Pt. Govind Ballabh Pant Memorial Lecture: X

Sustainable Development of the Indian Himalayan Region: Linking Ecological and Economic Concerns

Prof. J.S. Singh

Professor Emeritus,
Banaras Hindu University, Varanasi
& CSIR Emeritus Scientist, Botanical Survey of India, Allahabad, U.P.

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About Prof. JS. Singh

Prof. J.S. Singh, Emeritus Professor at Banaras Hindu University and CSIR Emeritus Scientist at Botanical Survey of India, Central Circle, Allahabad, was born on December 26^{th} 1941.

He did his graduation and post graduation from Allahabad University and obtained his Ph.D in Botany (Ecology) from Banaras Hindu University, India. He has his special academic training at Colorado State University, USA.

Prof. Singh is fellow of the Third World Academy of Sciences, Indian National Science Academy, Indian Academy of Sciences and National Academy of Sciences, India. He has received several prestigious awards such as S.S. Bhatnagar Award (1980), Pitambar Pant National Environment Fellowship (1984), Pranavanand Saraswati Award (1985), Dr. Birbal Sahni Gold Medal (1999) and Prof. S.B. Seksena Memorial Medal (1999).

Prof. Singh's international membership includes: Interdisciplinary Committee of the World Culture, Mexico; Board of Governors, Board of Directors and Programme (Advisory) Committee of International Centre for Integrated Mountain Development, International Association for Vegetation Science.

Apart from several prestigious assignments, Professor Singh was also Chairman of a Ministry of Environment & Forests Expert Working group for Integrated Action Oriented Ecodevelopment Research Programme in Himalayan Region. He is also currently a member of National Forest Commission.

Professor Singh has supervised 43 doctoral students and published over 400 research publications. He has made significant contributions towards understanding the development, dynamics and disruption of natural ecosystems in order to provide a scientific basis for environmental protection, maanagement and conservation. His work is characterized by discovery of new facts concerning ecosystem functioning, new methodology for biological resource study, and collection of hitherto unavailable data on a variety of ecosystems for evolving management strategies.

Pandit Govind Ballabh Pant Memorial Lecture

J.S. Singh
Professor Emeritus, Banaras Hindu University, Varanasi 221005
And
CSIR Emeritus Scientist, Botanical Survey of India, Allahabad 211002

At the outset I would like to express my gratitude to the members of the Governing Body of the Govind Ballabh Pant Institute of Himalayan Environment & Development for giving me this opportunity to deliver the 10th Pandit G.B. Pant Memorial Lecture. Panditji was a great visionary who always thought of development of the Himalayan Region and its people, demonstrating in his words and actions, a clear understanding of the implications of local action on national development. The linkage between resource management and regional development was also a theme that Panditji was strongly aware of. Conservation of forest resources while ensuring rights of use for the people of the Himalaya was one of the areas where Panditji contributed significantly. His vision, dedication and contributions have been aptly recognized through the conferring of the Bharat Ratna by the country to him. It would not be incorrect, therefore, to say that Pandit Govind Ballabh Pant was aware and concerned about the ecological and economic linkages in the Himalaya.

With the increasing realization that the natural resources of mountain areas are vital for both upland and lowland people, the Global Agenda for sustainable development has brought mountains to sharp focus. Development needs addressing local aspirations and national compulsions have to be met if economic upliftment is to be achieved. However, development interventions also imply a demand on resources as well as modifications of existing natural systems. Development in the mountains, therefore, has to have a different approach, given the fragility and vulnerability of the Himalayan ecosystems due to the uniqueness of mountain specificities (Jodha, 1992). Development interventions ignoring the imperatives of mountain specificities will invariably result in resource misuse and subsequent accelerated environmental degradation, which would be disastrous not only for the local populace, but also for downstream inhabitants. Such negative impacts of unplanned development, insensitive to mountain specificities, are already becoming common, the most frequent being the regular incidences of landslides, river obstructions and flash floods in the mountain and the recurrent floods in the plains.

In addition to the negative impacts of localized development activities, the effect of climate-induced changes, itself an outcome of unsustainable practices and waste generation, on the mountain systems is frightening. Global warming and its effects on glacier recession has far reaching implications both in time and space. Together, the consequences of insensitive development approaches as well as climate-induced impacts have far reaching implications at local, regional and global level. The intense vulnerability of mountain ecosystems and their elements to the human as well as climate-induced changes therefore is of great concern. Not surprising, therefore, that the complexity of such issues continues to receive considerable attention at the global forum like the WSSD – World Summit on Sustainable Development (Johannesburg, August 2002) and Bishkek Global Mountain Summit (October 2002). These events have arrived at a consensus that mountains would require specific approaches and resources for sustaining livelihood needs and improving the quality of life. This would require an integrated approach, which gives due consideration to closely intertwined aspects of human socio-cultural/ socio-economic systems and natural ecosystem components/ processes.

I wish to share with you a few random thoughts on the basic ecological and social tenets which need to be taken into account in developing strategies for ecologically and economically sustainable development of the Himalaya.

Himalaya: Uniqueness

Among the global mountain systems, the Himalaya is the most complex and diversified, and separates the northern part of the Asian continent (Tibet, China, Siberia etc.) from the South Asia. The region being a discrete geographical and ecological entity figures prominently in major bio-physical settings of the Planet Earth. This vast mountain range (over 2500km in length, between 80 to 300km wide and raising from low lying plains to over 8000m asl.) produced a distinctive climate of its own and influence the climate of much of Asia (Zobel & Singh, 1997).

