

ECOSYSTEM FUNCTION OF BUFFER ZONE VILLAGES OF NANDA DEVI BIOSPHERE RESERVE

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Summary:

The Nanda Devi Biosphere Reserve is situated in Himalayan highlands biogeographic province of India was established in 1988 under the UNESCO's Man and Biosphere Programme (MAB) for the conservation of biological and cultural diversity. It consists of a central core zone (624.62 km²) surrounded by a buffer zone (1612.12 km²). In 1992 it was declared as one of the world heritage site by World Heritage Committee. Legally the reserve includes the areas of reserve forests, civil forests and panchayat forests and individual farmlands. From the geomorphological point of view, the buffer zone occupies the entire Rishi Ganga catchment. A total of 17 villages are situated in the buffer zone of NDBR, of which 10 villages fall in the Garhwal (district Chamoli) and 7 villages in Kumaon (districts Pithoragarh and Almora). The present study was carried out in the 10 buffer zone villages belonging to Chamoli district of Garhwal Himalaya with a total population of 2253. The Nanda Devi Biosphere Reserve is one such protected area where local people inhabited in the buffer zone areas have been deprived of the traditional uses of the natural resources from the reserve. Ignoring the dependence of the local people for their subsistence needs has created conflicts between protected area managers and the local people. The main issue of conflict in this reserve was the right of the people to use the forest resources which they were traditionally been collecting before the area was accorded a status of national Park and Biosphere Reserve.

Hence, the debate should not be between whether biodiversity should be maintained at the cost of local inhabitants or local people should be allowed to exploit the natural resources at the cost of biodiversity. Rather, conservation should demonstrate how biodiversity can be optimally maintained while fulfilling the needs of the local people.

Therefore, to understand the issues related to reserve people conflicts in Nanda Devi Biosphere Reserve, an integrated study was undertaken in the buffer zone villages considering people perception and attitude towards the reserve establishment. In addition to this, the ecosystem function of the buffer zone villages considering different sub-system of the village such as agriculture, including medicinal plant cultivation, animal husbandry and

domestic and forest sub-system as well as inter-linkages and interdependencies between the sub-system were evaluated and analyzed ecologically and economically. Such an analysis is expected to be a value for designing strategies for sustainable development of the buffer zone villages on one hand and conservation of biodiversity on the other.

Reserve-People conflicts

Reserve-people conflicts in Nanda Devi Biosphere Reserve (NDBR) located in the Himalayan highlands biogeographic province of India, were studied intensively over a period of two year's from 1995 to 1997, through socio-economic, cultural and attitudinal surveys. The impact of reserve establishment and people perception towards development priorities were also studied through interactive discussions with the local people. The reserve had been established for the conservation of *Moschus chrysogaster* (musk deer), *Panthera uncia* (snow leopard), *Lophophorus inpejanus* (monal pheasant) and many important flora of immense value and protects some of the unique high altitude and alpine habitats in Indian Himalaya. The results showed that before creation of national park in 1982 and reserve in 1988, people in the area were fully dependent on the reserve for the collection of resources like medicinal and aromatic plants, fuel, fodder, leaf litter, timber, livestock grazing, working as a tour guides and porters with the expedition team, etc. however, now there is growing unrest among the local communities, who are being denied access to resources after the creation of the Biosphere Reserve, on which they have traditional rights to utilize since time immemorial.

The results of attitudinal survey indicate that the majority of the respondents (70%) have negative attitude, towards the policies adopted by government for conservation. Among many reason of conflict, the main was ban on the expeditions to the Nanda Devi peak. The findings of these results suggest that the main reason of the growing people-government conflict was the lack of consideration on the question of providing alternative livelihood means following curtailment of people's rights in the area. So it is necessary to find out short and long term solutions to reserve people conflicts. Promotion of medicinal plant cultivation, degraded land rehabilitation, improve economy through sustainable harvesting of non-timber forest products, eco-tourism and extension programmes may be some feasible options to be implemented in the NDBR to resolve the conflicts.

Agriculture

The agroecosystem functions of the lower (1900-2800m) and higher (2800-3600m) regions of the buffer zone of Nanda Devi Biosphere Reserve were studied over a period of two years. Four villages viz., Lata and Tolma from lower region and Dronagiri and Malari from higher region were considered for the study. Over 35 species of food crops comprising cereals, pseudocereals, millets, pulses, oil seeds, vegetables etc. are grown in the traditional agroecosystem of the region. But during recent past the area under cultivation many of these crops has declined to a large extent. The traditional crops such as *Eleusine coracana*, *Fagopyrum esculentum*, *Panicum miliaceum* etc., have been reduced to 25%-50% under cultivation during the last three decades due to various reasons.

