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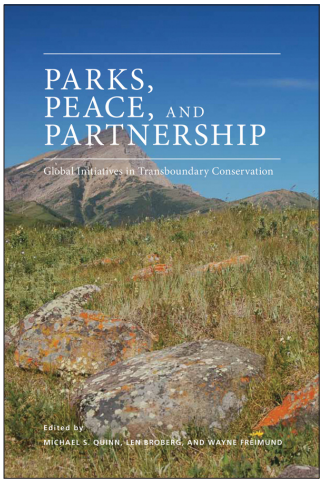
Parks, peace, and partnership: global initiatives in transboundary conservation



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Feasibility of a Corridor between Singhalila National Park and Senchal Wildlife Sanctuary: A Study of Five Villages between Poobong and 14th Mile Village

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INTRODUCTION

The rate of species extinction has been increasing rapidly during last couple of decades worldwide, and so has been the concern to protect wildlife and their habitats. Hunger for economic development has led to conversion of a substantial amount of land inhabited by wild animals into land suitable only for human use. Very often these conversions were carried out in unplanned ways, leading to discontinuities in wildlife habitat. Establishing

corridors to restore wildlife habitat connectivity is considered a possible solution to sustaining species in the face of development pressure.

India is rich in biodiversity, harbouring about 8 per cent of the total world biodiversity. Around 45,000 plant species and approximately 81,250 of animal species are present in India (MoEF 2005a). However, fragmentation of wildlife habitat continues unabated, with a sharp increase since 1990 (FAO 2005). The extent of annual depletion of forest cover prior to 1990 was 0.03 per cent (MoEF 2005b). Thanks to recent policy initiatives, the decline in forest cover has been arrested. Forest cover increased at an annual rate of 0.57 per cent (0.36 million ha) between 1990 and 2000 (FAO 2005; 2007). However, the tempo could not be maintained and the annual rate of increase fell to 0.04 per cent (0.03 million ha) between 2000–2005 (FAO 2005). Further, it would be wrong to assume that such a positive national trend is visible uniformly across the country. For example, the trend of deforestation has been continuing unabated in Eastern Himalaya region (Wikramanayake 2003). It should be noted that around 15.6 million hectares (23 per cent) of recorded forest area is under Protected Area (PA) network in India (FAO 2005), containing the last available habitat for different endangered species like lion, tiger, elephant, rhinoceros, red panda, Himalayan black bear, and clouded leopard.

Although such reserves are the cornerstone of biodiversity conservation within a region (Folke et al. 2002), more recent work finds that islands of biodiversity (protected areas) are not viable. Rather, those interested in biodiversity conservation should think in terms of a landscape-based protective strategy (Chang 2007; Metcalfe 2005; FAO 2005). The Darjeeling Himalayas are part of the Eastern Himalaya biodiversity hotspot identified by conservation organizations like the Critical Ecosystem Partnership Fund (CEPF). Areas must have high species endemism, more than 1,500 species of vascular plants and have lost at least 70 per cent of the original wildlife habitat to qualify as a CEPF hotspot (CEPF 2010). Thus, the Darjeeling Himalayas must be managed with the landscape view, integrating habitat connectivity, in order to conserve the biodiversity within the region.

Wildlife habitat in the Darjeeling Himalayas decreased over the last couple of centuries. Trees were felled with impunity to facilitate tea

plantations and build factories and labour lines, carve out land for settled agriculture, and construct roads, railways, bridges, and urban settlements. Indigenous species of trees in the remaining forests were cut down and replaced mostly by plantations of exotic species to increase the commercial value of forests. Introduction of cleaning, weeding, and fire protection lines for better forest management weakened the resilience of the entire ecological system in this location (Ray 1964). For example, the area that is the focus of this paper between Singalila National Park (SNP) and Senchal Wildlife Sanctuary (SWS) was once covered with sub-tropical montane forest that has been largely cleared (Chhetri et al. 2005). A larger share of this area is under tea cultivation. There are a few sub-tropical forest patches existing here and there on land belonging to private individuals. Land recorded as forests and lying with the Department of Forests has converted to shrub land with sporadic existence of trees and the forest cover is only maintained on private land (Chakrabarti et al. 2002). Such activities have gradually created discontinuities within formerly continuous wildlife habitat that extended all the way from the Singalila National Park to what is known today as Neora Valley National Park (Map 1).

