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FOREST ISSUES AND CHALLENGES IN PROTECTED AREA MANAGEMENT: A CASE STUDY FROM HIMALAYAN NOKREK NATIONAL PARK AND BIOSPHERE RESERVE, INDIA

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Abstract

Forestry issues and challenges in terms of ecosystem conservation and management has been a debatable topic over the years. Protected area such as biosphere reserves, national parks and wildlife sanctuaries are facing unpredictable pressure of global issues such as environmental degradation, biodiversity loss, climate change, and raw material supply. Using the Nokrek National Park and Biosphere Reserve forest ecosystem in the Himalaya region as an example, this research focused on governance, economical, and technical situation that shape and improve forest management. Effective local institutions promotes biodiversity maintenance and livelihoods, and forest management requires information on status and condition of forest, therefore, emphasis put to describe threats causing loss of biodiversity, current issues and future challenges in Himalaya region. Review studies and field data indicate the study area is rich in wild flora and fauna, and act as homelands of Achik (Garo) tribe. This paper presented a framework of forest assessments and monitoring, and for discussions about ways to improve forest conservation and management that achieve environmental objectives, and at the same time promote local and national development, and contribute to sustainable local livelihoods.

Keywords: *Forest Issues; Challenges; Threats; Biodiversity Management, Nokrek Biosphere Reserve, Himalaya, India*

Introduction

The Biosphere Reserve (BR) replica of UNESCO's Man and the Biosphere Programme (MAB) reflects a shift towards extra accountable conservation, explicitly acknowledging humans, and human-interests, in the conservation landscape [1]. The *Man and the Biosphere Programme* was launched in 1971 after the 'Conference on the Rational Use and Conservation of the Resources of the Biosphere in 1968' [2-3], with three concerns: association of environment with development, conservation of genetic material and ecosystems and international network of scientific research and monitoring [4]. By the end of 2012, a total of 612 reserves were recognized in 117 countries worldwide with prioritized aim of conservation and sustainable development [5].

Biodiversity loss due to habitat loss and deforestation, climate change, excessive nutrient load, unsustainable use, invasive alien species and human expansion activity [6-9] strained

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researchers and decision makers across the world to think on the natural resource management and explore alternative approaches that are effective in preventing ecosystem degradation and species extinctions [10], and at the same time promote sustainable resource use. In recent years, many research studies have pointed out that the biodiversity loss has increased dramatically due to increasing human intervention in the natural environment [11], and species are estimated to be disappearing at a rate more than a thousand times faster than is known historically [12]. This loss of species threatens the availability of essential ecosystem services that are vital for the survival of human communities. In an attempt to tackle this situation, forest agencies across the globe have adopted conservation and management policies by creating wild habitats such as Protected Areas (PAs) in the form of biosphere reserves, national parks and wildlife sanctuaries, for biodiversity conservation that is critically endangered, threatened or vulnerable [13].

The importance and relevance of PAs lies in the conservation of bio-resources, and also in supporting sustainable development initiatives. However, presently the PAs in India are facing numerous challenges and are in critical and threatened condition [14]. The local indigenous people lack their customary rights on land and park resources, which have raised fundamental issues about the survival of local communities in BR, national park and wildlife sanctuaries [15]. This has an impact on the survival and livelihood base and refrain of local people for their basic inputs like non-timber forest products (NTFPs), firewood and fodder for livestock; causes eviction of local traditional communities by displacing people, and cutting them off from their principal source of economic livelihood and results in various environmental problems and socio-economic conflicts [16]. Sometime strict conservation regulation lead to population increase of several species (examples, elephant, tiger, leopards etc.) in many areas, and results spill-over effect of animals for space and food, and explains the resource scarcity which causes environmental degradation, population growth, poverty, inter-group tensions, people displacement and institutional collapse, and show the way to instability and conflict [17]. Local support through socio-economically beneficial activities such as tourism, alternative employment opportunities, cultural preservation and making local people essential shareholders in conservation benefits helps in PAs management.

India (latitude 8.4'-37.6' N, longitude 68.7'-97.25'E; total of 3,287,263 sq km area), one of 12 mega-biodiversity country in the world, abode with 89,000 faunal species and 49,000 floral species recorded mainly from its ten biogeographic zones (namely, trans-Himalaya, Himalaya, Desert, Semiarid, Western Ghats, Deccan plateau, Indo-Gangetic plain, Northeast India, Indian Islands and coastal areas), and heavily dependence on its natural resources for economic growth. The statistics of the government of India indicate that 4.8% land is protected for the specific purpose of wildlife conservation. There are currently 678 PAs in the country (18 biosphere reserves, 104 national parks, 515 wildlife sanctuaries and 41 tiger reserves), which are legally recognized under the Wildlife Protection Act. Most of the PAs support several forms of land use, such as agriculture, livestock grazing, collection of firewood and non-timber forest products [NTFPs], and extent of support depends upon the type of PAs. It is estimated that about 20% of the 222 PAs are the centre point of physical arguments, conflicts between the local people and the forest authority over resource utilize. Studies suggest that the policy making and their implementation have been ineffective in achieving local people participation inside the PAs, and as a consequence several flagship and keystone species are getting critical endangered, and some have been extinct.

The present research focused on forest management within PAs considering the Nokrek National Park and Nokrek Biosphere Reserve as the main study area. Efforts are made to analyze the current biodiversity richness, threat status, current issues and future challenges in terms of conservation faced by the PAs of India. The study is mainly based on primary data collected during field study, secondary information collected from forest guards/officers, review

of published literatures, and interactions with local Garo people living in and around the BR, and forest officials dealing forest management. The studies were carried out during 2007-2012 while studying the floristic diversity and anthropogenic impacts causing threats to the Nokrek biosphere reserve. The objective of the paper was to describe the richness of biodiversity, address the forest issues and challenges, current status, future challenges and ways to improve forest management.

Material and Methods

Study location, and its Importance

This study was carried out on Nokrek biosphere reserve (latitudes N 25˚15'-25˚29', longitude E 90˚13'-90˚30'), designated as a UNESCO World Biosphere Reserve in 2009, and has been selected for research owing to its significance within the biodiversity map of India and in Meghalaya state. The area comes under the tropical and partly subtropical climate zones, with high rainfall and high humidity [18]. Temperature ranges from 6-8˚C in winter to 25-37˚C in summer season. The average annual rainfall recorded from the past ten years is about 2,400 mm. The forests covers constitute 22% of the geographical area out of which 5% of its area falls under protected area (PA) network. The NBR spread within an area of 820 sq km and is situated in the core of three Garo districts of Meghalaya state in India [19] (Fig. 1).