The great variation in topographical features along three dimensional framework (i.e. latitudinal: South- North; longitudinal: East- West; altitudinal: Low-High) cause immense diversity in climate and habitat conditions within the region. The Himalaya owes its origin to the collision between two landmasses (the Peninsular India Plate and the Eurasian Plate) about 55 million years ago. However, the Himalaya orogeny does not relate to a single event; the western part being the more recent. Temporal and spatial variations caused by diversity in geological orogeny has resulted into a marked difference in climate and physiography and consequently in distribution pattern of biotic elements. The Himalaya is at the juncture of five major biogeographic regions – (Palaearctic; Mediterranean; Indo-Chinese; Indo-Malayan and Peninsular India). This spatial position and heterogeneous dispersion of biodiversity elements have led to complexity in biogeographical patterns of the region.

Figure 1: Location of Indian Himalayan Region

The Indian Himalayan Region (IHR) stands at the biological and cultural cross-roads of Asia, the meeting point of floral and faunal assemblage and cultures of the Indian sub-continent, stretching over 2500 km from eastern border of Pakistan on the west to the frontiers of Myanmar in the east. It covers fully/partially twelve states of India: Jammu &Kashmir, Himachal Pradesh, Uttaranchal, Sikkim, Arunachal Pradesh, Nagaland, Manipu, Mizoram Tripura, Meghalaya, Assam & West Bengal (Fig. 1). Multiple ethnic composition is striking feature of the region with more than 171 tribes inhabiting the region among the total 573 scheduled tribes of India (Samal et al., 2000). Broadly divided into Eastern Himalaya, Central Himalaya and Western Himalaya, each region has its rich cultural diversity, though the ethnic spectra of the north eastern region differs conspicuously from that of the central and western region in regard to their origin, resource use patterns as well as their management regimes. The economic activities of the communities in the IHR varies from sedentary agriculture to nomadic pastrolism and from jhum cultivation to intensive terraced cultivation. The region has a total geographical area of about 5,30,795 sq km being inhabited by 3,15, 93,100 people, representing 16.16% of total area and 3.73% of total population of India. (Table 1) (Nandy & Rao, 2001). Its forests display phenomenal biodiversity that is used to meet diverse needs of the people. The beautiful landscapes, numerous rivers and streams cascading down the mountain slopes, diversity of cultures and religions, colourfull festivals of indigenous/ ethnic communities present strong attractions for people all over the globe, be they nature lovers, tourists, or seekers of peace and truth.

Table 1. The population of Himalayan States as per 2001 provisional census figures and percentage change in contribution to the total IHR population in last decade.

STATE	Area (km^2)	Population	% contribution to the total IHR population		% change (1991-2001)
			1991	2001	
Arunachal Pradesh	83,743	1091117	2.74	2.75 (0.11)	0.62
Assam Hills	15, 322	998509	2.58	2.52 (0.10)	-2.15
Himachal Pradesh	55,673	6077248	16.37	15.34 (0.59)	-6.30
Jammu & Kashmir	2,22,236	10069917	24.43	25.41 (0.98)	4.01
Manipur	22,327	2388634	5.82	6.03 (0.23)	3.66
Meghalaya	22,429	2306069	5.62	5.82 (0.22)	3.59
Mizoram	21,087	891058	2.18	2.25 (0.09)	2.99
Nagaland	16, 579	1988636	3.83	5.02 (0.19)	

					31.07
Sikkim	7,096	540493	1.29	1.36 (0.50)	6.01
Tripura	10,492	3191168	8.73	8.05(0.31)	-7.73
Uttaranchal	53,483	8479562	22.32	21.40 (0.83)	-4.21
West Bengal Hills	3,149	1605900	4.11	4.05 (0.16)	-1.51
INDIA	**3287263**	**1,02,70,15,247**	**-**	**-**	**-**

(Source; Nandy and Rao, 2001)

Value in parenthesis are % contribution f the respective state to the total country's population.

Environmental security and people's aspirations

Despite its rich biological and cultural resources, the region is under-developed. Present trends of environmental trends of environmental health suggest that existing interventions are unsustainable. Economic indicators too, do not reflect the desired effects on economic upliftment. In addition, the inherent fragility of the mountains as well as the increased vulnerability of the Himalaya to human-induced environmental impacts make the people to live in the shadow of fears of natural hazards. Large number of studies carried out in the region focusing on development interventions/ initiatives reflect the unscientific exploitation of resources leading to increasing environmental degradations. Reduced forest cover (Singh et al., 1985, FSI, 2003), accelerated soil erosion and increased silting of water bodies (Valdiya, 1985, 1987), drying up of springs (Valdiya & Bartarya, 1991), replacement and disappearance of species (Saxena et al., 1984; Singh et al., 1984) and increased ratio of energy expended in fodder, fuel collection, and agricultural activity that increase drudgery of womenfolk (Singh et al., 1984) are some of the tell-tale symptoms of environmental ill-health. The region is fragile from both ecological and geological points of view. Because of extremely active geodynamic condition of the Himalayan region, even minor tampering with the geo-ecological balance can initiate environmental changes that may eventually reach to alarming proportion (Valdiya, 2002). The Himalaya is still very young and falls under the category of high seismic zone. The threat of a major earthquake, as per the prediction of some seismologists, is looming large. Despite the fact that large number of agencies/departments that look after diverse concerns, such as forests, soil and water conservation, agriculture, horticulture, road-building, hill development, still it is quite apparent that the success is not uniform and environmental degradation has attained a crisis level.

