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BIODIVERSITY CONSERVATION IN HIMALAYAN REGION

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Abstract
The Indian Himalayan region (IHR) stretches over 2,500km from Jammu & Kashmir in the northwest to Arunachal Pradesh in the north-east, and covers partially/fully twelve mountainous states of India. The region with a geographical coverage of approx. 16.2% of the geographical area of the country is inhabited by about 42 million people. The IHR represents three bio-geographic zones (namely, trans Himalaya, Himalaya and North East India) and nine bio-geographic provinces. Each of these provinces has remarkable cultural, ethnic and biological diversity. The region contains snow- clad peaks, glaciers and dense forests with rich diversity. Over 9,000 Himalayan glaciers and high altitude lakes form a unique reservoir storing about 12,000 km^3 of fresh water. Mighty streams like the Indus, Sutlej, Yamuna, Ganga, Kali, and Brahmaputra arise from the Himalayan region. In the IHR forest is major land use/land cover category (as recorded forest area). According to the State of Forest Report, forests cover ~ 41% of geographical area in the IHR out of which 16.9% area is under very dense forest cover, 45.4% under moderate forest cover and the remaining 37.7% under open forest category. Himalayan forests are extensive and diverse and they differ significantly from both tropical and temperate forests with respect to structure, growth cycle and function; as well as in terms of ecosystem processes.

Key Words: cycle, ecosystem, forests, Himalayas, landscape, region, tropical, vegetation

Introduction

The forest vegetation in the Himalayan region ranges from tropical dry deciduous forests in the foothills to alpine meadows above timberline. The biomass productivity (17.0 -21.0 t/ha/yr) of the pristine forests of the region is comparable to the highly productive forests of the world ranging from 15.0– 30.0 t/ha/yr among major forests of the region. The C pool in the IHR forests (vegetation + soil) has been estimated at 5.4 billion ton ((@65 mt C sequestration which is annually valued at Rs.37.5 billion/yr) Singh. Diversity and uniqueness of Himalayan forests has contributed significantly towards richness of biodiversity elements at different levels that places the region amongst 34 identified Global Biodiversity Hotspots.

The Himalayan region being a forest dominated landscape; the forestry sector calls for immediate attention and implementation of action oriented programs. In this context, keeping the experiences of on-going forestry research in the region in view, and recognizing the current needs, an attempt has been made through this article to highlight some important issues which require in-depth efforts to better understand the forests of this region, particularly for their role in human well-being and sustaining the Himalayan ecosystem. The emphasis in identification of issues is to highlight hitherto neglected and/or less explored areas of research that have convergence with the contemporary global thinking as well as hold greater significance for emerging priorities at the national level. For instance, India's National Action Plan on Climate Change-NAPCC, considering national and global importance of the Himalayan Ecosystem, has made special provision of a National Mission for Sustaining Himalayan Ecosystem, one of eight missions and the only mission which is location specific. Furthermore, specifically focusing on forestry sector, the National Mission for a Green India has given directions for defining priorities specially in order to ad- dress climate change (CC) vulnerabilities in the landscape by way of, enhancing carbon sinks in sustainably managed forests and other ecosystems, enhancing resilience and ability of vulnerable species/ ecosystems to adapt to the changing climate and enabling forest dependent local communities for better adaptation in the face of climate variability.

Considering the above, it is an opportune time in the United Nations Decade on Biodiversity (2011-2020) to rethink and reorient our forestry research in the region to con-tribute in achieving long-term national and international goals of forest biodiversity conservation and sustainable development [9]. Further, in the Rio+20 era, when global attention has increasingly focused on sustainable development needs under the accelerated global change scenario, there is an urgent need to reorient research priorities to address the changing global needs in order to arrive at realistic monetary contribution of tangible and intangible benefits of forests to the GDP. Furthermore, the current global thinking on forests supports cross-sectoral and cross-institutional policies promoting sustainable forest management and stresses the importance of integrating sustainable forest management objectives and practices into the mainstream of economic policy and decision-making.

Emerging Concepts on Forestry and Biodiversity Conservation

In the recent decades quantification and valuation of forest ecosystem services (FES) has occupied the centre stage of research agenda the world over. Emphasis is being paid to value the intangible services of the forest ecosystems so that conservation efforts of the stakeholders are rewarded in economic terms and compensation mechanisms (payment for ecosystem services) are devised and brought into the policy framework. In the IHR, FES are intricately linked with the livelihood of the people, hence well recognized but poorly understood. Therefore, systematic studies are required to better understand, quantify and value the FES. Particularly the regulating services of the forests such as pollination, soil and water conservation, soil fertility maintenance, C-sequestration, bio-diversity conservation, etc., deserve priority attention. Forests play a key role in removal of accumulated CO_2 in the atmosphere, and sequester it in vegetation, soil and wood products. There is a great scope for using Himalayan forests as C-sink and developing C-mar-kets through the involvement of local inhabitants in management of forests. Special efforts need to be made to harness benefits from programmes like 'Reduced Emission from Deforestation and Forest Degradation' (REDD) under the United Nations Framework Convention on Climate Change (UNFCC). This can be achieved if ad- equate emphasis is given to integrate policy studies and ecologists and environmental economists join hands to address this aspect.