Fig. 1. Core zone (undisturbed forest) of Nokrek Biosphere Reserve, Meghalaya

Nokrek and Tura hill ranges contributes about 22% of the total area of the PA network in Meghalaya. It is the second smallest biosphere reserve in the country and first biosphere reserve to set up in eastern Himalaya, and comes under a part of Indo-Myanmar biodiversity hotspot region. The major attributes of the Nokrek biosphere reserve are enumerated below:

- On 29th November, 1986, a suggestion was made (vide Govt. Notification No. FOR.23/86/204 dated, 29-11-86) by the Government of India for the establishment of a biosphere reserve and national park in Garo hills in Meghalaya, with an area of 820 sq km. Inside the forest area, about 47.48 sq km were acquired from 20 (twenty) A'king Nokmas during 1986 for National Park.

- On 13th September, 1988, it was declared a Biosphere Reserve by the Govt. of India, MoEF Order No. 27/59/81-C5, with a total area of 820 sq km. On 23rd December, 1997, the core area was declared as the Nokrek National Park (NNP) with an area of 47.48 sq km (vide Government of Meghalaya Notification No. FOR.23/86/316 dated 23.10.1997).
- In 2009, the Nokrek biosphere reserve was recognized under UNESCO's Man and Biosphere (MAB) Program, which innovates and demonstrates approaches to conservation and sustainable development.
- Citrus Gene Pool Sanctuary within the network of a biosphere reserve of National Park significantly came to the lime light when intensive investigation and research was carried out for a number of years by a team of experts of the National Bureau of Plant Genetic Resources (NBPGR), Regional Centre at Shillong.
- The Fishery Department of Meghalaya is of the view that the northern part of NBR is an ideal place to set up fishery projects Mahseer Hatchery Centre, to boost up the declining population of the Mahseer (*Tor putitora)*, a endangered fish which is considered as most sporting, by anglers.
- Hoolock gibbon (*Hoolock hoolock*), the only living Apes in India, considered to an endangered species of animal, found in this Biosphere Reserve.
- The virgin forests of NBR provide shelter to the migratory wild elephants during summer season that used to migrate from the neighbouring areas.

Therefore, the core and the buffer zone from all approachable sites were selected as the study area for the following reasons: (i) the area is rich in biodiversity and home to many endangered and threatened species; (ii) livelihoods of local garo communities are based on biological resources and have an impact on biodiversity; and (iii) all three types of monitoring (state Government-, Non-Governmental Organization- and community-based monitoring) are practiced in this area.

Data collection

The information and data required for analysis of the Government state-managed and community-based monitoring were collected during six year research from the study area, while data on Non-Governmental Organization-managed monitoring were collected from both primary and secondary sources. The research was qualitative, and the following tools were employed in a step-by-step process: (1) direct field survey observation, (2) key informant interviews and (3). Informants group discussions.

Informant interviews were carried out during four times, June 2007, December 2007, September 2009, and February 2013 and with a total of 118 interviewee's views were selected through purposive sampling and all were one-way or other way representative of the dominant/minor stakeholders in the Nokrek biosphere reserve. The selection of informants was mainly based on whether they are involved in monitoring and conservation activities of biodiversity. The interviewees selected include both gender (male/female), and of various age groups, from different stakeholder groups: (a) Village Head 'Nokmas' or 'Mukhia', community head and head of family of various villages, having knowledge of biodiversity status, legal framework and administrative arrangement; (b) Members of community fisheries/protected area, including heads of community fisheries; (c) Aged fishermen not as active members of either as community fisheries or protected area, but have a good knowledge on traditional monitoring methods and interventions; (d) Forest rangers who are working in the management of core area; (e) NGO staff from the Wildlife Conservation Society (WWF). The details are given in Table 1. Direct observation was employed to verify data gathered; detect hidden data on biodiversity, habitat, use and fishing gear; and obtain information relevant for the

comparative assessment of methodology, perceived cost, ease of use and compatibility. Finally, results verified on the basis of observations on practices, protocols, results of monitoring reports and documented interventions.

Table 1. People participated in stakeholder group discussion for assessment in Nokrek biosphere reserve

Stakeholders		Gender		Number of people	Age (Years)
Group	**Managers**	**Female**	**Male**		
Communities people	o Village Head (Nokmas/Mukhias)	: 3	: 16	: 19	: 60-70
	o Community head	: 0	: 11	: 11	: 60-70
	o Aged villagers (Head of family)	: 5	: 12	: 17	: 50-70
Fisheries	o State fishery	: 2	: 5	: 7	: 40-50
	o NGOs fishery	: 1	: 1	: 2	: 50-55
	o Community fisherman	: 3	: 6	: 9	: 40-60
Forest Department	o MoEF members	: 0	: 2	: 2	: 35-40
	o State foresters	: 3	: 10	: 13	: 50-55
	o NGOs-WWF	: 0	: 2	: 2	: 30-50
	o Managers Community	: 1	: 8	: 9	: 45-55
NGOs	o State consultant	: 0	: 1	: 1	: 57
	o NGOs	: 1	: 7	: 8	: 25-50
	o Outsiders	: 5	: 13	: 18	: 20-60

Results and discussion

Biodiversity richness and current status

Nokrek ecosystem is an assemblage of forests and grasslands, and it is the home of 1319 species under 676 genera of angiosperms plants [20], 113 species of pteridophtes belonging to 49 genera and 28 families [21], 248 species of mosses (bryophytes) belonging to 120 genera [22], 298 species of butterflies under 156 genera, 22 subfamilies and 6 broad families [23], 34 species of cladocera (phyllum arthropoda) under 24 genera and 7 families [24], 70 species of rotifers (class eurotatoria, fresh water invertebrates) under 24 genera and 15 families [25]. A scrutiny of literatures on vertebrates states that NBR is also the home of 423 species of birds, 26 species of amphibians, 124 fish species, 62 species of reptiles and 85 species of mammals [26-28], all of which collectively highlight the biodiversity richness of NBR. Besides, it is an important tourism destination for both the domestic and foreign visitors. Although, Nokrek is a rare expression of nature's bounty, many scientific facts are believed to be still unexplored [29].

