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Biosphere reserve models around the world are becoming increasingly people-oriented and conservation-conscious in achieving their objectives. However, reserves established in developing countries, such as the Nanda Devi Biosphere Reserve in India, are facing management versus people conflicts due to the insensitivity of management to both genuine and irrational demands coming from people who are motivated by potential

economic benefits. The present case study focuses on the issue of crop and livestock depredation by wildlife as a major source of conflict. Feasible solutions in the given socioeconomic context are outlined here; some of these are being tested by the authors in the study area. The results are expected to provide more sustainable livelihood measures and stimulate greater participation in conservation programs.

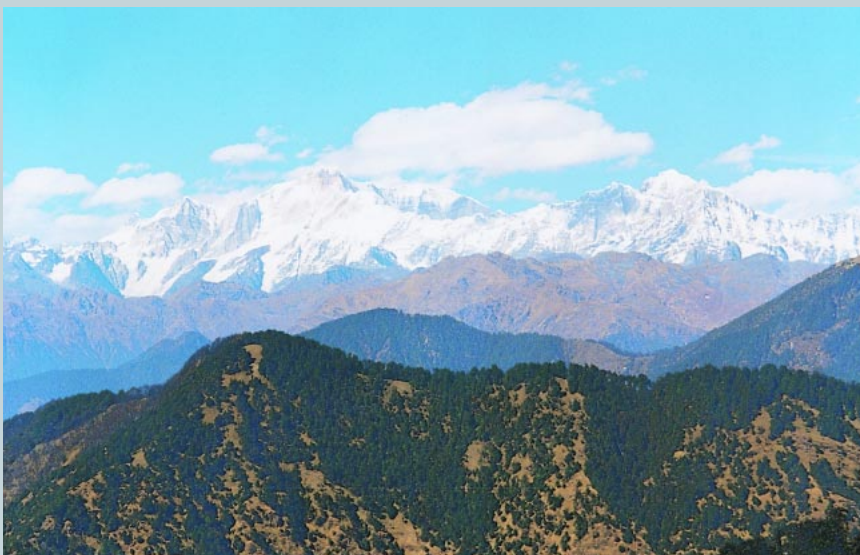


FIGURE 1 Snow-clad mountains with extensive alpine grazing lands constitute the core zone of the Nanda Devi Biosphere Reserve. (Photo by R. K. Maikhuri)

The problem

The main issue of conflict in the Nanda Devi Biosphere Reserve (NDBR) is the right to use the forest resources to which the inhabitants of buffer zone villages are traditionally entitled before a particular area is accorded the status of a national park and biosphere reserve. There are several reasons for the increase in conflict between local people and the government. These include failure to consider the question of alternative means of livelihood following curtailment of people's usufruct rights in the area, loss of economic opportunities due to abandonment of tourism in the core zone, and livestock and crop depredation caused by wildlife.

History of conservation in the Nanda Devi Biosphere Reserve

The Nanda Devi Biosphere Reserve, which covers a total area of 2236.74 km², was

established on 18 January 1988 under UNESCO's Man and Biosphere Program (MAB). It occupies a special place in the biosphere reserve systems of the high altitude Himalayan region of India. Its core (Figure 1) and buffer zones comprise a unique combination of temperate forest, alpine meadows, very high peaks (the highest, Nanda Devi West, is 7817 m), and glaciers. The buffer zone consists of reserve forests, civil forests, and village-managed *panchayat* forests (forests administered by the Forest Department and Revenue Department and earmarked for a specific *panchayat*, or village; user rights are clearly defined and managed by an elected village council). In geomorphological terms, the core zone occupies the entire Rishi Ganga Catchment (a tributary of the Dhaulti Ganga) (Figure 2).

