Biodiversity Conservation in the Kangchenjunga Landscape

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ICIMOD

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The International Centre for Integrated Mountain Development (ICIMOD) is an independent regional knowledge, learning and enabling centre serving the eight regional member countries of the Hindu Kush-Himalayas – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and the global mountain community. Founded in 1983, ICIMOD is based in Kathmandu, Nepal, and brings together a partnership of regional member countries, partner institutions, and donors with a commitment for development action to secure a better future for the people and environment of the Hindu Kush-Himalayas. ICIMOD's activities are supported by its sponsors: the Governments of Austria, Denmark, Germany, Netherlands, Norway, Switzerland, and its regional member countries, along with programme co-financing donors. The primary objective of the Centre is to promote the development of an economically and environmentally sound mountain ecosystem and to improve the living standards of mountain populations.

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Contents

Section 3 – Socioeconomic and Livelihoods Aspects

Section 4 – The Policy Perspective

Foreword

In recent years, there has been a paradigm shift in global conservation approaches with a 'people and parks' replacing the earlier 'people or parks' concept. This is exemplified in the current landscape approach to biodiversity conservation, which advocates an integrated approach focusing on local communities so that conservation becomes sustainable. The landscape approach examines the history of human activities in a particular environment and integrates social, cultural, economic, and environmental factors to bring benefits to both the natural world and the people living in the area.

The International Centre for Integrated Mountain Development (ICIMOD) has been involved with several conservation initiatives at the landscape level over the past ten years. The heavy reliance of the local population on the ecosystems for their livelihoods has become increasingly clear, as has the way in which their activities can adversely affect these systems. With support from the MacArthur Foundation, ICIMOD began work in 2002 on a project aimed at developing a sustainable approach to transboundary biodiversity management of the landscape surrounding Mt. Kangchenjunga in the eastern Himalayas – a mountain shared by Bhutan, China, India, and Nepal. The aim was to support development of a transboundary landscape approach to management of the area that would establish a landscape that could sustain diverse ecosystem processes and services so that, at the species' level, extinction and genetic erosion could be checked and, at the ecosystem level, the services enhanced to improve the livelihoods of the communities for generations to come. The approach involved development of unfragmented, contiguous, and extended habitats across the landscape and identification of conservation corridors to connect established protected areas and fill gaps.

Protecting the dynamic and rich biodiversity of the Kangchenjunga landscape and alleviating poverty through conservation measures are formidable challenges. This publication presents a collection of research papers on the key conservation and development issues in the southern half of the landscape. The seventeen papers discuss conservation needs, biodiversity values, socioeconomic conditions, and potential enterprise development through income-generating opportunities and policy perspectives. Emphasis has been given to the sustainable use of forest resources; the prospects of bioprospecting for non-timber forest products (NTFP) and vegetable production as alternative livelihood options; and improvement of agricultural practices and livestock management. From a regional perspective, the key objectives are the identification of transboundary issues and the feasibility assessment for conservation corridors. The publication also discusses conservation measures in an around existing protected areas and the impact of conservation policies on land-use and land-tenure systems, traditional resource use, and customary laws.

The landscape activities have facilitated regional cooperation for conservation and sustainable use of resources throughout the Kangchenjunga landscape. We hope that this publication will help readers to understand the importance of this critical landscape for global conservation and the need to make conservation effective and integrative. It is also intended to bring to a wider audience the realisation that sociocultural and economic issues are crucial elements in the success of transboundary biodiversity conservation, and that the negative impacts of resource conservation on poorer people can be minimised and communities motivated to support equitable and sustainable ecosystem conservation and use.

I am confident that the publication will make a valuable contribution to the collaboration and effective biodiversity conservation in the Kangchenjunga landscape, as well as encouraging similar initiatives in the other important transboundary complexes in the Hindu Kush-Himalayas.