In the Himalayan region, for a number of reasons, economic health cannot be understood and measured independent of ecological wealth (Samal et al., 2003). The Himalayan people rely on surrounding bioresources for sustenance - be it food, fodder, fiber, fuel or medicine. These resources are, therefore, intimately associated with the life style of ethnic groups. Due to abundance of forests till recent past, there was a major problem of identifying choices to develop natural resources other than the forests. There was hardly any option but to use forest land for the development of any given sector, which has put tremendous pressure on forests (Singh & Singh 1987).

The people of the IHE, like elsewhere in other mountain ecosystems, are heavily dependent for their livelihood on their immediate natural resources and production from primary sectors such as agriculture, forestry, livestock, etc. the dependency of the continually growing population on finite resources, lack of viable technologies to mitigate the mountain specificities and enhance production to meet the demands are depleting the resources along with increasing marginality of farmers, ultimately promoting the poverty.

Environment as a holocoenotic resource system

Environment and ecology have become highly emotive and popular terms, and yet they have different meanings to different people (Singh, 1998). While for a biologist, environment of an organism, whether plant, animal or man, is the collection of other organisms, chemical and physical elements with which the organism interacts (Conway & Romm, 1972). For a sociologist, environment includes as much of what is external as can be reached in any given interval of time, and "each localized population now draws its food and other materials from such a wide area that an accurate description of its effective environment poses an almost insurmountable problem" (Hawley, 1973). This also means that spatially separated systems are in fact functionally related (Singh, 1998).

Ecology is the science that elicits the functional inter-relationships among the different components of environment on the one hand, and between the organism and environment, on the other. A major ecological principle states that environment is holocoenotic in nature, and therefore any change in nature, and therefore any change in one component is bound to change the states of all other components; for example, deforestation leads to increased runoff (hence flood problems), increased soil erosion (hence saluation of water bodies), disappearance of species (hence gene erosion), and atmospheric loading of Co_2 (hence global warming) (Fig. 2). Thus the demand for timber and firewood across the country has had an impact on the forest of the Himalaya and deforestation in the Himalaya affects the flood situation of the Gangetic Plains. This explains how the scale of deforestation effects, ranges from local to regional to global.

Figure 2: Consequences of deforestation indicating the holocoenotic nature of environment. Any change in one component is bound to change the status of all others (after Singh, 1998)

Thus environment not only comprises the life support system for the biological organisms, but also is a system of interacting resource subsystems. The term resource implies management. A proper management will not disrupt a system because a dynamic equilibrium will be maintained among its subsystems and components (Singh, 1998). Therefore, the environmental degradation is the outcome of mismanagement leading to unbalanced and over-exploitation of resources.

Bio resources

Biological diversity is the very basis of human survival and economic well-being as it provides food, medicine and industrial raw materials, and offer a potential for providing many more, yet unknown, benefits to the offers a potential for providing many more, yet unknown, benefits to the persistent as well as future generations. The Indian Himalayan region with 22% of its geographical area under forests, is recognized all over for its biodiversity richness (Khoshoo, 1992). The climate and consequently the biological communities vary considerably along the altitudinal gradients giving a heterogeneous dispersion of biodiversity elements in the region. The north east India along with Myanmar is already identified a bio-diversity hot spot (Myers et al., 2000). The eastern Himalaya (including north-east India) harbours about 8000 species of flowering plants and is considered a cradle of flowering plants, whereas the western Himalaya supports over 5000 species of flowering plants (Rao 1994). The IHR, as a whole supports nearly 50% of the total flowering plants of India, of which 30% flora is endemic to the region. There are over 816 tree species, 675 edibles, and nearly 1743 species of medicinal value found in the Indian Himalayan region (Samant et al., 1988). The local people have been using these medicinal plants traditionally for curing many diseases since generations. However, the valuable minor forest products like edible and medicinal plants, dyes, resins, fiber, cane, and bamboo are being exploited without any value addition thus depriving the local people of the economic benefit that should accrue to them.

Water resources

In the Higher Himalaya, a large portion of the land lies above the snowline. Approximately, 10-20 % of the area is covered by glaciers while 30-40% of the area remains under seasonal snow cover varying from 0.48 ± 0.43 to 2.20 ± 1.25 millions km^2 (Bahadur, 2004). Permanent snow and ice occupies an area of bout 43,000 km^2 in the Himalaya, which changes both in time and space (Upadhyay, 1995). Fluctuations in snow and ice cover are responsible for climate and hydrological variaion to a great extent. The shrinking of glacier in the Himalaya is the reflection of changes in global energy balance at the earth surface. Implications of changes in snow and glacier mass can be serious considering there services rendered by them such as enormous cooling, controlling monsoon, perennial water supply for drinking, irrigation and hydropower and moderation of flood and drought in the plains. Further, the amount of moderation of flood and drought in the plains. Further, the amount of sediments that flow downstream from the Himalaya is a serious matter of concern. It is not surprising that the life-span of reservoirs formed by damming Himalayan Rivers has been reduced by more than half of that originally estimated due to heavy inputs of sediments. A very large share of water from 3 major river systems, viz., Sindhu in Western Himalaya, Ganga in Central

Himalaya and Brahmaputra in Eastern Himalaya goes unused and their potential has remained virtually untapped for betterment of mountain communities.

Human Resources

The population of IHR increased by 2.7 times in the last 4 decades with an annual average rate of 4.19%. Though in the last decade (1991- 2001) the population growth rate (25.43%) shows a significant decline, it is still higher than the national growth rate (21.53%) (Table 2). The decrease in decadal rates for the states of Himachal Pradesh and Uttaranchal reflects the increased out migration from these states. Migration in these areas has basically arisen due to the lack of employment generation opportunities- the agro-sector still forms the major employment generating sector and the lack of development of other sectors constraints absorption of local manpower. Out migration from these states consist mainly of male workers. With able bodies males migrating out of the mountains, the burden of production falls on the women.