Out of the total 1319 species of angiosperms, orchids are represented by 137 species [30], 157 species of ethno medicinal plants [31], 71 species utilized as wild food plant [32], 23 species poisonous plants [33] and 97 species timber yielding and 73 species cultivated/planted in the buffer zone. A total of 276 species of plants comes under threatened categories [34-38]. The scrutiny of literatures reveals 3 species are endemic to India, 15 species are endemic to eastern Himalaya, 16 species are endemic to Northeastern states of India, 17 plants species are endemic to Meghalaya [39-46]. Das and Deori [47] reported 3 species of orchids out of 137 species, viz. *Eria clavicaulis* Lindl., *Eria ferruginea* Lindl. and *Liparis delicatula* Hook.f. are endemic to Northeast India (parts of Indo-Myanmar biodiversity hotspot), and Kataki [48] reported 3 species viz., *Micropera mannii* (Hook.f.) Tang & Wang, *Eria ferruginea* Lindl., *Thrixspermum musiflorum* A.S. Rao & J. Joseph are endemic to Meghalaya state. However, all the orchids species comes under CITES Appendix II which requires conservation.

Besides the rich floral and faunal biodiversity, NBR is also the residence of several tribal communities like *Garos, Koches, Rabhas, Hajjongs* and *Banars*. They have traditionally a rich culture and depend on forest resources for their livelihoods. The entire Nokrek forest area

comes under one of the Scheduled V category [tribal sub-plan area] of the state and majority of inhabitants are tribal. The tribal population constitutes about 92% of the total population of the area. There are 132 villages situated inside the buffer area and the total population recorded is 78,233 people [49].

Threats to biodiversity in the study area

The world's biodiversity is under the threat due to the variations in climatic conditions and associated habitat patterns that have affected life on earth. During prehistoric times, plant and animals could partly adjust to natural variations in temperature and precipitation by latitudinal and altitudinal shifts in their distribution ranges [50]. It was only with the commencement of anthropogenic activities and the resulting strong increase in the fragmentation of natural habitat that the ability of plant species to adjust to change in climatic conditions by means of shifts in their distribution ranges became severely limited [51-52]. Fragmentation and isolation of habitat, drastic changes in microclimatic condition especially in small forest fragments due to shifting cultivation, hunting, mining, over-exploitation and illicit extraction of natural resources are some of the major anthropogenic activities combined with natural calamities and invasive species are major threat to the biodiversity in Nokrek Biosphere Reserves. These threats are discussed in detail under different heads and subheads below:

a. *Human population growth*

The geometric rise in human population levels during the twentieth century is the fundamental cause of the loss of biodiversity in most of the tropical countries. Human population growth adds to the impact of all the other causes causing threat to the biodiversity because more people require more space and more resources for food production and livestock grazing, and for wood for fuel, construction, and energy.

The local community residing within the reserve is Garo tribes which are basically called '*Jhumias*'. There are 26 clans locally called Aching around the national park. According to an estimate in 2001, the total human population within the biosphere reserve were 39,432 [53], with an average density 48.08 per sq.km and population per village ranges between 20-2200 people. But now in 2013, it is estimated that the population has increased two times which impels more extraction of forest resources. The undisturbed buffer zones of this reserve were transformed into agricultural land due to rapid jhum cycle. Humans also tend to settle in those areas of high biodiversity, which have relatively rich soils and other attractions for human activities.

b. *Habitat loss and fragmentation*

The rapid increase of human populations and modern development have brought sudden, irreversible and far-reaching disturbances of natural conditions essential in the protected areas for the survival of several plant and animal species. For wild plants, habitat degradation is the primary cause of species loss at local, regional and global scales. The other treats like urban developmental activities, water development, road building, damming, recreation, fire-raising, fire-suppression, agriculture and tree logging all destroy and degrade natural habitats of biodiversity. Habitat loss and degradation are harmful not only to a single species, but to the whole population and community, and related ecosystems. This fragments remaining habitat and edges of habitats, are strongly affected by their surrounding matrix. The subheads provided below cause habitat loss, degradation and fragmentation in the Nokrek biosphere reserve as noticed while surveying the area.

Forest clearance. It is estimated that 8000 years ago the forests covered on the earth were about 50% of total land on the earth, and at present it remains to 30% [54]. Deforestation in the form of forest clearance is the primary driver of biotic extinctions in the tropical regions [55-56]. Dramatic changes in ecosystem productivity due to deforestation and the resulting loss of biological diversity is one of the pronounced effects of human activities on the global biosphere [57]. As of now, the forests are being cleared at faster pace than ever before. With

this speed most of the forests of the world will be lost leading to large- scale loss of biodiversity. For example, with the current level of deforestation, by 2100 only about 10% of the land area of the Indian Himalaya will be covered by dense forest (> 40%canopy cover)- a scenario in which almost a quarter of the endemic species could be wiped out, including 366 endemic vascular plant taxa and 35 endemic vertebrate taxa [58]. Forest clearance is a common activity in the NBR practiced by local tribes inhabiting the biosphere reserve, which causes heavy loss to plant diversity.

Jhum cultivation. Every year thousands of hectares of forest are destroyed as a result of the practice of shifting cultivation or "slush and burn", causing changes in forest ecosystems [59]. Shifting cultivation, locally called '*jhum*', is the primary occupation of the garo tribes living in and around the buffer area of NBR. Maize, zinger, areca nut, rice, chilly, local potato (*Monihot esculenta*), *Dioscorea* species and many other are planted in the jhum field by this tribe of Nokrek. They apply slash-and-burn methods for clearing forest patches for cultivation, and causes extensive cutting and burning activities. After 2-3 years of cropping, the land looses it fertility and the garo farmer's shifts to another piece of virgin forested land for cultivation. The vegetation in the fellow land regenerates during the fallow period. After a certain numbers of years, 3-15 years, the farmers return to the same piece of land, which was left fallow a few years back [60] (Fig. 2).

Fig. 2. Threat of Jhum cultivation in Nokrek

Those activities in NBR, directly or indirectly, affect the rich plant diversity and cause forest land degradation, habitat destruction, loss of soil fertility and productivity, depletion of quantity and quality of water resources, and slowly depleting the biodiversity. Besides, it accelerates the soil erosion manifold; it causes air pollution, loss of soil nutrient and useful soil fauna and microbes. Burning of slash lowers soil acidity, organic matter and total nitrogen, but enhances phosphorous. The clearing of forest areas at regular and frequent intervals for this activities results in the loss of primary forests and formation of secondary forests. This causes substantial loss to tree diversity and associated vegetation, which is adapted to primary forests. The repeated use of land with short jhum cycle finally converts the jhum fellow into degraded wastelands.