The result of fragmentation and its effect on the natural system is increased endangerment of a number of species in this region like red panda (*Ailurus fulgens*), Himalayan black bear (*Ursus thibetanus*), clouded leopard (*Neofelis nebulosa)*, Monal Pheasant (*Lophophorus impejanus*), Western Tragopan (*Tragopan melanocephalus*), Chestnut-breasted Partridge (*Arborophila mandellii*), and Himalayan salamander (*Tylotrotriton verrucosus*). In addition to these fauna, several floral species like bikhumma (*Aconitum* sp.), rudraksha (*Elaeocarpos granites)*, jatamaasi (*Nardostachys jatamansi*), salanay/panch pattey (*Panax pseudoginseng)*, kutki (*Picrorhiza kurroa*), taxus (*Taxus baccata*), and tsuga (*Tsuga dumosa*) are threatened or critically rare (see Chetri et al. 2005). Flora like *Abutilon indicum* and *Gloriosa superba* have already become extinct in the wild and are surviving only in some nurseries. Members of the resident communities surveyed for this study report eighty different plant species formerly common in the region between SNP and SLWS. Nine of them have become extinct by now. Thirty-four bird species and thirty other

animal species are sighted by the locals at present. To improve landscape connectivity and thereby preserve species diversity, immediate bridging of habitat discontinuities is necessary.

In direct conflict with maintenance of a viable biodiversity corridor, a high density of hooved game (wild boar [*Sus scrofa*], red [*Cervus elaphus*] and roe [*Capreolus capreolus*] deer) is maintained by supplementary feeding. The artificially high density of herbivores depletes natural food sources, eliminates undergrowth, and changes the tree stand structure, negatively affecting habitat structure and natural resource availability. As a result, natural regeneration stops, forest and river ecosystems lose their integrity, and functioning of the natural ecosystems are disturbed (Parfenov 1996). Villagers from each and every settlement surveyed have reported an increased incidence of crop depredation by wild boar and sighting of Himalayan black bear, wild boars, leopards, deer, porcupines, and rabbits during recent times.

This analysis seeks to answer the following questions:

- Is it possible to establish suitable corridors for ensuring free movement of the wildlife across the Darjeeling Himalayas?
- Is a corridor network feasible in view of the existence of multiple stakeholders and land ownership pattern in this region?

The international biodiversity significance of this area and rapid degradation of forests and wildlife habitat during the last few decades, combined with the experience of Joint Forest Management (JFM) as a potential remedy – in terms of both success and failure, compel such questions (Chakrabarti et al. 2004; 2005).

The objective of this chapter is to determine the location of a possible corridor and its socio-economic feasibility between Singalila National Park (SNP) and Senchal Wildlife Sanctuary (SWS). Restoration of a corridor involves conversion of a particular patch of land from its present use to forest cover. Such conversion may involve change in ownership, restricted use, or even dislocation of human habitat, depending on the

present land use and ownership pattern. Obviously, such an intended change will involve simultaneous gains to some with possible losses being incurred by some others. A corridor is socially feasible if the net gains (gain-loss) are positive and those gaining are willing to compensate for the losses incurred by the other group. We conducted socio-ecological studies in five villages during 2004–2005 (Poobong phatak, Pussumbeng phatak and Alubari, Ghoom bhanjyang, Bhalukhop & 14th Mile) to understand the issues involved: investment requirements, generation of livelihood options through employment and surplus, compatibility with the available land, and other floral and faunal resources. Corridor feasibility throughout the region is then judged in terms of the net gains generated.

CONCEPTUAL FRAMEWORK

The concern for conservation is perhaps more influenced by the selfish interest of mankind to survive than out of sheer love for non-human living species. Researchers are convinced that social variables that influence the quality of human lives are intimately linked to a host of biophysical variables – biodiversity and global warming being the prominent ones (Stern et al. 2006). Interactions between biophysical and social variables produce what is known as a Social-Ecological System (SES) (Hadjibiros et al. 2005; Janssen et al. 2007; Vincent 2007). The stability of the socio-ecological system is at the centre of the issue of conservation.