Rainfed cultivation on steep terraced slopes is the predominant form of land use. About 7.8% of the total cultivated land is irrigated. The grain/tuber and by product yield (kg/ha) of all the crops was found maximum in the higher region of the NDBR as compared to lower region. The crops such as *Solanum tuberosum*, *Phaseolus vulgaris*, *Fagopyrum* spp. and *Hordeum himalayens* are the common crops and cultivated in both the regions. The annual energy output/input ratio ranged between 0.97to 4.3 at lower region and 1.5 to 4.9 at

higher region of NDBR under rainfed condition. However, under irrigated condition, the efficiency ratio was recorded between 1.8 to 6.3.

In general, the kharif season crops practiced when all auxiliary output were considered together, (such as by-product, herbaceous vegetation, fruits, fuel from agroforestry trees etc.) at lower region is found energetically efficient (output /input ratio 3.9) as compared to rabi season crops at same region and kharif season at higher region. The monetary output /input ratio of the kitchen garden crops was estimated to be higher at both the regions than the kharif and rabi season crops. Among the agricultural crops cultivated in the region Monetary output /input ratio was obtained maximum for the mixed cropping of potato and kidney bean at both the regions, with higher economic efficiency ratio (7.2) for rainfed and irrigated conditions (7.6) at higher region. Across the regions, the monetary output /input ratio was observed least for *Hordeum himalayense* (0.59) at lower region.

The surplus of the total agricultural produce was assessed to 27% (in Tolma village), and 87% (Dronagiri village). This surplus is sold by the farmers to middlemen traders. It was observed that while exporting traditional crops, the farmers of the region are highly exploited by middlemen. After the imposition of conservation policies in the region the damage caused by wildlife to the crops has increased and accounted 4 per cent in malari village to as high as 60 per cent in Tolma village. For the economic betterment of the people in the region and conservation of the biological resources, a comprehensive programme of conservation should be launched considering improvement of agronomic yield and soil fertility, value addition of the traditional crops creating proper marketing facilities etc., in the region.

Medicinal plants cultivation

Rich diversity of medicinal plants growing under diverse environmental conditions occur in the Nanda Devi Biosphere reserve. The Bhotiya tribal communities of this region have been collecting and using large number of medicinal plants from the wild for their multifaceted use since time immemorial. But during the recent past, due to over exploitation of these medicinal plants to meet the increasing demand of the pharmaceutical industries, their number have drastically reduced, leaving little scope for their natural regeneration. Therefore, cultivation of these valuable species is certainly warranted.

Although various research organizations have been working on different aspects of medicinal plants over several years and also advocating their cultivation in the region but unfortunately very few of them have made any meaningful efforts towards cultivation and surveying the areas where a variety of medicinal plants are being cultivated since last three decades by the Bhotiya tribes inhabiting the buffer zone and adjoining areas of Nanda Devi Biosphere Reserve.

About eight different economically promising species viz. *Allium humile*, *A. stracheyi*, *Saussurea costus*, *Angelica glauca*, *Pleurospermum angelicoides*, *Megacarpaea polyandra*, *Carum carvi*, and *Dactylorrhiza hatagirea* used for medicine, spices, condiments and vegetables being cultivated by these tribes, were studied in relation to their agronomic practices, uses and ethnobotany, yield potential and cost- benefit analyses associated with their cultivation. Majority of the households are involved in the cultivation of *Allium* spp. because it has huge exchange/barter potential. Among the species, per hectare production was found higher for *Saussurea costus*, followed by *Pleurospermum angelicoides* and *Angelica glauca* under cultivation as compared to that growing in wild. However, the net return and monetary output/input ratio was found maximum for *Carum carvi* (25.0) and minimum for *Megacarpaea polyandra* (6.0). Out of the total production of all the medicinal plants (7694 kg/ha), maximum quantity (4038 kg/yr) is exchanged or bartered, followed by marketing and own consumption, However, the unsystematic

marketing channels, have led to the exploitation of cultivators/ collectors. Therefore, before recommending their large scale cultivation, a proper marketing of medicinal plants should be ensured. Besides, small cottage industries dealing with the extraction of medicinal plants and manufacturing indigenous medicines/ drugs and essential oils can be established in remote and far flung areas having easy access to the resource. This will not only generate the employment opportunities and improve the local economy but would certainly reduce the existing pressure on their natural habitat.

Animal husbandry

Cows, bullocks, sheep, goats, horses and mules are the important animal husbandry components of the buffer zone of NDBR. Cattle are reared for milk, organic manure, draught power *etc.*, while sheep and goats for meat, milk, and wool and sometimes used as pack animals in remote and far flung villages, where no other facilities of transport are available, Horses and mules are reared for transportation purposes, Among the livestock sheep and goat rearing are the main traditional animal husbandry system of the people in the region which is considered to be high remunerative in monetary terms. However, the recent survey reveals that the livestock population particularly sheep and goat has been reduced to 82-73 per cent during last two-three decades from the buffer zone villages. It was partly due to imposition of Government conservation policies and partly due to socio-economic changes.