Mineral mining activities. The state of Meghalaya is rich in large deposits of coal, limestone, uranium, gypsum and clay, including kaolin, glass, sand, quartz and feldspar. Coal deposits distributed throughout the state, mainly along the southern fringe of the Shillong

plateau (400 km), and it is believed to have 562.8 million tonnes in 20 deposits [61]. Coal deposits occur as thin seams which range in thickness from 30 cm to 1.5 m in sedimentary rocks, sandstone and shale of the Eocene age [62]. Coal mining activities are carried out manually by the 'rat-hole' method and those methods are crude, uneconomical, vulnerable and unscientific because it involves cutting of vegetation of surrounding areas, digging a pit of 5 to 100 m^2 till coal seam is reached, making a side way tunnel, and finally extraction of coal from the pit by wheel-barrows [63].

Extensive coal mining activities are common in the southern parts of the Nokrek biosphere reserve, which comes under buffer zone, but very close to the core area. The people made parallel galleries along seams at short distance instead of digging a pit strait. They dig out sand and gravels along with coal from the tunnel. These activities have led to the increase in patchiness in the form of fragmentation in the existing forest vegetation and to the creation of a landscape dotted with mine spoils. This is causing degradation and loss of vegetation cover, which ultimately results in loss of valuable plant species like *Nepenthes khasiana*, *Goniothalamus sesquipedalis*, *Citrus indica* and specific Cane and rattan species of Nokrek biosphere reserve.

The total estimated reserve of limestone in the state is about 2462.5 million tonnes which are found in Cherrapunjee and Shella-Bholagang area in Khasi hills (38%), Nongkhlieh and Lumshong in Jaintia hills (55%) and Darrangiri-Era and Anig-Siju in Garo hills (7%). Limestone mining activities are carried out in the southern range of the Nokrek Biosphere Reserve in the Garo hills. Few limestone quarries are located near the boundary of the buffer zone of this BR. Chisingre and the way to the Chokpot area are sites rich in limestone. Many fossils like Shale, Starfish and primitive plant species are recorded during field tours to the buffer area of the Nokrek biosphere reserve.

During the rainy season, soluble materials of mining activities like coal dust, lime stone etc. get dissolved in the water and enter into the nearby streams originating from the hills and reaches adjoining cultivated lands. The acid run off from mines also dissolves heavy metals such as copper, lead, mercury into the ground or surface water. Studies by Sharma et al. [64], Sharma & Barik [65-66] and Nath [67] proved that soil and water of mining sites usually have high acidity, which affects most of soil chemistry, reduces soil productivity and deteriorates aquatic environment. Mining activities bring water and air pollution, which results in the loss of top fertile soil, therefore, the loss of soil productivity and ground vegetation serve as a signal for an imminent transition to a desert state.

Rock quarrying and stone crushing. Quarrying activities cause significant impact on the environment. During extraction of materials for processing, rock blasting give rise to noise pollution, air pollution, damage to biodiversity and habitat destruction. One of the livelihood sources of the people of NBR are stone quarrying. This activity of extracting stones/rocks destroys the plant wealth in many areas and causing treat to loss of biological diversity of NBR. Bansamgre, Chokpot, Oragitok, on way to Williamnagar and many other places this activity is practiced by the garos. The density and frequency of plant species is less in the quarry areas as compared to the diversity at the place far from quarry areas. Majority of the species are at threatened and vulnerable rates, which indicated that they are at critical points of survival and also subject to the activity of quarrying.

Grazing and Browsing. Grazing and browsing of animals also plays an important role in reducing growth of the herbaceous plants. Cows, goat, pigs, horses and many other animals are domesticated by garo tribes inhabiting the buffer area of the Nokrek Biosphere Reserve. It is estimated that more than thirty thousand grazing animals domesticated in the buffer area of NBR. Grazing animals remove newly grown saplings, affecting the regeneration process. The browsing animals mainly affect the growth of seedling/sapling. Grazing animals eat plant parts, thereby directly removing vegetation and altering ecological processes within remaining

vegetation. The feet of moving grazing animals exert great pressure on soils. This pressure can break soil crusts, compact soils, and erode fragile soil types.

Grazing animals affect soils through their daily movement, and also by actively digging to obtain subterranean foodstuffs (e.g. tubers). Animal wastes (urine, feces and carcasses) redistribute nutrients within ecosystems. Nutrients consumed in eaten plants are deposited within relatively small parts of the landscape, often at high local concentrations. Animal behavior patterns affect the spatial distribution of deposition sites. Increases to soil nitrogen and phosphorus levels strongly affect plant composition, and promote exotic species over native species. In addition to these primary impacts, grazing animals also influence other important ecosystem processes such as seed dispersal. Plant ecologists often group these processes into two simpler groups: (1) the direct impacts of herbivore (losses of plant parts); and (2) indirect (environmental) impacts (e.g. soil changes). These two processes are not independent and interact considerably: soil changes affect subsequent plant growth, and reductions in plant cover by herbivore affect soils, as witnessed by scalds and erosion.

Human developmental activities. Construction of dam, building, and road and their maintenance, promoting tourism in unplanned manner in hot spot biodiversity area are some of the factors causing threat to protected areas. Such threat factors were recorded in NBR. There is a big dam project proposed on Daribok stream, a tributary of river Simsang whose maximum water flows in the buffer area of this biosphere reserve. This dam construction will have direct impacts to the biological, chemical and physical properties of rivers and riparian (or "stream-side") environments. The dam will acts as a barrier between the upstream and downstream movement of migratory river animals. The dam wall will blocks the fish migrations which will be hampering the spawning and rearing habitats fish species. The dam also traps sediments, which are critical for maintaining physical processes and habitats downstream of the dam. Changes in chemical composition, temperature, dissolved oxygen levels and the physical properties of a dam reservoir are not suitable to the aquatic plants and animals that evolved with a given river system. The reservoirs often host non-native and invasive species like snails, algae, predatory fish etc. that further undermine the river's natural communities of plants and animals.