The mainstay of mountain people in the region is subsistence agriculture based on biomass resources of surrounding forests. Each energy unit of agronomic production entails about 10-20 units of biomass energy from the forests in terms of fodder, forest floor litter for crop-field manuring, agricultural implements and firewood. With the changing trends of climate and global economies, the agricultural scenario in the region is fast changing. This has certain impacts on the forests and forest resources. In this context, the carrying capacity of forests vis-à-vis agricultural intensification/ diversification needs to be understood. While considering intricate linkages of forests with agriculture and horticulture in the region, among others, the role of forests in providing "pollination services" needs to be considered on priority. This need is evident, as over 90% of flowering plants are pollinated by animals and majority of crop plants are pollinated by insects; bee pollinated crops alone contributing about 30% of human food, and reduction in the population of native pollinators, due to habitat loss of insects will result into insufficient pollination and crop productivity. Studies reveal that declining apple productivity in Himachal Pradesh is a result of inadequate pollination and the farmers are now compelled to rent colonies of honey bees for pollinating the apple orchards @ Rs.500/colony and devise short-term solutions (such as hang- ing flower bunches "bouquets" on apple trees until the "polliniser" trees in their orchards begin flowering) to attract the pollinators. Therefore, land use changes have consequent impacts on pollinators diversity and density.

As is well known, forests are also a rich repository of genetic diversity. In future biodiversity is expected to bring enhanced and economic prosperity to the people living in biodiversity rich areas, like the Himalaya. There is, therefore, an overwhelming need, with community participation, to make special plans, and provisions for initiating activities that will facilitate the maintenance, protection, conservation and wise use of biodiversity in the entire IHR. The issues of forest biodiversity conservation, sustainable use and benefit sharing, as defined in the CBD Program of Work for Mountains, deserve priority in forestry research. Among others, the role of forests as habitat for unique (i.e., endemic, charismatic, flagship or umbrella species) and high value (e.g., medicinal plants, wild edible plants, etc.) elements of biodiversity also requires adequate research attention. Studies on response of forest biodiversity, especially the unique and high value taxa, towards changing climate and harvesting intensities would help in appropriately defining the effective forest management regimes. Further, the development of modern science and technologies notably biotechnology and information technology have increased the value of biodiversity and associated traditional knowledge of its use and conservation. Un- der the Biological Diversity Rules, 2004 published by Govt. of India, National Biodiversity Authority at National level and State Bio-diversity Boards (SBBs) at State level have been formed and the process of constituting Biodiversity Management Committee (BMC) and maintaining 'People's Biodiversity Registers' has already be- gun in the country. The adequate research must flow in for making the products of this nationwide process authentic and acceptable across stakeholder groups and the access and benefit sharing (ABS) mechanism need to be give due consideration.

A critical assessment of available information on Himalayan forests is essentially required and the outcome should be used to create a globally acceptable Himalayan forest database such as: (i) most often, in existing literature, the ecological value of selected prominent (dominant/co dominant) taxa has been exaggerated with gross underestimation of the role of other associates. As a result, management and conservation prescriptions of forests are largely focused to dominant taxa; (ii) there is very little information on possible effects of habitat/spatial heterogeneity on demographic processes of individual species that masks the questions on inter and intra-specific interactions of plants; (iii) most of the available information appears to be biased in favour of hermaphrodite or monoecious group of species. Therefore, many significant dioecism dependent effects on structure and function of forest stands have remained unaccounted. These aspects, and many others, highlight the gaps in Himalayan forest database. Such gaps can be filled through appropriately designed research studies in the region. Also, in view of the significance of Himalayan biodiversity, Govern- ment of India has established over 173 Protected Areas (PAs) in the IHR, which has steadily expanded over the years. Therefore, there is a need to have a systematic conservation planning, which considers the detailed distribution patterns of biodiversity within forests, the socio-economic situations and conservation effectiveness of existing PAs.

Fire has now become an integral part of the mountain land-scape, particularly around the human settlements. Forest fires of medium to severe magnitude are often witnessed in the IHR in late spring and summer, and sometime during the long dry spells in winter also. Further, anthropogenic pressures magnify the loss of forest wealth due to fire. Pine forests represent a fire adapted ecosystems, and the upward expansion of chirpine (Pinus *rox- burghii*) in the climax oak (*Quercus* spp.) forests is ushering changes in the forest ecosystem services. Some pioneering studies on forest fires do exist; however, fire being a powerful tool that affects the forested landscape and also contributes to black carbon in the atmosphere. These aspects need to be studied in some detail, particularly with respect to several structural and functional attributes of forests (such as, soil erosion, nutrient leaching, invasion of weeds, loss to the native biodiversity, etc.).

