief turnover time of less than an hour. On the other hand, a village pond, a grassland or a forest ecosystem have a turnover time that may have to be viewed in terms of decades or hundreds of years; the time frame becomes even greater for a landscape of interacting ecosystems. The temporal scale, however, has to be based on pragmatic considerations. Too short a time frame may have value only as a short-term strategy which may not be the ideal, but may be necessitated because of ecological, economic, social and/or cultural constraints. Though sustainability implies a time frame that is infinite, so that resource use does not lead to appreciable changes in resource quality and quantity, this is not practical. Hence, one may settle down for a short-term strategy of 5-10 year time frame and a more reasonable 50-100 years time frame for a more ideal long-term strategy for sustainable development.

In a rural landscape, one needs to consider a complex set of ecosystem types - both natural and man-made. Agriculture in a limited sense on the one hand, and a village unit in a broader sense on the other, could be viewed as ecosystem types that are man-made and sustained through external inputs by the humans. On the other hand, natural ecosystem types such as a village pond, a patch of grazing land forests at varied levels of degradation

or management all also form part of the rural landscape. This brings us immediately into the question of recognizing the spatial dimensions of the unit for sustainability - a given ecosystem type, a landscape or indeed the planet earth itself viewed as an interacting biosphere system. In practical terms, however, a given ecosystem type is too small a unit, whilst the global scale is too difficult to comprehend because of extreme complexities. Therefore, one may wish to strike a middle path and settle down for a consideration of 'landscape' as the unit for sustainable resource use and its development.

Viewing mountains as an eco-cultural landscape

Many mountain societies all over the world have institutionalized in a variety of different ways large or small cultural landscapes/sacred ecosystems, as part of their belief system. In the Indian context too, culture-linked ecosystem management is to be found in many of the mountain societies, who have many natural resource-linked institutions (Ramakrishnan *et al.* 1998). The concepts of 'sacred species', 'sacred groves' and 'sacred landscape' represent various stages in social selection. The guiding principles that regulate the use of natural resources are embedded in the codified and often non-codified institutions that they have evolved. Building upon traditional institutions provide the necessary connectivity between policy planners and the developmental agencies on the one hand with local communities on the other. Natural resource management with community participation should be the bottom line in this whole effort, for which a whole variety of tools derived from both the 'traditional' and the 'formal' knowledge systems should be effectively used. It is in this context this publication becomes significant, where a whole range of issues linking biodiversity with sustainable development are discussed by a number of leading experts.

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