Roads and building construction act as barriers to the animal movement and lead to habitat fragmentation. Many faunal species will not cross the open space created by a road due to the threat of predation. This prevents species from migration and allows species to accumulate in one area which will cause species mortality. The main environmental impacts of road construction in hilly regions are soil surface erosion, sediment yield, pollution of off-site waters, slope failures and mass movement, direct loss of habitat by the conversion of the original land cover into an artificial surface, and indirect loss of habitat by the fragmentation of an ecosystem into smaller and more isolated patches [68].

c. *Over-exploitation of plant biodiversity*

The over-exploitation of biological species by man-kind is the most significant cause of species disappearance from the earth. A certain quantity of plant species use is sustainable, as plants populations will grow to replenish the stock taken. Conversely, in many cases too much quantity is taken, and leaving the resource unable to regenerate fast enough. Every now and then whole individuals are taken example, as when logging trees for timber, and sometime just a part of plants are used, example when harvesting leaves for a herbal medicine. Himalayan region is a home of several tribal communities and people collect firewood, fodder (from woody plants, shrubs and herbs), and litter from forest floor to prepare organic manure. Apart from these, people in also collect medicinal plants, mushrooms and morels, berries, seeds, flower, honey, lichens, dyes, resins, canes, fodder, firewood, fibers and other non-timber forest products (NTFPs). In forests extraction of biomass by local people in little quantities continuously is major problem. These disturbances occur in chronic form involving removal of

a small amount of biomass at any given time, but persisting all the year, without any respite for recovery. Some cases of over-exploitation of natural resources of NBR are discussed below in subheads.

Collection of Non-Timber Forest Products (NTFPs). There is excessive collection of NTFP from the forest areas within the Nokrek biosphere reserve. These non-timber forest products play a significant role in the livelihood of forest dwellers garo tribes and other communities living in the vicinity of the forest, as well as people at large in the immediate surrounding area. This causes depletion of local plant diversity in the area. Even today the garo villagers residing within the BR depend on their traditional medicinal practices for their well-being. Most of the medicinal plants are harvested from the wild. This causes a serious impact of the rare and threatened plant and animal species of the Nokrek biosphere reserve. The harvesting of Agar (*Aquilaria agalocha*) from the forests is a regular practice in the southern parts of the Nokrek Biosphere Reserve. This is causing a population decrease of this particular species from the area. *Phyrnium capitatum, Cinnamomum tamala, Cinnamomum bejolghata, Piper betel, Areca catechu,* Canes, broom grass, wild edible plants, medicinal plants, bamboo, spice and condiments, banana, ferns etc. comes under NTFPs.

The Zingiberaceae family is abundant in the Nokrek Biosphere Reserve. Lots of Zingibers are under threat, due to unlimited extraction thereof from its natural habitat. People cut it for animal fodder, while flowers and fruits are used for cooking and also as spices.

Medicinal and aromatic plants. Meghalaya state has been recognized as a store house of medicinal and aromatic plants due to its topographical location in the eastern Himalaya. There are more than 700 medicinal and aromatic plants abode in the state and out of these, many plants are under endangered category and endemic to this region. A study by Singh et al. [31] documented 157 species of plants under 134 genera and 81 families pharmaceutically important resources used in primary health care by the ethnic Garo tribes of Nokrek biosphere reserve, and 12 traditional healers were practicing ethnobotanical treatment in this area. These plants were commonly used in the treatment of 67 health-problems. More than one-fourth of the plant species documented were used in the treatment of cough, flu, and cold, which are prevalent ailments in the study area. The leaves, root, rhizome, and tuber were the most commonly used plant parts while decoction was the most common method of drug preparation.

Wild edible plants. A study by Singh et al. [32] reports that the Garo tribes of Nokrek biosphere reserve heavily depends on wild plant for their food. This study have documented reports on 71 species under 61 genera and 42 families of plants, of which 38 species are used as vegetable and 33 species edible as raw or cooked as food by the garo tribes. For vegetable purpose they are using *Alpinia malaccensis, Amorphophallus bulbifera, Amblyanthus glandulosus, Artemisia indica, Baliospermum micranthum, Chlorophytum arundinaceum, Bauhinia purpurea, Begonia roxburghii, Chlorophytum khasianum, Clausena excavata, Clerodendrum wallichii, Commelina benghalensis, Ficus hispida,, Dendrocalamus hamiltonii, Elastostema dissectum, Dioscorea oppositifolia, Dioscorea pentaphylla, Dracaena spicata, Entada rheedei, Eurya acuminata, Hodgsonia macrocarpa, Fagopyrum dibotrys, Ficus subincisa, Gmelina arborea, Houttuynia cordata, Medinilla erythrophylla, Oxalis corniculata, Mucuna bracteata, Murraya koenigii, Mussaenda roxburghii, Phlogacanthus thyrsiflorus, Sarcochlamys pulcherrima, Polygonum capitatum, Thunbergia grandiflora, Polygonum nepalense, Pteridium aquilinum, Sonchus aspera,* and *Zanthoxylum rhetsa*. Commonly used fruit plants from Nokrek biosphere reserves are *Aporusa octandra, Ardisia solanacea, Drymaria cordata, Baccaurea ramiflora, Buddleja asiatica, Debregeasia longifolia, Calamus erectus, Canthium dicoccum, Elaeagnus conferta, Canthium parvifolium, Citrus indica, Ficus auriculata, Garcinia kydia, Ficus oligodon, Meyna spinosa, Flemingia vestita, Grewia nervosa, Rubus alceifolius, Melastoma malabathricum, Melodinus monogynus, Piper thomsonii, Myrica esculenta, Stixis suaveolensa, Neocinnamomum caudatum, Nephrolepis cordifolia, Rubus rugosus, Syzygium diospyrifolium, Saurauia nepaulensis,* and *Syzygium praecox.* Stem pith of

Caryota urens is cooked as food along with rice, whereas young leaves of *Sonchus wightianus* are eaten raw by *Garo* tribes.

Extraction of Orchids. Orchids are known for their flowers, ornamental foliage and their medicinal values. A study by Singh [20] reports 137 species from Nokrek biosphere reserve. Most of the orchids are under the RET category and the destruction of the orchid species from their natural habitat causes the extinction of that particular species from the Nokrek hills. Some of the orchid species found in this BR *Paphiopedilum wardii, Renanthera imschootiana* (Red Vanda) and *Vanda coerulea* (Blue Vanda) are included in the Schedule VI of Indian Wildlife Protection Act, 1972 which regulated their collection and trade, remaining species of orchids which are of ornamental and medicinal value that can be artificially propagated and used for trade purpose. Lots of orchids are illegally smuggled out of the biosphere reserve and sold in nearby markets by the local garo villagers. This is really causing a threat and degradation of this species.