The loss of biological connectivity (Metcalfe 2005; Natural Resource Committee 2006) potentially undermines long-term environmental security of human residents and, therefore, poses a threat to the sustainability of the existing SES (GMS 2005). The key task of the world community, according to one school of thought, is to maintain contiguous natural habitats and sustain ecological diversity (Daming 2007; Johns 2000) around the world. However, biodiversity often tends to be undervalued from an economic, if not always from a socio-politico-economic perspective (GMS 2005). Recent attempts that argued in favour of increased economic value of biodiversity include Stern et al. (2006), Chopra (2006), Datta et al. (2006), and Gundimeda et al. (n.d.). A proper valuation of biodiversity

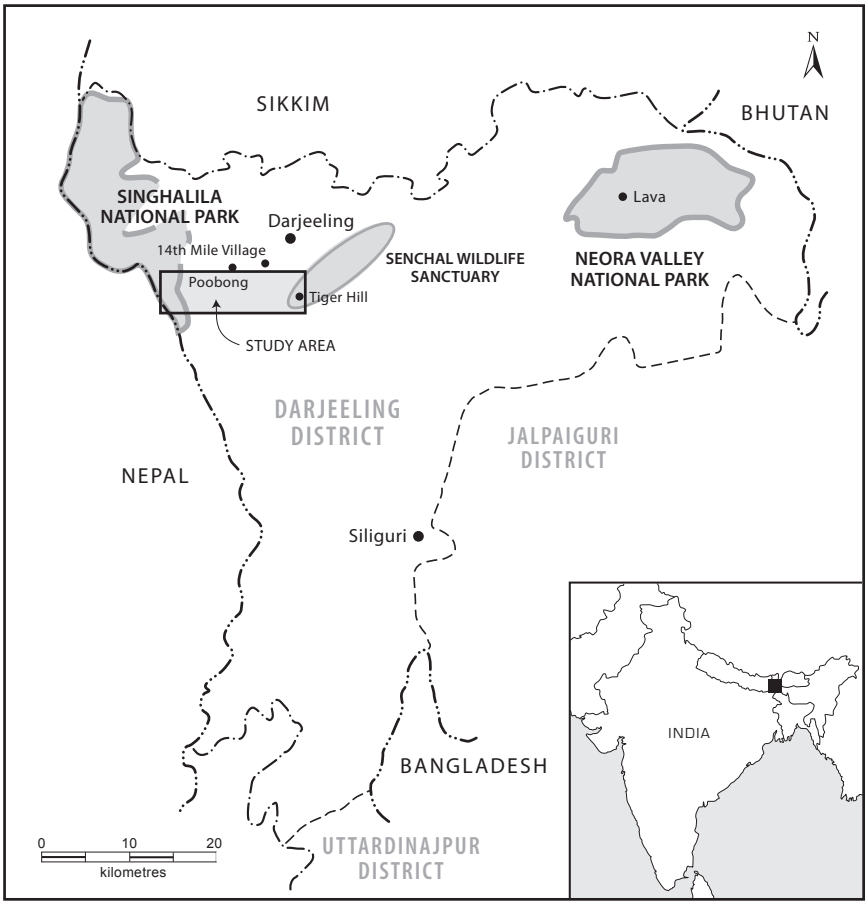
necessarily requires a thorough understanding of the functioning and the sources of vulnerability to an SES (Daming 2007). The issue of the resilience of an SES becomes key to such valuations.