Almost all the reserve forests within the Nanda Devi Biosphere Reserve are in the Chamoli district. All the areas of the biosphere reserve in the Bageswar and Pithoragarh districts are civil areas outside the limits of the reserve forests. These areas came under the control of the British after they defeated the Gurkhas in 1815. However, initial government control of forest resources began only in the last two decades of the 19th century. The reservation process began in 1911, and technical management of the forests was assumed by the Conservator of Forests, Kumaon Circle, from the Deputy Commissioner in 1912. Scientific forest management came into existence in 1960. However, timber exploitation on a large scale did not succeed due to the famous 'Chipko Andolan (tree hugging) Movement,' launched in the village of Reni. The pris-

tine area with valuable wildlife that constitutes the Reserve was declared a sanctuary in 1939. The Nanda Devi Biosphere Reserve was given heritage site status by the World Heritage Committee in 1992.

Biological and economic significance of the area

The Nanda Devi Biosphere Reserve region is one of the most biologically diverse areas in the Indian central Himalaya. Though the area lies at a high altitude, dramatic changes in elevation have resulted in the existence of a number of unique vegetation types distributed over a variety of topographical and climatic zones, sometimes influenced by human intervention (Figure 3). This has had the effect of a bridge, facilitating the influx of many taxa, as well as a barrier, promoting endemism. The reserve is a repository for a large variety of medicinal plants and animals of economic value. However, due to excessive exploitation, populations of numerous plant and animal species have declined in their natural habitats. These species are now rare, endangered, and threatened.

The reserve also represents a great potential for tourism, which, if undertaken carefully, would help improve conditions for the tribal population of this region. Furthermore, the control of the

village resources (through *panchayat* forests) in most parts of the buffer zone is strong. There is a high degree of popular participation in community resource management for biodiversity conservation and economic development.

Differing opinions

A study conducted by the authors has shown that all stakeholders (local people, Biosphere Reserve management officials and staff), irrespective of sex, age, and affiliation, felt there was a loss of benefit to the local population after the Biosphere Reserve was established. But NDBR officials thought that the loss of benefits was adequately compensated through ecodevelopment activities undertaken by the management. Improved stoves, pressure cookers, an afforestation program, and a grazing resource improvement program provided both wages and benefits to the residents of most villages in the buffer zone. However, villagers in all three economic categories (high-, medium-, and low-income groups) felt that the loss of economic opportunities far exceeded the benefits of ecodevelopment programs. The reasons given were (1) loss of grazing resources (40%), (2) loss of access to non-timber forest products or NTFPs (23%), (3) loss of income due to restrictions on tourism activities (24%), and (4) loss of

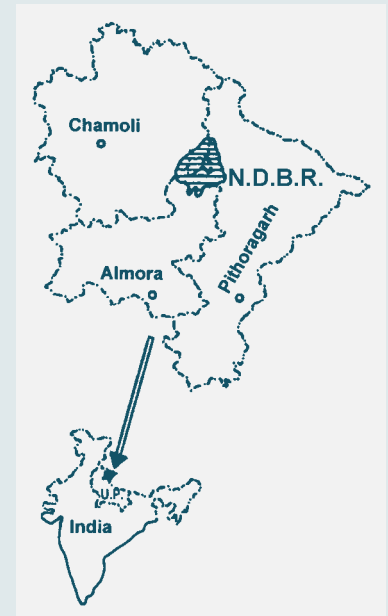


FIGURE 2 Location of the Nanda Devi Biosphere Reserve (NDBR) in Uttarakhand, India.



FIGURE 3 As the village of Malari in the buffer zone of the Reserve is in the rain shadow zone, an extensive irrigation system was developed using snowmelt waters from streams. (Photo by R. K. Maikhuri)



FIGURE 4 A women's self-help group analyzes the impacts of the Reserve on their lifestyles and perceptions. (Photo by R. K. Maikhuri)

property and produce due to wildlife depredation (13%). While women (constituting about 10% of those surveyed; see Figure 4) gave loss of subsistence needs as the primary reason (100%), most male respondents (60%) cited loss of economic opportunities (Table 1).