Bamboos cutting. Bamboo is the secondary form of vegetation, one of the versatile multi-purpose, woody and fast growing tall grasses belonging to the family Poaceae. They grow naturally in some parts of the world and also cultivated by the people for different uses. There are about 150 species of Bamboos in India of which about 90 species are reported from Northeast India. In many places, especially in the southern range of the Nokrek biosphere reserve, illegal cutting of bamboo species were reported while surveying the area. *Bambusa vulgaris, Bambusa tulda, Bambusa pallida, Melocona bamboosoides, Dendrocalamus hamiltonii* and *Dendrocalamus strictus* are common factor extraction from this BR.

Canes extraction. Canes, commonly called 'rattans' are prickly palms belonging to the family Arecaceae. They are one of the most important forest produce from Northeast India particularly Meghalaya state. There is a great demand for cane from the local inhabitants for using as construction material (roofing and cordage), furniture, as food, medicines etc. In India, about 60 species of canes are found, of which 25 species occurs in Northeast India. Twelve species of canes found in Nokrek biosphere reserve, of which *Calamus gracilis, C. flagellum, C. latifolius, C. leptospadix* and *C. flagellum* local market demand. These species are extracted continuously from the buffer zone, and now local people approaching in the core area for their collection. This is yet another factor causing threat to biodiversity in the NBR.

Pressure of over-exploitation on spices and condiments. Cinnamomum zeylanica (Dalchini), *Cinnamomum iners* (Bon Dalchini), *Cinnamaomum tamala* (Tejpat), *Amomum subulatum* (Wild cardamom), *Illicium griffi thii* (Lissi), and *Piper peepuloides* (Pipli) are common in the Nokrek biosphere reserve. Regular and continuous extraction from the natural habit causes threat to loss of this species from the wild.

Logging and firewood collection. Officially logging is prohibited in the transition and core area of the NBR, but logging to some extent is allowed in the buffer zone of the biosphere reserve. Occasional illegal logging of timber for charcoal preparation is quite common in the NBR. Besides, firewood collection by village people and tea garden at Oragitok and Chandigre area, communities surrounding the core zone in the BR is posing a threat to the flora and fauna of the BR reserve. Some common trees like *Duabanga grandiflora, Terminalia chebula, Lagerstromia parviflora* and *Shorea robusta* (planted by Forest Department) are mostly cut and used by the garos of the reserve area.

Loss of agro-forestry resources. Many development activities of road constructions and footpath creation have changed the land pattern, which overburden with materials causing most of the agro-forestry trees form the area to die. The remaining trees cannot be used as fodder by villagers, due to the dust covering their leaves. Another disturbing aspect is that the grazing land gets converted to dumping sites and agro forestry land is also threatened. Therefore, the threat to the *N. khasiana* forest increases day by day.

Over-consumption and over-harvesting. Over-consumption is the harvest of species at a rate higher than can be sustained by the natural reproduction of the population. Over-harvesting

can result in extinction of the species at the population level and even extinction of whole species. In India, for example, wild Himalayas ginseng (*Panax pseudoginseng*), has been over-harvested from its natural rich habitat to the point of being endangered due to its potential as ethno-medicine and needs pharmaceutical industries for development of drugs. Similarly, *Nepenthes khasiana* (insectivorous plants), an endangered species [49] recorded from Nokrek Hills are extracted out from the natural habitat for its potential as medicine and for ornamental purposes sold in the local market by the local tribes. During its survey in 2007, four population was recorded spreading over an area of about 6 ha, and in 2012, its area reduces to only 2 ha in the Nokrek hills. Therefore, the overexploitation of this particular species has categorized it under critical endangered category.

d. *Over-harvesting of wild fauna*

The population of wild animals in nature can remain stable only when there is a balance in their rate of reproduction and the rate at which they are caught and killed. If the rate at which they are hunted exceeds the rate of their reproduction, the number of population of these fauna is bound to be greatly reduced. On account of high morbidity and countless superstitions, many of the animals' diversity are killed and their body parts are used in the manufacture of medicines. This encourages illegal hunting and trading of the vulnerable species. As a result of this, several fauna have become endangered species.

Birds. Large numbers of birds are illegally caught and traded every year despite national laws and international trade agreements. Unsustainable hunting for food or sport and trapping for the cage-bird trade has been implicated in the extinction of many bird species in NBR, and remains a significant threat in these days. Butchart [69] reported that one-third totaling 3,337 of bird species have been traded internationally. Of these bird species, 266 are considered to be globally threatened (Bird Life International 2008; http://www.birdlife.org/). Taking all internationally traded bird species, factors related to international trade have caused an overall deterioration in their extinction risk. Overexploitation particularly affects some bird families, including parrots, pigeons and pheasants, and is most prevalent in Asia. In Nokek, Garos hunts and eat bird species like jungle fowl and pigeon from wild, and even sale it to nearest local market.

Fish. It is estimated that more than 70% of the world's fish species are exploited or depleted due to illegal and unregulated fishing worldwide. Overfishing occurs when fish species are caught faster than they reproduce, which is the result of growing demand for fish around the world, combined with poor management of fisheries and the development of new, more effective fishing techniques. Farming activities in buffer zone of NBR by using agro-chemicals such as weedicides and pesticides on the crops cultivated along the banks of several rivers like Simsang, Dedari Chibima and several small originating streams from the Nokrek and Tura ranges are poisoning fish population to death as these chemicals enter into the rivers when it rains, or seeps into the river through the soil, and affect their growth and breeding population.

The use of local fishing methods, such as poisonous plants (*Calotropis gigantea* (L.) R.Br. ex Ait., *Cassia fistula* L., *Costus speciosus* (Koenig.) Sim., *Garuga pinnata* Roxb., *Pongamia pinnata* (L.) Pierre, *Wrightia tinctoria* (Roxb.) R. Br. etc.), drag nets, bamboo, and in other instances the use of dangerous chemicals are responsible for the depletion of fish resources and pose a great threat to the livelihood of the communities in these areas. If left unchecked, it will destroy the river ecosystem and jeopardise the food security of thousands of people for whom fish are a primary source of protein.

Animals. The Nokrek biosphere reserve is the home of Red panda (*Ailurus fulgens*), Hoolock gibbon (*Hoolock hoolock*), Stump-tailed macaque (*Macaca arctoides*), Chital (*Axis axis*), Pig-tailed macaque (*Macaca leonina*) and several other wild animals. Asian elephant (*Elephas maximus*) reported migrated to this reserve in summer season. Achik (garos) were known as head hunted of wild animals, and they do as for fun, prestige and for local meat. As for example, chital (*Axis axis*), a common Indian deer are hunted by the garos for their meat and

skin. As per IUCN, this species is listed as 'Least Concern', but the rate at which the population of this animal is decreasing in PAs, they will be under endangered category within short period. Therefore, over-harvesting and illegal killing causes species extinction which is a great threat in this biosphere reserve.