In this region competition for resource use, development of road networks, hydro-power projects and other developmental activities, mineral extraction, market oriented agriculture, forestry and livestock grazing, etc., have contributed towards land use and land cover changes. Deforestation also causes change in precipitation, temperature and ultraviolet beta radiation arising from changes in CO_2 levels in the atmosphere and albedo effect, and the consequential damage to the ozone layer. Forests that experience a net loss of biomass volume through mortality due to disease or fire become net C emitters. However, we lack adequate research on most of these aspects. Among others, effective use of RS and GIS technology towards assessment of patterns and intensity of land use and land cover change in the region, and development of likely scenarios both at spatial and temporal scale should form another research agenda in the region.

Climate change is a reality now; more so the Himalayan eco-system is sensitive to this change. In this context biophysical models in association with regional CC scenarios need to be used to assess the impact of CC on forest ecosystems in terms of shifts in boundary of forest ecosystems and upward movement of tree lines, forest ecosystem change matrix, change in species mix and composition of vegetation types and species vulnerability to identify vul- nerable forest ecosystems, regions and hotspots. Implications of CC on phenological shifts in plants has been well established globally, particularly in temperate climate that has certain implications on structural and functional aspects of the forests, including mismatch in timing of pollinators, seed maturation and seed germination. It is envisaged that the effects of CC on the sub-alpine and alpine plant species that inhabit mountain ranges with restricted habitat availability, above the tree line, would experience local extinction if they fail in moving to higher elevations. Identification and management of corridors for facilitating effective movement of biota (including wildlife) in the face of CC have, therefore, should gain research attention.

The Himalayan forests, on account of large dependence of inhabitants for a variety of biomass needs, are under different levels of chronic disturbance. However, understanding of the relationships between disturbance levels, vegetation (and regeneration) patterns, which provide important basis for predicting the status of species diversity and population dynamics in plant communities is poorly understood. Few studies in recent years have, however, provided empirical evidences of disturbance sensitivity pat- terns of Himalayan forests, such as in oak forests and sub-al-pine forests of the west Himalayan region. Considering these clues, forests in the region require more intensive investigations for better understanding the impacts of ongoing changes under continued anthropogenic pressure, and prioritization of such zones for implementation of afforestation and reforestation programmes in community wastelands to divert the pressure from surrounding forests should be used for devising research and action agenda. Also in, many of the old–growth forests regeneration is hampered on account of abiotic factors those require suitable silvicultural interventions that require and systematic studies across diverse forests under varying disturbance intensities. In this context, invasion of weeds such as, *Lantana, Eupatorium, Parthenium,* spp. etc. have posed an additional risk to forest biodiversity and resources in the region that requires ways and means of systematic eradication of such weeds. Further, possibilities of utilization of these species, as a part of participatory eradication strategy, need to be worked out along with cost-benefit assessment.

Soil and water conservation (SWC) is one of the most important ecological services of the mountain forests. Regulation of hydrological regimes (stream flows and atmospheric moisture) by the forest vegetation both at local and regional scale drives a variety of eco- system functions. Provisioning of water for people and role of forests in soil formation and soil fertility replenishment has both local and regional relevance. In spite of this crucial link of forests and water the hydrology of the forests and forested watersheds in the IHR is least understood. It is still uncertain that which of the forest types (viz., broadleaf or conifer) and tree growth forms (evergreen or deciduous) are desirable for achieving SWC in the region without compromising other ecosystem services reasonably. Therefore, hydrological studies on forests are essential for planning afforestation and soil and water conservation programmes in the IHR.

Forests are an important source of NTFPs (including medicinal plants) on which livelihoods of a large section of mountain communities depend. For example, *Morchella esculenta* (edible fungi) and selling Kafal (*Myrica esculenta*) a wild edible fruit that is found in the forests of western Himalaya alone earn appx. Rs.1.4 million/ season. It is expected that with the CC, increase in drought cycles and concomitant increase in forest fires the benefits accrued from these forests would influence forests, NTFPs and medicinal plants based livelihoods of the inhabitants. It requires proactive actions for climate change resilient forestry on “forests for food” thinking and make strategies for forest management and encourage farm forestry to meet the need of the people in the face of CC. Thus, working out feasibility of forest resources and forestry activities in promoting rural development in the region should be considered as a part of intensive research agenda. For example, the wealth of non-timber forest products (NTFPs) in pharma, nutraceuticals and cosmetic sectors in Himalayan forests could contribute significantly to the primary sector based domestic products, pushing up the per capita income of local communities.

Conclusion

In keeping with the fact that, due to unique vertical gradient, the Himalayan biodiversity is highly sensitive to CC as well as to the anthropogenic impacts, and realizing that the Himalaya is considered almost a ‘white spot’ in terms of climate data, development of long-term data sets relating to mountain meteorology and related aspects of atmospheric science have emerged as a research priority. Towards meeting this goal, the region would require a strong net- work of Long-term Observational Sites following globally accepted protocols. This initiative, along with the ones suggested earlier would help in adequately representing hitherto less represented Himalayan forest data base in global data base. Vital aspects such as plant-animal interaction, reproductive biology, tree architecture, hydrological and soil and water conservation function of forests, soil binding capacity of root system, etc. have remained marginalized due to the so called anthropocentric bias in research activities; the situation calls for hard core taxonomists, ecologists, wildlife biologists and environmental engineers, etc. to take up these challenges in more holistic and integrated manner.

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