Extraction of NTFPs was allowed under government control in 5–6 year rotations in each part of the forest until

the area was declared a national park. The village cooperatives used to earn about Rs. 664,982 per year (ie, US\$33,249 @ US\$ = Rs. 20 in 1981) through export of NTFPs from this area. This is a substantial income for each household where other economic opportunities are limited. Crop growing was never a prime source of income for local inhabitants. However, changing socioeconomic conditions (especially the end of trade relations with Tibet in 1962, as well as population growth) made it necessary to diversify traditional subsistence agriculture to include more cash crops (increased acreage for kidney beans, amaranth, and potatoes). These crops demand more intensive nutrient inputs, hence the need for forest litter, which became scarce due to restrictions on human activity in the forests after 1981. In addition to this resource scarcity, crop depredation by wildlife such as ungulates, monkeys, wild boars, and bears accounted for losses of about Rs. 538,620 (ie, US\$13,466 @ US\$ = Rs. 40 in 1996) from 284 ha of cropped area in 1996 (Table 2). In that year, 104 of 156 beehives kept by the farmers were also damaged by wildlife. In economic terms, this amounted to a loss of Rs. 60,280 (US\$1507).

TABLE 1 Analysis of responses on loss of benefits for local people due to establishment of the Nanda Devi Biosphere Reserve (total: 419 households; US\$ = Rs. 40 in 1996).

Reasons given for loss of benefits	Male	Female
Reduction of area accessible for grazing and leaf litter	150	18
Reduction of nontimber forest products	88	8
Increased killing of livestock by encroaching wildlife	39	16
Reduced employment opportunities due to decline in tourism	100	—

TABLE 2 Total loss of various crops and honey due to wildlife depredation in the buffer zone of the NDBR (Chamoli District). Values in parentheses are per household per year (US\$ = Rs. 40 in 1996).

Crops	Quantity (kg)	Monetary equivalent (Rs.)
<i>Solanum tuberosum</i>	22,286	89,144
<i>Phaseolus vulgaris</i>	7241	159,300
<i>Amaranthus spp.</i>	2537	25,370
<i>Triticum aestivum</i>	17,883	71,532
<i>Fagopyrum spp.</i>	9673	96,730
<i>Phaseolus lunetus</i>	6034	96,544
Total	65,654 (156)	538,620 (1285)
Honey^a	582 (5.94)	60,280 (615)

^a156 hives are maintained by 98 households in the study area.

Further options

Conflicts relating to the Nanda Devi Biosphere Reserve are very complex. People have become hostile to attempts to conserve wildlife; at the most, they take a passive view of the attempts of forest officials to conserve the area. Almost the entire population of villages in the buffer zone (sometimes even outside the buffer zone) depends on the reserve for a variety of resources, but forest rights and access to forest resources have been curtailed. Consultation with local people and villagers about the purposes of the Reserve is almost nonexistent. The experience of top-down conservation programs in recent decades has led to a breakdown of the local community's relationship to the natural environment and is the cause of the increasing hostility of local people toward conservation. This is especially true with respect to the reserve management authority.

Studies conducted by the authors on cropping patterns suitable for the region and on the function of village ecosystems suggest that a drastic modification of agriculture is needed to produce nonpalatable medicinal and aromatic plants suitable to local conditions (Figure 5). Such crops are fetching high monetary returns on small sites near inhabited areas where protection measures could easily be taken. As the produce is of high value and is generally non-



FIGURE 5 *Picrorhiza kurrooa*, a medicinal plant cultivated in the buffer zone villages of the Reserve, has a potential to mitigate conflict by reducing the total area needed to meet the cash requirements of the local inhabitants. About 25 such species are now being domesticated and 11 are being cultivated by local people. (Photo by R. K. Maikhuri)

perishable, marketing will be easy. Food grains could be imported from regions far from the protected area. The areas near the forest fringe where cultivation of food crops is currently being practiced could be utilized to produce fodder for animal husbandry. Such a model is being attempted in one of the villages, and the results are encouraging. It is conceivable that more effective conservation could be achieved with less government enforcement if some forms of control were turned over to local villages, as planned for the Annapurna Conservation Area in central Nepal. Moreover, empowering local people can improve efficient management of available resources through sustainable harvesting of forest products.

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