In spite of militancy and large-scale migration from the Jammu and Kashmir State, it shows a steady increase of population growth during the last 40 years. The situation north-eastern state of Nagaland is alarming, as it recorded 5.4 fold increase in population in the last 4 decades, though it recorded lower birth rates (19.2 per 1000 in the last decade), suggesting a significant in migration. The implications of this, again is an increased pressure on resources and subsequently, of accelerated environmental degradation.

Table 2: Decadal growth rate of Himalayan states for last 40 years

STATE	Decadal growth rate (%)					Average exponential growth rate (1961-2001)
	1951-61	1961-71	1971-81	1981-91	1991-2001	
Jammu & Kashmir	9.4	29.65	29.69	28.92	30.46	2.60
Himachal Pradesh	17.9	23.04	23.71	20.79	17.53	1.93
Uttaranchal	22.6	24.42	27.45	24.23	20.27	2.16
Sikkim	17.8	29.38	50.77	20.27	32.98	3.01
West Bengal Hills	35.90	25.16	31.02	26.91	23.54	2.38
Assam Hills	60.0	62.79	N.A	78.66	22.74	2.56
Arunachal Pradesh	N.A.	38.91	35.15	36.83	26.21	2.94
Nagaland	73.4	39.88	50.05	56.08	64.41	4.21
Manipur	35.0	37.53	32.46	29.29	30.02	2.08
Mizoram	36.6	24.93	48.55	39.69	29.19	3.02
Tripura	78.7	36.28	31.92	34.30	15.74	2.57

Meghalaya	27.0	31.50	32.04	32.86	29.94	2.74
IHR*	24.0	29.14	28.98	28.54	25.43	2.47
India	**21.6**	**24.80**	**24.66**	**23.85**	**21.35**	**2.12**

* Census operation was not conducted in Assam and Jammu & Kashmir in 1981 and 1991 respectively; interpolation method is used to incorporate the data of Jammu and Kashmir and Assam Hills into IHR.

The population variables are both determinants and consequences of the development process. It helps to understand whether country's economic development and foodgrain production has been able to keep pace with its burgeoning population. The annual exponential growth rate of food-grain production during 1991-2000 was 1.9%, which just about matched the population growth of the country. The situation of IHR is bad as the net sown area comprises only about 10% of its total reporting area and growth rate of human population is much higher than the national average.

The literacy rate (7 years and above) of IHR (about 67%) is marginally higher than the national average (65.38) recorded in 2001 census. The total literacy, literacy rate of males, females and percentage contribution of female to the total literacy is given in the Table 3. The higher difference in male and female literacy indicate varying socio-economic factors of the respective states.

Table 3. Literacy rate of the Himalayan states and percentage change in literacy

STATE	Literacy Rate* (%)	%change in Literacy level (1991-2001)	Male Literacy (%)	Female Literacy (%)	% of literate female among total literates
Jammu & Kashmir	54.46	NA	65.75	41.82	36.24
Himachal Pradesh	75.91	18.87	84.57	67.08	43.76
Uttaranchal	72.28	25.16	84.01	60.26	41.17
Sikkim	69.68	22.37	76.73	61.46	40.73
West Bengal Hills	72.87	25.75	81.28	63.92	42.50
Assam Hills	60.68	54.80	69.75	50.65	39.62

Arunachal Pradesh	54.74	50.34	64.07	44.24	38.01
Nagaland	67.11	8.86	71.77	61.92	43.67
Manipur	68.87	14.99	77.87	59.70	42.63
Mizoram	88.49	7.56	90.69	86.13	46.95
Tripura	73.66	21.87	81.47	65.41	43.19
Meghalaya	63.31	28.94	66.14	60.41	47.09

(Source:Nandy&Rao,2001)

The literacy rate is inversely proportional to the population growth of a nation. In India also the growth rate of human population has decreased significantly in states with higher literacy. In IHR too, states with higher literacy exhibited lower population growth rate, with exceptions such as those exposed to extensive international boundary.

To a large extent, population dynamics such as population growth, population distribution, population density, in and-out migration, have vital responses to mountain specificities. Socio-economic factors such as ethnicity, type of economic activity and resource management practices play a major role in determining the pace of development. Some of the dynamics affect the specificities and thus the productivity of the area and the biodiversity in short or long term, while others mitigate the specificities through adaptability. Moreover, since demographic behavior is related to productivity, understanding of specific demographic issues like migration and population pressure and incorporation of these into productivity programme will result in multiple benefits, i.e. improving productivity and quality of life of the local people. Understanding, how local and indigenous people are associated with resource use and management, their needs and uses, their economic relations with the resources will help in the productivity of the resources. Identification of social, cultural, economic and political issues such as gender, poverty, education, land tenure, legal rights, trade, debt, and others will help in understanding how they affect the productivity. There is a need to know how gender is related to population –resource relationship and to identify women's role in development and planning to enhance productivity. The development process will include options which have larger human dimensions such as socio-economic conditionings and cultural principles, simple technologies and indigenous knowledge.

Interdependence of ecological and socio-economic activities

The problem in the Himalaya and the complex having intricate linkages between social, economic and ecological concerns. The solutions, therefore, cannot be addressed in isolation. To cite an example, the agro-and the forest ecosystems are so intricately inter-related and inter-dependent that it is futile to talk of forest management in isolation of the cropland. In the central Himalayan region it is estimated that the cost of subsistence agriculture on the forest ecosystem is very high, e.g. for each unit of energy obtained in agronomic production, seven units of energy are expended from the forest through the use of firewood, fodder and vegetal manure (Singh et al., 1984). A greater ratio of forest to cropland (5.18:1) is needed for sustenance of agriculture against the present ratio of 1.66:1. Problems have appeared because of the reduction in this ratio, implying that the carrying capacity of forests has already been exceeded. Similarly, the pasture development of revegetation of wasteland without solving the problems of animal husbandry, fodder and fuel requirements (Singh, 1997) is not possible.