Dr. Andreas Schild
Director General

Executive Summary

The region surrounding Mt. Kanchenjunga is among the richest landscapes in the Hindu Kush-Himalayan mountain system in terms of global biodiversity. It is shared by Bhutan, China, India, and Nepal. Because of its strategic location between the four countries; transboundary cooperation is needed to ensure effective conservation. The three countries in the south of the Kangchenjunga landscape, Bhutan, India, and Nepal have given biodiversity conservation top priority; fourteen protected areas have been established in the landscape. These protected areas are isolated, however, depriving the landscape of crucial linkages. At the same time, worldwide experience has shown that biodiversity conservation requires a comprehensive multiscale approach that includes protection of both reserve and non-reserve areas, and considers human dependence on natural resources for livelihoods.

ICIMOD has adopted the landscape approach to biodiversity conservation as a way of meeting the need for integration of biodiversity conservation with community livelihoods, and using a holistic approach to meet local, national, regional, and global conservation goals. With support from the MacArthur Foundation, and working together with regional and national partners, ICIMOD introduced a project that used a participatory approach to develop conservation corridors linking isolated protected areas in the southern part of the Kangchenjunga landscape; formulate community-based participatory biodiversity conservation strategies and action plans; and enhance regional cooperation for conservation in the three countries. The project also focused on improving the livelihoods of the community living in the landscape through identification, promotion, and adoption of conservation-linked development opportunities.

The strategic process led to identification of six potential conservation corridors linking nine protected areas in the landscape. It was crucial to understand the various sociocultural, economic, and biological elements; but there was a wide gap between the knowledge base available on resources; prevailing challenges for conservation; and national, regional, and global conservation policies. This realisation led to implementation of a number of participatory action research projects to compile information on issues related to conservation challenges, potential options for economic policies, and imperatives for effective conservation of the landscape. This publication provides a summary of seventeen of these action research projects that helped measure the extent to which quantitative or qualitative targets would be met and addressed by conservation planning in the region. The publication also helps identify major conservation issues and development challenges and will support design and formulation of the most appropriate and feasible conservation strategies for sustainable biodiversity conservation in the conservation corridors of the landscape.

Acknowledgements

ICIMOD expresses its sincere thanks to its three regional member countries Bhutan, India and Nepal for their extended support during the conceptualisation and feasibility assessments for developing conservation corridors between the existing protected areas in the Kangchenjunga landscape, and acknowledges with gratitude the support of the MacArthur Foundation which was crucial for the implementation of the initiative.

ICIMOD acknowledges the support of, and thanks, all those who contributed to the research articles and helped strengthen the baseline information for conservation planning in the Kangchenjunga landscape.

The Centre is particularly grateful for the assistance provided by the different communities of the landscape, government line agencies, partners from various community-based organisations, NGOs, and INGOs; all of whom worked together on the priority issues at local, national, and regional levels.

Last but not least, we thank Professor Ram Prasad Chaudhary for his thorough review and critical comments, Greta Rana for her editorial inputs that helped us improve the research contents and bring the publication into its present shape, and the ICIMOD publications team who produced the book in its final form.

Acronyms and Abbreviations

BRS	Barsey Rhododendron Sanctuary
CBD	Convention on Biological Diversity
CBFE	cool broad-leaved forest ecosystem
CFUG	community forest user group
DDC	district development committee
DFO	divisional forest officer
FWWE	freshwater and wetlands ecosystem
GoN	Government of Nepal
HKH	Hindu Kush-Himalayas/n
ICIMOD	International Centre for Integrated Mountain Development
INGO	international non-government organisation
IUCN	International Union for Conservation of Nature
JDNP	Jigme Dorji National Park
JFM	joint forest management
KBR	Khangchendzonga Biosphere Reserve
KCA	Kangchenjunga Conservation Area
MWS	Mahananda Wildlife Sanctuary
NGO	non-government organisation
NTFP	non-timber forest product
NVNP	Neora Valley National Park
PA	protected area
SNP	Singhalila National Park
SNV	Netherlands' Assistance to Developing Countries
SRS	Singba Rhododendron Sanctuary
SWS	Senchel Wildlife Sanctuary
TDCE	temperate dry coniferous ecosystem
TMCE	temperate moist coniferous ecosystem
TSNR	Toorsa Strict Nature Reserve
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
VDC	village development committee
WCMC	World Conservation and Monitoring Centre
WWF	World Wide Fund for Nature

Section 1

Introduction

Developing a Transboundary Biodiversity Conservation Landscape and Conservation Corridors in the Kangchenjunga Complex

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Transboundary landscapes provide benefits beyond the political boundaries of nations and states and across societies, gender, and generations.