The most important extracted forest products from Nokrek Hills are Honey, Gum, Wild Mushrooms, flowers and orchids, medicinal plants, timber, cane and bamboos. However, since the resident local human population has a strong level of dependence on NBR's resources, the use of local resource in the activities poses a number of challenges to biodiversity conservation in NBR. The specific challenges are: the loss of diversity due to collection of timber and fire-wood; the loss of diversity due to forest fire and the loss of diversity due to illegal hunting of wildlife. Since, human habitation in and around the Nokrek and Tura ranges lives in subsistence economy with little or no access to market, education, health and other sanitation services, which generally results in low human development indicators such as high infant mortality, below average longevity, etc. As a consequence of this, people try to improve their living standards by extracting more resources from these hills. That again results in severe implications on conservation of biodiversity and natural habitats.

e. *Land degradation*

Land degradation applied to the biotic and abiotic surrounding of an organism affected by human-induced processes. Due to unplanned use of biodiversity and indiscriminate use of chemical fertilizers, pesticide and various other chemicals to increase agricultural productivity, huge pressure has mounted on the productivity of the ecosystem. The use of strong dosage of pesticides has resulted in the killing of several useful microorganisms, friendly parasites, birds, beneficiary predators and helpful worms and nematodes. By clearing all the weeds from the fields using deadly chemicals (herbicides), the food crop plants have become more susceptible to pests/diseases. Aquatic environments are particularly vulnerable to pollution. Land use changes, waste disposal, and water impoundment and abstraction can profoundly affect their patterns of water flow and quality. Intensive forestry, agriculture and eutrophication are also responsible for the habitat degradation.

f. *Natural calamities*

The velocity of windstorm during the monsoon period is sometimes so high that many trees and shrubs get uprooted. The maximum damage is, however, caused by the storms which destroy flowers and immature fruits. The natural forest fire has not been recorded so far in the NBR. Wild elephant visit during summer from neighboring country Bangladesh and they move in groups of 15-50 at a time, and destroy the forest vegetations falls in their routes. This causes loss of small plants in the reserve area. Other natural calamities caused threats are discussed below:

- *Pollution.* Many types of human-caused pollution are a threat such as the release of excessive amounts of nitrates and phosphates from sewage and agricultural run-off; persistent organic pollutants that can concentrate in food webs (and in our own tissues) and adversely affect hormonal and reproductive function; pharmaceuticals used by people and in livestock production that are toxic to wildlife; acid rain; heavy metals; herbicides and pesticides; and plastics.

The air pollution, mainly dust, caused by running vehicles in border area of the buffer zone and the wind also affected the surrounding forest vegetation and human habitation areas, and slowly the growth of adjacent forest decreased, due to changes in the physiological activities of plants. Air pollution generally played a key role in changing the distribution of plant species and the ecology of susceptible plant communities in polluted regions. Air pollution also affects the biodiversity of the region. The local tribes and *Nokmas* of this reserve area believe that increasing pollution in Tura town is decreasing the natural growth of *Nepenthes khasiana*.

- *Invasive species.* A number of exotic and native weeds, insects and parasitic fungi are causing severe damage to some plants of the biosphere reserve. For example, *Mikania micrantha* is becoming a very troublesome weed of the forest. It grows and covers the whole canopy of the tree species, thereby preventing the growth of not only the tree species but also the growth of the many shrubs and herbs and medium sized trees. Some woodborer insects were also observed to damage valuable plant species by sucking the juice of the plants.

The changes in the area caused by developmental activities regularly affect the growth of native forests, the vegetation near human habitation areas and areas of agriculture/agro forestry. The invasive species such as *Lantana camara*, *Eupatorium odoratum, E .adenophorum, Mikania micrantha, Euphorbia hirta, Parthenium* sp., *Clerodendrum* sp. and many others are slowly and slowly colonizing the buffer area of the Nokrek Biosphere Reserve. Nevertheless, that invasion of new species may affect the growth of existing species in the future. Such invasive species may create demographic instability among the tree/shrub species and reduce tree/shrub diversity and can even change the structure of the forest of the Nokrek Biosphere Reserve in the near future. The presence of *Lantana camara* shrub as dense understorey perturbs the seedling recruitment of native tree species in the forest and that will lead to differential depletion of native trees.

Introduction of non-native species.

In many parts of the world, introduced species and diseases have significantly damaged native ecosystems. Once established in a new region, non-native species may invade new areas adjacent to the occupied area by natural dispersal. Such species may displace native organisms by preying on them or out-competing them for resources such as for food, space or both, which in turn has led to the elimination of indigenous species from certain areas. In instances, non-native species can reproduce with native species and produce hybrids, which will alter the genetic pool, which is an irreversible change. When an invasive species has established itself in the natural environment, it is likely to be impossible to get rid of it. Therefore, there is need to prevent new introduction of non-native species from NBR, and the step need to be initiated along with the local people and forest officials.

Besides the above discussed threats on NBR, still further threats come from several other sources such as excessive ultraviolet radiation from depletion of the ozone layer that can damage the proteins and DNA of land-based organisms, freshwater and marine organisms, war and conflict that can result in habitat destruction, over-hunting, and pollution; and climate change [70]. Natural events include geological events and disasters that have an impact on the population of plant species in different habitats. Threats include: intrinsic factors e.g. limited dispersal of seeds/pollens, restricted range, poor reproduction, natural disasters e.g. volcanic eruptions, earthquakes, and landslides; climate change e.g. a reduction in the areas with suitable climate for plant species to grow.

Institutional Dynamics and Management in NBR

The agreement on what constitutes an effective and sustainable forest management is still a debatable issue. However, effective conservation of biodiversity in any PA is incomplete without proper management initiatives. The major component of management in biosphere reserves like NBR include empowering local indigenous people, creating livelihood opportunity for the forest resource-dependent people, ensuring representation and equity among the forest officials and local people, strengthening resource security, providing property rights and participation in decision making.