The paper begins with a premise that the SES in this location has almost reached a threshold of system change and seeks to ascertain if a corridor can increase SES resilience. Sudden flip of a system damages the habitat structure and destroys wild animals and several plant species, which are key elements of the ecological environment in this region. This also affects the existing relationship of human society with the natural system. A social-ecological system implies a set of people, their natural and human-made resources, and the relationships among them (Janssen 2006; Anderies et al. 2004 provides a conceptual framework of an SES; also see Janssen et al. 2005). Resilience has been defined from many perspectives like ecological, social, systemic, operational, sociological, economic-ecological, and social-ecological. An ecological definition is the amount of disturbance that a system can absorb before it changes state (Brand and Jax 2007; Gunderson et al. 2002). From a social-ecological perspective, resilience denotes the capacity of a social-ecological system to absorb recurrent disturbances so as to retain essential structures, processes, and feedbacks (Adger et al. 2005). The magnitude of resilience in a system is measured by its capacity to absorb disturbances under sudden and undesirable internal or external changes (Folke et al. 2002; Janssen et al. 2007) before the system redefines its structure by changing the variables (Gunderson et al. 2002). We then looked separately into the ecological (vegetation type, plant and animal species including avifauna, and non-timber plant species extracted for human use and status of different plant and animal species along with the underlying causes behind present status) and social systems existing in this area (demographic, educational, occupational, and skill profiles in the settlements and institutions) and then considered the SES that results from interaction between these two systems. We generated an inventory of the problems of settlement residents in the study area and the possible remedial measures perceived by them. We then estimate the financial implications of implementing the plans suggested and identify a few institutional hitches that may crop up in implementing them. Before concluding, we suggest a possible road map

to begin restoring connectivity through the area, focussing on the social dimensions of such a project.

Apparently, the JFM program – introduced to strengthen SES – has not remedied several important challenges to SES resilience. It could neither make the ecological system more resilient, nor could it strengthen the social system. However, this program sensitized locals to the necessity to create and protect forests to re-organize the SES in the interest of social system resilience (Chakrabarti et al. 2004). This effort should come from within the villages, instead of imposing any new mechanism from above (Ostrom 2007). Some feel setting up a corridor across the villages may add to the resilience of the existing SES. The villagers are also keen to actively participate. However, such a change involves several costs. For example:

- *Social cost:* Restoration of a corridor will provide benefits to a section of the community/society while another section may lose out in the process. If the gain of the former is not big enough to compensate for the loss of the latter, it will be difficult to establish a corridor and manage it sustainably.
- *Cost of property rights transfer:* The present property right regime that vests the ownership of the forest land in the state, may not be effective in ensuring sustainable management of the proposed corridor. Any proposal to integrate privately owned land with the proposed corridor would also require changes in existing property right structure. Transaction costs can vary 6 to 45 per cent across different states (Cacho et al. 2005, cited in Wunder 2007)
- *Research cost:* A corridor may not be effective unless and until the existing migratory behaviour of wildlife is known for certain and such knowledge is incorporated while laying out the spatial location of the corridor. Such knowledge base is scanty, necessitating a considerable research cost to develop the relevant database. Further, effective management of the corridor, once established, will also be dependent on creation of a knowledge base that enlarges through continuous



Map 1. Location of Study Area (Singalila National Park to Senchal Wildlife Sanctuary) and Surrounding Region (M. Croot)

recording of the feedback mechanism that operates between the SES's. Such a research cost will also have to be budgeted.

These three types of costs, taken together, constitute what we may term as the start-up costs. Thus start-up cost is the addition of social cost, cost of property rights transfer, and research cost. Experience in other regions of the world (Ecuador) shows start-up cost is considerable (US$69/ha)

(Wunder 2007). A collaborative and site-specific partnership between government departments, landholders, and private investors has to evolve to shoulder this responsibility in large part. We attempt to provide a qualitative estimate of a substantial component of social costs necessary to implement a corridor in the area, elaborated in the activity plan. The rest of the costs, like the costs involved in transfer of property rights or to carry out relevant research, have not been factored in.

SITE DESCRIPTION

Our study area is located between Singalila National Park (SNP) and Senchal Wildlife Sanctuary (SWS) (Map 1). The distance between these two protected areas is approximately twenty kilometres. We studied five of about twenty-five villages located in this area. The area lies mainly on the catchment area of river Balason on the south and the river *Chhota* (little) Rangit on the north. The average elevation varies between 125 metres and 200 metres.

METHODOLOGY

Information about all the households residing in these settlements was first collected through structured questionnaires. The information gathered included the profiles of the households in terms of their: demographic characteristics, educational attainments, seasonal engagements, occupational characteristics, and skill sets. To complement the information gathered at the household level, Appreciative Participatory Planning and Action (APPA) was utilize to generate village-level information about (ECOSS 2005): ecological profile, infrastructural profile, and institutional profile. In addition, APPA also helped identify villagers' perception about conflict, possible remedies, and a plan to implement the measures suggested.