It is apparent that sectoral practices of management (or development) will not work, and therefore, the only approach which will work is a holistic approach consistent with ecological and social principles. This approach also implies that the hill and the adjoining plains must be taken as the macro-planning unit, with smaller structurally and functionally definable units for micro-level planning. The various ecosystems should be categorized into protective, productive and waste-disilpative systems and should be managed as per their roles.

Until 1970s, there was geographical and political isolation of most of the Himalayan region. The low human population density at that time was largely responsible for maintaining a stable and slow economic growth without much detriment to environment and ecosystems, except for the places of commercial logging. From the perspective of the consumer society, most of the Himalayan region remained an economically backward entity. The basis of any planning for sustainable development in mountain areas has to be centered around man's relationship with nature. The relationship is desired to be governed by a sense of justice and equity. Each culture is the result of the people trying to survive within their environment and indeed of an attempt to optimize the use of its resources (Agrawal, 1992). Life style and production systems develop steadily by experimentation and observations over centuries till they became so culturally incorporated that they are like genetic knowledge. This has been inherent in many tribal societies but in modern acquisitive society "economy" gets priority over "ecology". There is a need to evolve a new paradigm to restore balance between economic interests and ecological imperatives. Although the ecological and economic systems have a myriad of inter-connections, the most simple and most obvious is this: ecological system provides raw materials to the economic system and absorbs the waste generated by the economic system (Fig. 3). Therefore, the system will be constrained by the productive and waste –absorption capacities of the ecological system. The moment one or both these capacities are exceeded, ecological backlashes are bound to occur. Once the waste-dissipative capacity of Ganga was exceeded, severe pollution problems emerged which is now costing the government a huge sum of money with still doubtfull level of final outcome. Same goes for the water bodies in the hills. As soon as the timber extraction or fuel extraction exceeded the limit of the harvestable productivity of the forest, the latter began to degenerate (Singh, 1998).

Figure 3: Interrelationship between ecological and economic systems (after Singh, 1998)

The ecological and economic considerations are therefore to be combined for attaining ecologically sustainable development. Both ecological and economic values can be served individually in a variety of ways, but combining ecological and economic considerations adds geometrically to the complexity of development programme (Caldwell, 1984). When socio-cultural systems are added on to the ecological-economic relationships, the situation becomes further complicated (Fig.4). However, development driven solely by economic considerations has changed the aspirations, value systems and management priorities. Demographic and legal factors further complicate the application of ecological considerations to development goals and processes. It is advisable that the management of such ecological resource upon which local communities depend should be decentralized, and these communities should be given an effective say over the use of these resources (WCED, 1987). This, today, is the greatest challenge nationally as well as in the global context.

Figure 4: Superimposition of socio-cultural system on the relationship of ecological and economic systems (after Singh, 1998)

There is also an imperative need for extraordinary care when it comes to modifying topography by excavation, placing loads of water and sediments in river impoundments, changing groundwater circulation through road cutting, or removing protective cover of forests (Valdiya 2002). Programmes of environmental security must be undertaken simultaneously with the implementation of development projects. The two programmes are inseparably linked. The environmental security and hazard management programmes must form an essential part of the paradigm of development in the mountain States.

Achieving sustainable development

Simply stated, sustainable development implies the use of ecological system in a manner that satisfies current needs without compromising the needs or options of future generations (WCED, 1987). Strategies for sustainable development must be based on reliable and comprehensive data on natural, socio- cultural and socio-economic resources, as well as on the environmental set up. These strategies should incorporate traditional knowledge and established production systems after these have been carefully evaluated.

The aim of sustainable development should be the maximize human well-being or quality of life without jeopardizing the life support environment. Although there is no unique definition of quality life, the following four groups of variable together might be considered its indicators: (1) Economic variables: per capita income, employment stability, income distribution; (2) Ecological variables; ecological degradation, environmental quality, use of renewable and non renewable resources, man-initiated energy consumption; (3) Socio variable: social security, emotional support, intellectual growth and mental satisfaction; (4) Cultural heterogeneity and (5) Political variables: scope and uses of government services, political participation, political power advantage and policies.

The solutions for ecological and economic problems in the IHR are to be sought within the permissibility of mountain specificities and adaptability of people which is governed by socio- cultural principles. Identifying sustainable landuse practices, promotion of on-farm activities, value addition to all resources and adoption of environmental friendly technologies, restoration of degraded ecosystems, biodiversity conservation, water resource development, promoting community based management, upgrading infrastructure, improving quality education and capacity building to ensure benefits are but a few priority activities to improve livelihoods, income and environment of the Himalayan region.

Ecological sustainability

Sustainable landuse practices

The term 'land use' includes all the natural (water bodies, forest, agriculture, rocky area, grassland and pasture land) and cultural or manmade (settlement, urban area, agricultural uses, road and path) uses of land. Land uses differ from area to area and state to state. Also, the villages at the bottom of the valley and the one situated up the slope of the same mountain have different land use systems. Lately the status of various areas under different land uses has depleted due to increased human pressure and therefore would require different strategies for sustainable development. Tribal communities have inherent dependence on different land uses and they identify all these lands with the types of its utilization. Such inherent knowledge of land uses be harvested to upgrade the status of these lands.