Meghalaya state is known for effective community forest management. Several local institutions are found in and around NBR that are designed to promote conservation of biodiversity and local livelihoods. The Government of Meghalaya, through its Joint Forest Management (JFM), has adopted eco-development as a strategy for securing support from local communities in PA management. Eco-development Committees along the lines of Vana Surakhya Samiti provide a strong linkage between conservation and development; and they may

include ecotourism and off-farm activities, as well as providing specific alternatives to local dependence. The responses from local communities and the state governments regarding the threats causing factors responsible for the depletion of biodiversity especially to the wildlife like Red panda (*Ailurus fulgens*), Hoolock gibbon (*Hoolock hoolock*), Stump-tailed macaque (*Macaca arctoides*), Chital (*Axis axis*), Pig-tailed macaque (*Macaca leonina*) , has led to the completion of many projects for conservation of wildlife supported by MoEF, DST, DBT and other funding agencies in Nokrek biosphere reserve.

Current challenges

It is over and again discussed in national meetings, seminars, policy making and assumed that all the local members of a community in a forested area must be equally benefited, if the community is to develop effective resource management institutions. Despite the provision of benefit sharing, the sharing provisions are questioned on various counts. Again, the benefits derived from the establishment of local village level committees are doubtful in terms of its sustainability in the long term. Gender sensitization is one of the major concerns in the management of forest resources concerning women's participation, equalization and their involvement in various community and economic activities. Women and girl children particularly from low caste/poor tribal families collect small timber, firewood, fodder, various NTFPs etc. from the nearby forest area to sustain their livelihood. But, these families are least empowered, neglected and increasingly alienated from participation in decision-making forums. Therefore, lack of participatory of process still remains same in the planning, implementation, monitoring and evaluation of management programs in the Nokrek biosphere reserve.

Several times the destruction of natural resources and the resultant biodiversity loss inside the biosphere reserve is strongly attributed to a lack of a well defined and secure system of property rights. This is because most of the land in NBR belongs to private communities. Therefore, the concept of co-management or collective action by local institutions where both the state and local communities have some rights and responsibilities over the resources, have been widely accepted. However, the local communities inside Nokrek are mostly unaware about their property rights over the forest resources that many times results in loss of biodiversity as well as affected their livelihood. The local institutions functioning inside the buffer zone of NBR required to finance biodiversity conservation related projects as well as put efforts to enhance local livelihood opportunity.

Eco-tourism in Nokrek has the potential to generate substantial revenue, but that is not enough to meet the requirement. Communication networks are not good in Nokrek, which slightly decreases the morale of reserve staff and forest department. On an average one Forest Guard looks after 15-30 sq km of the forest area which is quite large. Because of large scale vacancies in the level of Forest Guard and Forester, a Forest Guard look after the in-charge of two to three beats, approximately an area of more or less an area of 50-80 sq km. It shows that the Forest Department of NBR is severely short to protect the rich biodiversity in Nokrek and Tura ranges. All these issues have severely hampered effective management of the Nokrek National park and small wildlife Sanctuaries, and pose a serious challenge towards biodiversity conservation as well as maintaining pace with the local communities in Eastern Himalaya.

Future challenges

The challenges commonly faced at the NBR were the lack of appropriate interaction between the local communities and FD, consequential arguments among stakeholders on the lack of their execution and unstable revenue, absence of a follow up to management plans. A local forester mentioned that there was an increase in tourists from urban areas which was a menace to them and politicians disturbed the functioning. In this reserve, no scientific mechanisms existed for the sustainable utilization of natural resources available for local use. There was a lack of facilitators to solve issues within and among stakeholders. Opportunities and incentives (like ecotourism, value addition of NTFPs) need to be created for the benefit of local communities so that they will actively engage in the management plan.

Conservation of biodiversity in the NBR requires a broader approach, as for examples, identification and protection of the most sensitive areas outside the present core area of the reserves, maintaining the remaining forest matrix under the sustainable management regimes, involving the local communities in the process of management, and encouraging the uses of synergetic with the conservation plan. Recent purchases by private enterprises of new protected areas, the willingness of local administrations or the local chief Nokmas to establish a new legal conservation framework, and local people considering sustainable management of their lands and surrounding, all will represent the encouraging opportunities for the management and conservation plan.

Proposed recommendation to Improve Forest Management

Stop illegal logging and deforestation:

- prevent illegal takeovers of public lands, including protected areas of illegal timber removal
- look up command-and-control systems to improve legality
- put emphasis to increase public institutional presence in boundary areas;
- promote efforts at forest product legality assurance and forest management certification
- use internationally generated reduction of emissions from deforestation

Increase security of tenure and resource access for forest owners:

- need to transfer rights to communities, especially those that depend on forest resources, often helps promote forest managements while also improves their local livelihoods
- put emphasis to secure long-term access for concessionaires to public forests as it may promote good forest management

Simplification of management rules and regulations:

- needs procedures for developing and approving forest management plans
- needs improved mechanisms for verification of compliance. This requires more feasible for full range of logging operations, especially for smallholders.
- Set of rules to be applied should vary with forest type, size of logging operation, and intensity of management. This will allow for flexibility in management practices that reflects differential forest user goals.

Develop incentives to improve forest management:

- forest certification promote sound forest management practices
- introduce bonds system in a government account at the beginning of concession period and gradually returned to the concessionaire if harvesting executed as per agreement

Others suggestions:

- need to develop incentives to enhance Carbon Stocks in logged, burned and degraded forests
- need to increase efficiency of Forest department through appropriate taxation
- need to promote post-logging silvicultural treatments
- forest workers need proper training regarding biodiversity management, and if possible put reward for excellent workers.

Conclusions

In this study we have made an attempt to understand the complex issues and management challenges faced by the NBR. It is found that the rich resource-full NBR is under serious threat. Both the government policies and local village level institutions have failed in a large way to conserve biodiversity as well as promote local livelihoods. Eco-tourism, which is highly neglected inside Nokrek, should be promoted and get utmost attention because it may

serve as a panacea to curb local livelihood problems. Filling up of staff vacancies is very crucial towards conservation of biodiversity inside NBR.

The loss of biodiversity comprises a major threat to the sustainability of our community and presently, reality is that majority of financial decision-makers is not aware of biodiversity-related problems or does not know how to tackle them in their practice. In particular, fund managers have limited ideas about the true concept of biodiversity and as a result most of them do not consider it relevant enough for incorporating these concerns in investment decisions nor to actively invest in pro-biodiversity business. There is an urgent need for a lot of capacity building training activities to raise the skill and capabilities of these stakeholders. Though the process of empowerment is a long and backbreaking task, it is suggested that the implementation of better participatory programs through these institutions will not only strengthen empowerment process but also redesign these grass root institutions more people-centered. But, whether the strategies taken by these grass root level institutions are adequately directed to promote the livelihood interests of the primary gatherers and to preserve rich biodiversity is a moot point. Further research would be necessary to identify sector-specific constraints.

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