SOCIAL SYSTEM

There were 216 households with a total population of 931 in the five villages studied. 478 of them were male and 453 female. Twenty-three per cent of the population was aged below fourteen years. Literacy rate in this area was quite high (72.9%) compared to national average (64.8%). Out of those who received education:

- 632 (82.7%) are educated up to primary level;
- 106 (13.9%) studied up to secondary level; and
- 26 (3.4%) went for studies beyond secondary level.

Four hundred and four (52.9%) dropped out after receiving primary-level education. Table 1 provides a summary of occupations held by the highest-earning members of the surveyed households.

Average annual income of the households from different economic activities works out to be approximately Rs.58,000 (about US$1,090). Twenty-six per cent of the households were below the poverty line.

Infrastructure:

Inhabitants of all the five villages under review have access to metalled (crushed rock) road, a health centre within an average distance of 3 kilometres, and a market within an average distance of 2 kilometres. The supply of safe drinking water from the Public Health Engineering Department of the Darjeeling Gorkha Autonomous Hill Council (DGAHC) is not equally assured across all these villages. However, the villages are all electrified and all the households have access to electricity. Children from these villages can go to a primary school located within one kilometre from their settlements. Opportunities for pursuing secondary/higher secondary education exist at Ghoom-Jorebunglow. Recently a new degree college has come up at Jorebunglow offering degree courses in humanities and social science.

Table 1. Occupations of the highest-earning members of households surveyed near Neora National Park.

Occupation	Earners	%
Farming	71	32
Permanent government service	49	22
Daily wage labour	36	16
Carpentry	22	10
Masonry	14	6
Driving	13	5
Petty business	10	4
Rearing livestock	5	2
Total	220	100

Institutional Profile:

There are five formal institutions functioning, three of which are formed out of internal initiatives to deal with various socio-economic problems. Forest Protection Committees/Eco-Development Committees were formed under the program of Joint Forest Management (JFM) to involve community people in forest management and to establish a vibrant socio-ecological system except in Bhalukhop village. *Panchayats*, institutions for local self-governance at the village level, were set up to fulfill the Indian constitutional obligation for village governing bodies and working for development in rural areas. Nepali Girls Social Service Center (NGSSC), a non-governmental organization, is working for socio-economic development in Pubobg phatak village. Mandir committee or clubs in all the studied villages are conducting some social events. Excluding FPC/EDC, other institutions build a suitable environment for different institutions to work here.

SOCIAL-ECOLOGICAL SYSTEM

Since 1856, migrants serving as tea garden (TG) labour established different settlements. Initially the TG management provided them shelter to stay and fuel wood to cook. However, in course of time migrants and members of split families settle and take up permanent residence. This increased population settled in adjacent forest areas and used forest resources for their sustenance. Clearance of forestland for agriculture and collection of fuel wood, fodder, and non-timber forest products (NTFPs) for their sustenance was a general practice. As a result forest area shrunk and changed its state. However, they still depend on the adjacent or captive forest for their daily needs of fuel wood, fodder, and some available NTFPs. Average annual value of the resources collected free from the forests (fuel wood, fodder, NTFPs, and timber) per household has been estimated at Rs.22,000. The extent of dependence of the households on forests appears to be 37.6%. A quantitative estimation of present dependence on forest resources is:

- Household mean fuel wood consumption is 20.4 kilograms daily, although only 2.7 kg/day for 14th mile;
- On average, each household consumes 36 kilograms of fodder daily; although only 0.5 kg/day for 14th Mile;
- Twenty-eight floral species are in use as NTFPs by the communities and only '*Chirato*' is harvested commercially.
- Household mean timber consumption is 0.6 cubic feet annually. Only people living in Bhalukhop area derive timber from the forest, residents of the rest of the villages buy it from the market.
- On average, each household consumes 1 kilogram of NTFP annually.
- Mean household water consumption is 234.4 litres daily, procured from the *jhoras* lying within the forests.

It is evident that the villagers surveyed depend a lot on the resources available from forests for their livelihood requirements. If the forests are not managed properly to ensure that such extraction of resources – fodder, timber, fuel wood, NTFPs, and water – are confined to the natural regeneration capacity (resilience) of the forests, the ecological system centred around the forest vegetation will disappear. The destruction of the ecological system will also endanger the existence of the social system built around the forest resources available therein. Both the systems, and the social-ecological system as a whole will reach a threshold of irreversible change.