Bandana Shakya

Introduction

The Convention on Biological Diversity (CBD) defines biodiversity as variability among living organisms from all sources including terrestrial, and marine and other aquatic ecosystems; it includes not only diversity between species but also between and within ecosystems and genes. Biodiversity is an important resource because it supplies food, medicines, fibres, fuel, building materials, and other needs. The commitment made by world leaders to 'sustainable development' during the Earth Summit reflects the significance of biological diversity for the health of people and the planet. The delicate balance between human needs and availability of resources is imbalanced because to provide abundant food, improved shelter, and sound health, we

overlook environmental degradation, over-harvest and exploit our resources, and reshape and modify the natural landscape (WSSD 2002a,b). Pressure from human population growth, poverty, and inappropriate agricultural and industrial practices has caused degradation of the habitat, displacement of species and wildlife, and erosion of genetic diversity. The loss of biodiversity now threatens our food supplies, opportunities for recreation, and economic growth. Our usual efforts to protect biodiversity through establishment of parks and reserves, which have increased significantly in number and extent over the last two decades (Chape et al. 2005; IUCN 2005), look inadequate as many of the critical biomes and species are still outside protected area regimes (Rodrigues et al. 2004; Chape et al. 2005). Moreover, the areas in which people live, work, forage, and worship have been ignored; and that too plays an important role in biodiversity conservation (Hamilton 1993). Biodiversity conservation is, therefore, a matter of global concern for safeguarding this valuable resource upon which the health and well-being of the entire planet depends; and needs multifaceted activities that involve understanding of a variety of social, economic, cultural, and conservation issues (UNDP 2004).

The Hindu Kush-Himalayan (HKH) region is considered to be the most complex mountain system in the world. The region contains all or part of four of the world's 34 'Biodiversity Hotspots': the Himalaya, Indo-Burma, Mountains of Southwest China, and Mountains of Central Asia hotspots (Figure 1). These hotspots have a rich variety of gene pools, species, and