The energy and economic efficiencies of the animal husbandry system practiced by the buffer zone village at Lower and Higher region reveals that net profit from individual sheep and goat was accounted to be Rs. 507 and 528/yr, respectively. The economic efficiency of sheep (7.03) and goat (6.93) was found higher as compared to other animals and least for bullock (0.93). However, the energy efficiency ratio were found higher for horses and mules (0.60) and least for cows (0.14). Earning through export were found maximum in Dronagiri village (Rs.23449/family/yr) and minimum in the Lata village (Rs 2908/family/yr).

On an average, out of total fodder demand, maximum (58%) was obtained from agriculture land use system. In the event of out grazing, cattle of the lower region of NDBR were observed dependent on forests while that of the higher region were on alpine pastures. Grazing incidence showed that earlier there were about more than 15 pastures available for summer grazing, but now they have been reduced to 7, because 9-10 pastures have been included in the core zone. As a result, the grazing incidence on the pastures lying in the buffer zone have increased to 6 animal unit/ha as against of 3 animal units/ha before 1982.

Therefore, it is important to formulate better strategies for resource management that complement the wider ecological and socio-economic objectives. The strategy will also need to consider the social, cultural political and institutional elements that effect the management of natural resources. The technical and institutional support for the better implementation of action oriented programmes is urgently needed for successful livestock development.

Ethnobiological study of the Bhotiya tribe

The inhabitants of the buffer zone villages of Nanda Devi Biosphere Reserve (NDBR) depend entirely on the surrounding vegetation to meet their subsistence demand of fodder, fuel, timber, food medicine etc. Edible and some medicinal plants collected/ consumed in the large scale by the local people of NDBR were quantified and their monetary equivalents were calculated based on the prevailing market rates. Present study was conducted for complete two years (1995-1997) in 10 buffer zone villages of Nanda Devi Biosphere Reserve, lying in district Chamoli of Garhwal Himalaya. These villages are inhabited by the

Tolchhas a sub-community of the Bhotiyas. Ethnobiological point of view a total of 173 plant species were observed which are used by these people. Of which, 82% plant species are used for medicine, spices and condiments, vegetables and fruits etc. and 18% are used for house construction material, fuel, fodder, agricultural implements and fencing etc. The quantification and documentation of the indigenous knowledge related to uses of these wild resources which is restricted only with a few people locally known as vaidhya (local medical practitioner) is extremely important and also important is to assess their contribution in the village ecosystem function otherwise it will be lost forever in the process of acculturation which is taking place in this community at an alarming rate.

Village Ecosystem

The village ecosystem function of the buffer zone villages (located at lower and higher regions) of NDBR, have been analyzed for their energy and economic efficiencies. Agriculture is the main occupation of the people of the region. The primary production system in the village comprises agricultural land, land under medicinal plant cultivation and kitchen gardens. Economically medicinal plant cultivation was found efficient (output/input ratio 10-13) as compared to agriculture and kitchen garden. The kharif season crops practiced at lower region were found energetically more efficient than the kharif season crops of higher region and rabi season crops of the lower region. Kitchen garden crops (viz., green vegetables, cabbage, cucurbits and other seasonal vegetables etc.) cultivated at higher region showed high energy and monetary efficiencies ratio than the lower one.

The forests are closely linked with domestic sector, agriculture, animal husbandry and provide food, fodder, leaf litter for agriculture and timber, etc. The per capita per year wild edible collection was found maximum in Malari village. Whereas, other forest resources (*i.e.*, leaf litter for organic manure, house construction material, etc.) was collected maximum by the Tolma village.

Among the villages of the total average food energy consumed (5495 MJ per capita per year), the agriculture alone contribute maximum (52% to 55%) of food energy in the diet of the local people, followed by import from the market, animal husbandry and forests, The per capita per year total monetary return was recorded highest from animal husbandry to the people living in higher region whereas at lower region the maximum monetary return was obtained from agriculture. The income/expenditure ratio was exhibited highest for the villages of the lower region of the buffer zone. Human labour is the only output derived from the domestic sector which makes a number of contribution for smooth functioning of the village ecosystems.

Linkages among the different sectors of village ecosystem viz., agriculture, medicinal plant cultivation, kitchen garden, animal husbandry, cottage industry, domestic sector and dependence on forest were analyzed with a view to develop appropriate strategies for sustainable development of buffer zone villages so that the objective of conservation of biological resources and better management of Nanda Devi Biosphere Reserve can be achieved.

The current study indicated that open access to natural resources by the traditional communities may be deterrent due to current population pressure. However, strategy of domesticating high value low volume minor forest produce will be helpful for achieving both conservation objectives and economic upliftment of local people. The current study has conclusively supported this hypothesis.