However, the extent of dependence is gradually shrinking. Such declines may be caused by two prominent drivers: first, reduction in the availability of resources from the forests, and, second, increase in the availability of alternative substitute resources from the non-forest based economic system.

Our survey revealed that resources that were easily available earlier have become scarce. Harvesting of fuel wood has become a time-consuming task. People are travelling longer distances to harvest the resource and getting less quantity of fuel wood. Residents are increasingly adopting fossil fuel (kerosene and liquid petroleum gas), even though such fuels are not readily available locally. Fragmentation and clearing of watershed areas reduced the availability of water, with a simultaneous deterioration in its quality. Villagers have to go farther to collect drinking water. Less availability of fodder in the forest forced the residents to reduce the number of cattle. They are using part of their land as pasture and part as a fodder/fuel wood plantation. People use cement houses in place of culturally preferred wooden homes, as wood has become a scarce resource. Non-timber forest products collection is reduced abruptly, even though it is a part of their subsistence livelihood system. Man-animal conflict has increased. Recurring incidence of landslides during the monsoon season causes the loss of 1.2 to 1.6 hectares of land every year. These constraints on resources from the forest push the SES toward crossing a threshold beyond which the ecological system will not recover, followed by a collapse of the social system. Anderies (2006) documents an example of such a collapse of the prehistoric Hohokam society that flourished for around 1,450

years in central and southern Arizona. There is substantial evidence that the social system in this eastern Himalayan region is tightly linked to the availability of ecosystem services from the traditional forest ecosystem, suggesting that a similar outcome is possible.

GENERAL TRENDS OF VISIBLE CHANGES IN RECENT PAST (1984 AS BASE YEAR) AND THE VILLAGERS' EXPECTATIONS ABOUT THE FUTURE

During an interactive session employing the Appreciative Participatory Planning and Action (APPA) technique, the villagers came up with the following visible changes in the studied area since 1984 and revealed their expectations about the future.

- Forest cover has been dwindling rapidly in all villages.
- Depredation of agricultural crops and livestock by wild animals reduces agricultural production and earnings from livestock rearing.
- Agricultural production has decreased.
- The livestock population has decreased.
- Milk and milk-based production has decreased.
- Income and quality of life, as measured by modern standards, have increased. The villagers are aware that their persistent improvement in quality of life has been achieved through unsustainable extraction of forest resources and a possible reduction in the availability of forest-based resources beyond a threshold that would lead to a sudden fall in the present level of income and quality of life, breaking the SES simultaneously.

Villagers want to reverse these trends and want to start new enterprises enabling them to re-organize the SES. Locals consider that their social existence cannot be separated from that of the existing ecological system and that both the systems are mutually beneficial if a system of adaptive co-management is in place.

The villagers prepared a plan considering the different suggested activities and anticipated outcomes (Table 2). To summarize, it may be noted that such a plan will involve a one-time investment of about 7 million Indian rupees (about US$130,000). Per capita investment is estimated to be US$138. Such investments are capable of creating 47,564 man-days annually (about fifty-one days per capita). Annual per capita surplus that can be potentially generated through such investments is estimated at US$108 (Table 3). However, given the estimated per capita income of about US$215, the villagers cannot manage to generate the investment funds out of their own resources to come out of the vicious circle.

REMEDIES SUGGESTED BY THE LOCALS

The following are the remedies which the villagers feel will help to regain resilience within the SES:

- To prevent the wild animals from entering the villages and reducing the incidence of landslides, more trees should be planted in the areas adjoining the villages. The villagers are willing to plant trees on their own land, provided they are supplied the seedlings or saplings.
- A possible solution to wild animal conflict is putting up barbed wire fencing around the village boundary. The villagers are willing to contribute free labour and also to identify locations requiring immediate fencing.
- Adequate funds are necessary to ensure regular and adequate supply of water for both drinking and irrigation purposes.

Table 2. Activities Suggested by Villagers to Remedy the Current Unsustainable Use of Area Forest Resources Using the Appreciative Participatory Planning and Action Approach.