Restoration of damaged ecosystems

The problem of ecosystem damage is global and as much as 43% of the earth's terrestrial surface has a reduced capacity to supply benefits to humanity because of direct impact of faulty landuse (Daily, 1995). Himalaya is no exception. In the past, under low population pressure, people extracted forest products from mature, complex forests or converted them to temporary agricultural fields to produce food and fibre without degrading the sites irreversibly (Fig. 5). Natural succession occurred after abandonment and these sites reverted to forests. At intermediate stages of succession, secondary forests were produced that provided many valuable products and services for humans (Brown & Lugo, 1994). This was a sustainable land use and is exemplified by jhum cultivation. However, mounting population pressure resulted in a decrease in the fallow period, and at many places the land became degraded or damaged with reduced potential of recovery and productivity.

Figure 5: Conservation of forest leading to sustainable land use and damage or degraded land. Pathway 1 represents temporary forest or to agriculture; pathway 2, natural succession after abandonment and pathway 3 represents prolonged over use with none or very short fallow period, leading to damaged land (Based on Brown & Lugo 1994).

The degraded ecosystem need to be restored or rehabilitated in order to (I) convert unproductive land to self- perpetuating ecosystems, (ii) prevent further damage to adjoining ecosystem, (iii) reverse the negative trend of land degradation, and (iv) prevent further loss and restore biological diversity. There are three major options: (i) Restoration, i.e. full recovery of species composition and ecological complexity, (ii) Rehabilitation, i.e. improvement of ecosystem function with only partial recovery of species diversity and ecological complexity, and (iii) Creation of alternate ecosystem, i.e. replacement by a different ecosystem for optimizing a given function e.g. productivity (Fig. 6). Choice is to be made depending upon the logistics and societal aspirations. The G.B. Pant Institute of Himalayan Environment and Development has successfully demonstrated the way for rehabilitation of a watershed in Sikkim (Sharma et al., 1998).

Figure 6: Options for the improvement of a degraded ecosystem (Based on Bradshaw 1977)

Biodiversity Conservation

The cumulative impacts of industrial civilization in last century have jeopardized the future of a large number of species, leading to mass extinction. The causes for this major catastrophe are: habitat loss and fragmentation, unplanned introduction of exotic species, over-exploitation of plant and animal resources, pollution of soil, water and atmosphere, and the possible global climate change (Singh et al., 1994). Today we are losing at least one higher-plant species per day from tropical forests alone. If the present trend continues, about 25% of the total 250,000 higher-plant species will be lost in the next few decades and another 25% by the end of the twenty first century. Further, we can expect the demise of 20-60 animal species per plant species lost. World –wide about 492 genetically distinct populations of tree species are endangered. At least five major mass extinctions have occurred in the past. The two most serious were those occurring at the end- Permian (245 Million yr ago) and end-Cretaceous (65 Million yr ago) when 96-97% species of marine animals were lost. The end – cretaceous extinction is also estimated to have removed more than 50% of plant species and may have played a pivotal role in structuring the Cenozoic flora. While the past extinctions occurred each time over a span of a million years or less, the present mass extinction may well occur within a short period of about 200 years. Biotic recoveries after mass extinctions are known to have occurred and there is no reason why this will not after the present anticipated mass extinction. The prospects of recovery have little practical value, however, because calculations based on the recovery period in the prehistoric past suggest that the time required will be at least 5 million years, or possibly several times longer. If the present mass extinction is allowed to proceed, the recovery may need a period equivalent to 20 times over the period of human tenancy of this planet.

Because of rich biological diversity of the Himalayan region, this millennium belongs to this region. The Himalayan region with its vast green cover is acting as "sink" for carbon dioxide, one of the gases responsible for global warming. This is one of the important ecosystem services being performed by the Himalayan region (Singh, 2002).

In view of going threat to biological diversity it is important to learn how natural communities/ ecosystems are affected by progressive erosion of biological diversity, and how the biodiversity can be used through biotechnology. Conservation and rational use of biodiversity of the Himalayan region could bring enormous economic benefits to the local populations and can indeed contribute to sustainable development. The G.B. Pant Institute of Himalayan Environment and Development has already produced an action plan for Himalayan Biodiversity (Dhar, 1997) and has developed the concept of biodiversity-based ecotourism. That should be exploited for larger benefits.

Community based management

For along term sustainable development of the Himalayan region, the communities of the area need to be empowered more for promoting common property resource management (CPRM). In the past, all the villages were having a strong CPRM structure and accordingly, enough institutions were available to watch over this. Since the colonial period unfortunately the resources (forests, water, pasture, etc.) were centralized, particularly in western and central Himalayan region. In north eastern region, however, resources still remain in the hands of the community and village institutions still manage them as per their need and choices. To increase the community participation in developmental activities there is a need to empower communities for CPRM so that the basic requirements are met from these resources.

People's participation, being a social phenomenon, takes a long time to evolve. Participation involves decision making, implementation, sharing the benefits, monitoring and evaluation. A number of factors, like physical & biological, economic, political, social, cultural, and historical are generally encountered in the process of participation (Samal & Sharma, 1997). However, creation of a common platform, identification of most pressing common problems, democratic decision making process, cooperative management system, special focus on women, and facilitating village organizations and need-based planned socio-economic development, etc., can encourage participation.