ACTIVITIES	Ghoom bhaanjyang	14th Mile	Pussumbeng phatak & Alubari	Poobong phatak	Bhalukhop
Agriculture	√	√	–	√	√
Mushroom Cultivation	√	–		√	–
Livestock Rearing	√	–		√	√
Dairy	√	–	–	√	√
Fodder Plantation	√	√	√	√	√
Cardamom Plantation	–	–	–	√	√
Forestry	√	√	√	√	√
Chirato Plantation	–	–	√	√	√
Floriculture	–	–	√	√	–
Forest Species Nursery	–	–	√	–	–
Ecotourism	–	√	–	–	–

√ = Willing to participate in; – = Did not specify.

Table 3. Projected Financial Costs of the Proposed Plan (values stated in rupees).

	Bhalukhop	Ghoom bhaanjyang	Poobong phatak	Pusumbeng phatak & Alubari	14th Mile	All Villages
Project						
Milk production (2 cows + 2 calves)	225,000	135,000	450,000	225,000	–	**1,035,000**
Milk Processing (butter, cheese, paneer)	50,000	50,000	50,000	–	–	**150,000**
Piggery breeding cum fattening (5 sows + 1 boar)	82,920	414,600	82,920	82,920	165,840	**829,200**
Goatery 25 does + 1 buck)	82,920	165,840	82,920	82,920	82,920	**497,520**
Poultry (400 Broiler birds)	68,040	68,040	68,040	68,040	–	**272,160**
Poultry (500 layer birds)	152,838	152,838	152,838	152,838	–	**611,352**
Farming (potato and raddish) on own land (8 ha)	176,400	44,100	220,500	30,870	15,435	**487,305**
Mushroom Cultivation on own land	–	4,000	4,000	8,000	–	**16,000**
Tree Nursery on own land (0.004 ha)	40,000	–	30,000	20,000	–	**90,000**
Floriculture on own land (0.4 ha)	40,000	20,000	20,000	20,000	–	**100,000**
Ecotourism on own land	–	–	–	–	1,000,000	**1,000,000**
Forestry for timber on own land (0.4 ha)	368,000	8,000	176,000	4,000	52,000	**608,000**
Cardamom Plantation on Forest land	150,000	–	75,000	–	–	**225,000**
Fodder Plantation on Forest land	320,000	80,000	160,000	80,000	32,000	**672,000**
Chiroto Plantation on Forest land	201,500	–	100,750	–	–	**302,250**
TOTAL	**1,957,618**	**1,142,418**	**1,672,968**	**774,588**	**1,348,195**	**6,895,787**

The villagers are willing to contribute free labour for development of the necessary infrastructure.

- Speedy and timely supply of relief materials needs to be ensured during natural calamities like landslides.
- The forest department should act in a more people-friendly manner and find ways to gain villager participation in the conservation of forest resources.
- A possible process remedy would be to institutionalize a social forestry or community forestry approach that will have as a goal restoration of contiguous forest cover to address wildlife habitat connectivity as well as the local community resource problems.
- Forest ownership issues should be discussed and an amicable solution crafted. The villagers feel that the ownership of forests should lie with them.

EXISTING INFORMATION GAPS TO BE FILLED AND A POSSIBLE ROAD MAP

The following steps might be taken to re-establish the missing link between social-ecological systems:

- Identify the migration routes of different wild animals. Even if the corridor is socio-economically feasible, it may not turn out to be a practical solution if the proposed location does not fall on the natural migration routes of wild species inhabiting SNP and SWS. Unfortunately, no such information is available in the public domain. However, sighting of a good number of faunal species by the residents of this region lends partial credence to the argument of having a corridor in this region as proposed in the present paper.