Economic sustainability

On farm and off-farm activities

In the Himalaya, land is the most precious resource of local inhabitants and majority of population is engaged in agricultural and allied activities. Over 85% women force is actively involved in these activities. A major share of Himalayan agriculture is done under rainfed conditions, and in scattered/ fragmented landholdings. Such areas are low in crop productivity and the subsistence agriculture does not provide income-generating opportunities to continuously increasing population. In this scenario the agricultural output is not enough to meet the year long food demand, and does not provide monetary returns. Consequently, a substantial proportion of male population migrates to other parts of the country in search of livelihood options. There are a number of on farm/ off farm activities which are low cost and eco-friendly. Application of such technologies and practices can play a major roll in rural development. The main on farm technologies are protected cultivation (polyhouse, polypit, polytech), income generating (cash crop cultivation, off season vegetable cultivation, floriculture, cultivation of medicinal plants, horticulture). Organic farming has a great potential in the mountains.

The main off-farm activities are integrated mushroom cultivation, apiculture, fruit & vegetable processing, sewing and knitting, traditional art. With a number of agro-climatic zones, the Himalayan region is well suited for cultivation of a large number of food crops, fruits, medicinal plants and other valuable species. Selected states have achieved much progress as host of horticultural crops like apple, orange, pineapple, banana, kiwi etc. are being grown extensively. There are enough possibilities to increase the extent of cultivation of these species in other regions as well.

Mountains have always been on the focus of the tourists because of their landscapes, forests, lakes, adventure, wilderness, and sacred and religious values. Of late, certain state governments have been promoting ecotourism as a potential mean to increase income from tourism sector and also preserving their ecology.

Hydro power development

The Indian Himalayan region with its numerous rivers and streams has the potential to generate almost one-third power requirement of the country. The hydro-electric power potential of the Bramhaputra system in eastern Himalaya is identified to the tune of 9988 MW (megawatt), for Ganga system 11,579,W and for Sindhu system 6,582 MW (at 60% load factor) (Valdiya, 1997). Unfortunately only a very meager quantum is being generated at present. Nearly 455 billion cubic meters of water flows down the Bramhaputra every year. The water is largely contributed by the rivers of Arunavhal Pradesh. This tremendous bounty of the Himalaya goes waste- without its potential abeing tapped. It may be noted that in addition to power potential the Bramhaputra, Ganga and Sindu systems have the irrigation potential of about 12.3, 185 and 49.3x 10^9 m^3 (Valdiya, 1997). There are many areas of hotsprings in the Himalayan region, the average heat flow of which is of the order of 107±26 mW/m^2. The energy of these hot springs can be profitably utilized for running electricity generating turbines and heating buildings and glasshouses meant for growing vegetables and flowers.

Since, it would be imprudent to go in for high dams in highly earthquake –prone Himalayan region of active faults, smaller dams would better serve the purpose of harnessing energy and storing water (Valdiya, 2002). Admittedly, the cost of production of electricity is high for small hydel projects. However, if one were to think of the real (total) cost of the water-resource development project that includes the values of the losses of natural resources due to submergence, the expenditure on restoring or repairing the damaged land, and the enormous financial implications for relocation of uprooted people, the higher cost of electricity generated by small hydel projects is more than compensated (Valdiya, 2002). Furthermore, the water resource development sites could develop into new townships that can absorb many unemployed youths to provide opportunities for businessmen, traders and skilled craftsmen.

Infrastructure and quality of life

Lack of infrastructure impedes economic development of the majority of the Himalayan States. In order to push forward the multifarious programmes of development and of scientific and technological pursuits the existence of a strong base of infrastructural facilities is essential. It also provides a unique opportunity to planners to pursue the goal of sustainable development with a position of strength, which lies in having the benefit of hindsight and not repeating the mistake or of replicating a model based on resource-intensive economic development. Instead of seeking subsidies, which are bound to make the States hopelessly dependent on doles and favours, the Governments should insist on compensation for providing ecosystem services to the nation. The Uttaranchal Government has already taken initiative in this direction.

Value addition and eco friendly techniques

The development process in IHR has not been able to introduce suitable interventions and technologies to mitigate mountain specificities, enhancing the production system, and to combat poverty of the growing population. Despite voluminous development interventions poverty is rampant and increasing IHR with few exceptions, while it is decreasing in the country (Rangacharyulu, 1998). The concept of value addition has not yet been fully developed in IHR region, through there are various areas which have the potential to yield more economic return by value addition. Let's take the example of medicinal plants which are collected and transported out of the region directly. Based on the available existing traditional knowledge of various usage, if some value is added and instead of the plant material if some products are made and marketed that would add manifold to the Himalayan economy. Similarly, there are a number of such resources which have tremendous potential for marketing.

Education and capacity building

Education has a very effective role to play in environmental management and sustainable development, and should provide a high order of common purpose and understanding between people, scientists and politicians. Education must result constituency which is politically effective in matters related to environment. Education should be developed in the context of Himalayan region where a child should be taught about its immediate environment and how could a better living be made within the region in harmony to nature.

We all agree on the prime importance of conserving the ecosystems and species in their natural environment, but we need to built capacity for this. Much has been written about the size of human population and its negative impact on environment and development. Quality of population is an equally, if not more, important factor because man himself, being a component of environment, component of environment, constitutes a resource. A high quality human resource can stretch the other available resource by better management, can develop alternate resources, can remarkably increase the output per unit resource use, and can successfully implement corrective measures during resource exploitation.

An enlightened consistuency will not press the politicians for, nor will it allow the construction of unnecessary roads, or setting up of industries and five-star hotels that conflict with the environmental imperatives. Education be such that public should realize from within, not told what is good for them and for their future generations, i.e. development of a sound socio-ecological ethics with explicit political expression.

Special education and training programmes are needed to be launched for women folk. They need to be trained in management of biomass and water, in ecotechnologies of agriculture, horticulture and forestry, in planning and budgeting production –related activities, in keeping accounts and monitoring progress, and also in home science and Medicare, handicrafts, etc. No endeavors of development would succeed without making the women socially strong and financially self-supporting or self- reliant.

Education must produce scientists and researchers who can cut across the traditional water tight disciplines and work in a transdiciplinary teams to tackle the multi dimensional problems of environment. Transdiciplinary research approach involves multilevel interactions and horizontal and vertical co-ordination of disciplines which lead to an entire common-purpose system having scientific, technological, planning and policy-making levels. Team members for such systems cannot be produced by traditional interdisciplinary teaching departments. These scientists should at least be able to understand the basic languages of several disciplines (e.g. biology, mathematics, computer science, physical sciences, and social science). Their training courses have to be broad and exacting at the same time, and should involve practical work-experience with real-life problems. Departments of ecology or institutions of ecology can fill in such a need. Participation and co-ordination by ecologists will also enhance the contribution by interdisciplinary scientists in the team. Besides ecology, we have to strengthen education in environmental geology, hydrogeology, mountain meteorology, environmental psychology and sociology, and ecological planning of hills. The academic institution would considerably benefit if the tradition of Visiting Faculty is adopted as a policy.

Long-term database

Himalaya region is an ideal ”crucible” for diverse planners, social scientists, technologists, and decision-makers to experiment and evolve a new paradigm of development. It provides an opportunity to intelligentsia of the society and throws a challenge to provide a solution to the malaise on both environment and economic fronts. However, long term specific databases are needed.

We know that there is a great deal of year to year variability in the ecological phenomena. Certain ecosystem responses are quick enough to be observed within 1 to 2 annual cycles, others are cyclic with variable temporal amplitude. This necessitates establishment of permanent sites for continued long term observations and monitoring of the impact of alternate management options. Without such a long term database it is difficult to characterize a natural system and to predict its response to a given development perturbation. Such a situation leads to a scenario where a crisis has developed, the decision maker wants a quick solution but the scientist calls for time to research the problem before suggesting a long-term solution. The result invariably is a quick fix with no recourse to more basic ecological measures, and therefore the solution implemented is not sustainable. The G.B. Pant Institute of Himalayan Environment & Development, as an autonomous institute of the Ministry of Environment & Forests with its 7 key core programs is fully equipped for taking up such kind of researches.

Indigenous knowledge, innovations and practices

Considering the role of indigenous system in resource management and sustained development of local people, Convention on Biological Diversity (1992) has recognized it as a tool for resource conservation through Article 8 (J) which reads "…. respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional life styles relevant for the conservation and sustainable use of biological diversity…". Article 10 (C) of the Convention also reads "protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements". Undisputedly, the role of indigenous knowledge is pivotal in the region in sustainable use and conservation of resources; however, they are fast disappearing resulting in habitat loss of resources.

In their efforts to survive in remote places having inadequate or no infrastructural facilities, the people of Himalayan region of India have evolved unique indigenous knowledge systems. These indigenous knowledge systems based on locally available bioresources, play a pivotal role in promoting the economy and in conserving the resources. The understanding of the indigenous knowledge system of native societies of the region is of paramount important in sustainable development (Samal et al., 2000), as these have a historical continuity of "living in harmony with nature" with mutual dependence on primary natural resources, and process a sound knowledge base of the behavior of the complex ecological system. For example, the traditional practice of multiple cropping, best suited for rainfed agriculture and prevalent in this region, is based on indigenous knowledge. Further different land races and crop varieties, in practice in the region, have probably evolved according to native micro-climate, soil conditions and tolerance to various biotic and abiotic stresses; the practice of cultivation of different land races minimizes the risk of crop failure due to pathogenic or climatic factors often observed with monoculture. A large number of socio-cultural practices comprising ethnomedicine, ethnoveterinary practices, sacred groves, etc., are applied by the mountain communities to survive in their environment (Farooquee and Nautiyal, 1999). In brief, the indigenous knowledge, innovations and practices of the people of region revolve around traditional values of resource use that include subsistence values (food, clothing, housing, medicine, energy), socio-cultural values (ritual, spiritual, aesthetic, educational, psychological), economic –commercial values (agricultural, industrial, pharmaceutical, tourism), and traditional practices of resource use (agro-diversity, wild edibles, medicinal plants & Ethnomedicine, forest & grasslands, ethnoveterinary, etc.). Unfortunately these practices are fast disappearing and eroding by growing tide of technification, and therefore, deserve immediate attention. Further, indigenous knowledge is scattered and associated with low prestige rural life and even those who are its bearers may believe it to be inferior (Warren, 1989). There is also a need to explore possibilities for their value addition and validation through appropriate science and technology inputs which would rejuvenate and enhance the efficiency of the products and improve their economic potential.

Conclusions

The unique majestic Himalaya has provided immense ecosystem goods and services in the past and, with proper planning and management will be able to provide the same in future also. However, we must acknowledge the fact that the whole IHR is facing anthropogenic pressure leading to overall degradation of its environment. Once symptoms of environmental deterioration become apparent, most often the only option left is to react to the situation and try to cure the problems by costly corrective measures. It is much better however, to be able to anticipate the problem and take up preventive measures in the very beginning. Proper education at various levels, long-range database and a holistic approach would bring us nearer to sustainable development involving better quality of life, improved economic status, minimized adverse effect on life-support environment. There is also a need to experiment and devise ways and means to ensure that the development does not destroy its bio-cultural diversity and social fabric. The Himalayan region should not be burdened with backward-dragging heritage of the past, nor be burdened with backward-dragging heritage of the past, nor be constrained by the mistakes that bigger states have committed since independence. I dream of the revolution sweeping Himalayan region and a new age of plenty and progress coming with the ushering of the next millennium. Our present embodies our future also. It is only the future that we have to think about.

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