- The species composition of the standing forests lying at both ends of the proposed corridor needs to be altered to facilitate habitation by the wild animals. Monoculture of *Cryptomeria japonica* in the forests under consideration should be replaced by indigenous mixed species forest in a phased manner.
- Once the corridor is found to be ecologically, socially, and economically practicable, identification of the exact location of the corridor should be taken up with active participation of different stakeholders. Such an identification process will be influenced by the characteristics (slope, aspect, soil quality), ownership, and use pattern of the land available. A thorough social cost-benefit analysis of the possible alternatives will help identify the exact location of the proposed corridor.
- Identification of the exact location of the corridor will simultaneously help locate the households who may be affected as a result. All the residents of the village may be affected in some locations.
- A proper rehabilitation plan for those affected in particular and for the village in general is to be developed. The planning process has to be participatory in the real sense of the term.
- Setting up of the corridor is expected to generate net benefit through enhanced biodiversity status, including arrested species extinction, and creation of other ecological and environmental values for the global community. Even so, some within the community may reap positive benefits. Necessary resources to compensate those being affected directly are to be raised from those deriving a net benefit out of the decision to lay the corridor.
- The restored forest in this proposed corridor should be of mixed type to provide suitable habitat to the wild animals and sustenance opportunities to the residents. The proposed area has been without substantial forest canopy cover for some time, resulting in altered soil condition. The suitability of the

soil for restoration of different indigenous species must be studied.

- Promotion of fodder and NTFP species restoration, a practice still not recognized as a policy option in and around state-owned forests, necessary to sustain the livelihood of the villagers needs to be ascertained.
- Introduction of appropriate technology for resource production and provision of proper training to the villagers for developing skills will be of paramount importance to ensure higher productivity and efficiency, promoting sustainable use in the long run. Identification, documentation, and dissemination of traditional knowledge bases (like cropping pattern, rainwater harvesting, etc.) that helped ensure the past sustainable livelihood of the villagers, as well as of the wild animals, are to be encouraged.
- The new plantations could be linked to the carbon credit market to provide sustainable incentive to the locals as well as the conservation issue at hand.
- Local-level institutions are to be strengthened and the villagers are to be encouraged to participate more aggressively in conservation and sustainable forest uses so that the issues regarding the share of harvesting rights among the different stakeholders may be resolved.
- Relevant and measurable ecological and social indicators need to be developed to monitor the status of the corridor and the SES. Examples of such indicators could include improvement increases in endemic species populations, increased migration of wild animals between the protected areas, and reduced man–animal conflict reports.

CONCLUSION

We identified the social-economic intricacies involved in creating a possible corridor to facilitate movement of wildlife between Darjeeling Himalayan protected areas in India. It is found that anthropogenic intervention in the name of development, establishment of human settlements, and forestry operations initiated a land-use change and added to the fragility of the forest ecosystem in this region that was contiguous historically. The commercial exploitation of timber and planting of fast-growing species changed the phytosociological integrity of the socio-ecological system. Large-scale removal of broad-leaved indigenous trees with dense canopies and subsequent plantations of exotic *Cryptomaria japonica* (a coniferous species not even of much use to indigenous wildlife) induced reduction in water-trapping capacity of forests, minimized soil water, and often rendered the land unsuitable for natural regeneration. Controlled weeding and fire-protection methods introduced to maximize timber production of some commercially viable species weakened the resilience of the entire forest system to any sudden disturbance. The present study of feasibility of restoring a wildlife connectivity between the Singhalila National Park and Senchal Wildlife Sanctuary does find that the community members:

1. are concerned about the rapid deterioration of the ecological system around them;
2. consider the ecological system as an inseparable part of the social system they belong to and hence feel themselves to be a part of a larger social-ecological system;
3. prepared a detailed plan that would help strengthen the linkage between social and ecological system restoration and add to the resilience of the resulting social-ecological system; and
4. are ready to contribute meaningfully to the investable resources through provision of voluntary labour necessary to arrive at the required changes.

However, the feasibility of the corridor is still uncertain. It is quite clear that the start-up costs are too high for the local communities to bear. They are sensitive enough to realize the impending destabilization in the SES but cannot act unless supported with resources from outside – federal, regional, or even international support from institutions that also stand to gain considerably from such an effort. The latest census report on medium, small, and marginal enterprises (MSME) carried out by the Development Commissioner, MSME, Government of India in 2000–2001 reveals that 1.39 person years of employment is generated per Rs. 100,000 (roughly US$1,860). The investments in the corridor will generate 1.92 person-years of employment and have the capacity to help protect the forests as well. Thus, the investments, even though beyond the capacity of the communities under consideration, are well within the capability of the outside world, provided there exists a willingness to contribute towards the social gain that accrues to mankind as a whole and adds to the resilience of the social-ecological system under review.

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