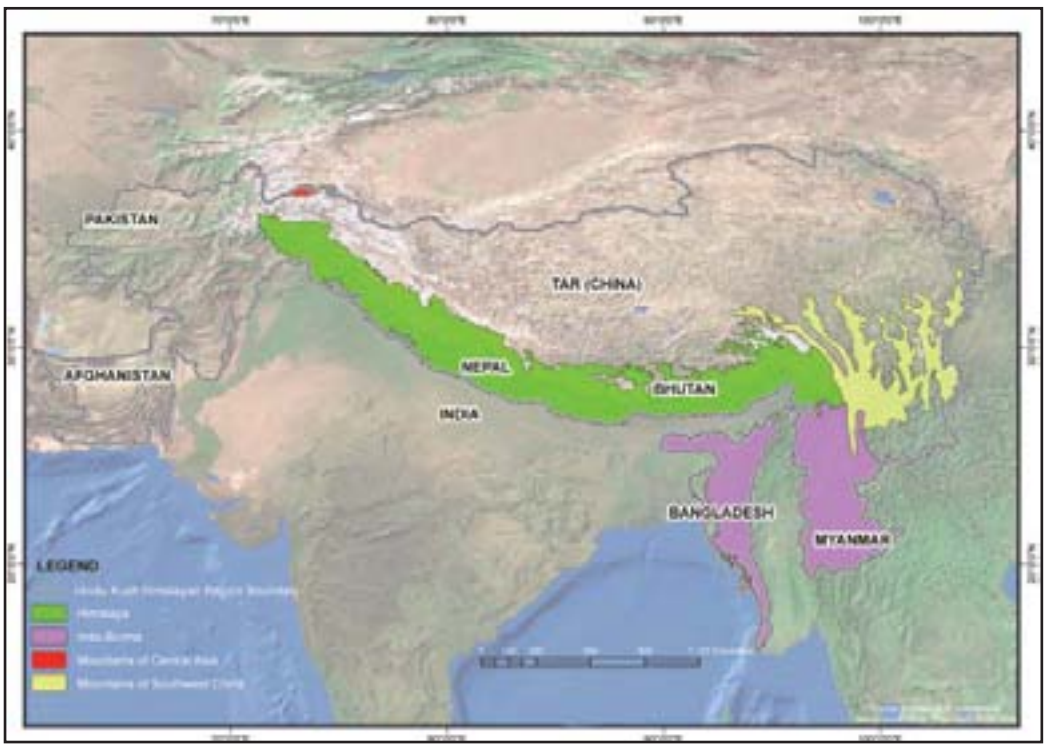

Figure 1: Map showing the four global biodiversity hotspots that lie partially or wholly within the Hindu Kush-Himalayan Region

ecosystems of global importance, many of them found only in the region: all are under a high degree of threat (Mittermeier et al. 2004). The ICIMOD member countries in the HKH region have shown their commitment to conservation by establishing 488 protected areas covering 39% of the area, which is much more than the 11.5% global standard. A recent gap analysis in the HKH region, however, revealed that these initiatives are still far short of conservation targets and many of the species, ecosystems, and forest types have still to be covered by current protected areas systems (Chettri et al. 2006). Moreover, the effectiveness of protected areas for biodiversity conservation has been questioned because of the lack of community participation, continuous habitat fragmentation within and outside the protected areas, poor management systems, and limited monitoring (Sharma and Yonzon 2005). The analysis also revealed that conservation measures taken to safeguard global biodiversity and render it sustainable are ineffective and insufficient.

Ecosystems and species found in the HKH region are not confined by geographical or political boundaries. Birds, mammals, insects, and other animals travel across local and national borders, and migration routes may even cross continents. They need special techniques for their conservation. The need for regional cooperation from the countries sharing such transboundary areas was felt as early as the 1980s as there are many transboundary protected areas in the HKH region which are fragile, located on distant borders, and critical for their conservation value.

Over the last decade, ICIMOD has been addressing transboundary cooperation actively with support from its partners. During this time, transboundary protected areas were identified and cooperation facilitated (WWF and ICIMOD 2001; Sherpa et al. 2003; Sharma and Chettri 2005; Chettri and Sharma 2006). In this publication, we present the knowledge developed through a series of research activities commissioned through numerous scientists and experts from three of its member countries (Bhutan, India, and Nepal) while working to develop corridors and advocate a landscape approach to biodiversity conservation in the Kangchenjunga complex. The publication is concerned only with the southern part shared by Bhutan, India, and Nepal where efforts have so far been focused. It is expected that the part in People's Republic of China will soon be included in these activities. This introductory section summarises the analytical findings of the various contributions and the recommendations made by the researchers and experts.

The publication has been divided into three thematic sections: biodiversity and conservation; socioeconomics and livelihoods, and policy perspectives. The first section deals with the biodiversity values of the landscape and conservation measures taken so far, and it brings a number of conservation challenges to the forefront. This is followed by a section on socioeconomics and livelihoods which argues for a community-based approach to conservation and transboundary cooperation for effective conservation linked to sustainable development of the landscape. The last section highlights the policy development processes in the three countries sharing the southern area of the Kangchenjunga landscape and their compatibility in regional and global conservation planning and measures to address conservation effectively.

Biodiversity Conservation

The Kangchenjunga complex, shared by Bhutan, PR China, India, and Nepal is an important transboundary landscape (CEPF 2005). The diversity of habitat types found in the landscape ranges from seasonally dry, deciduous woodlands in the lower foothills, through rich subtropical and temperate broad-leaved forests in the middle hills, to subalpine coniferous forests and highland meadows, all within a hundred kilometres distance. The extreme topographic relief of the world's third highest mountain constrains the dispersal of plant and animal species and affects microclimatic conditions. The designation of 42% of the southern part of the area as protected area network with an additional 11% as proposed corridors makes the landscape an important biodiversity repository. Our review and research revealed that the landscape is rich in biodiversity and a great proportion of species are threatened or endemic to the region. The flagship species of the landscape include the snow leopard (*Uncia uncia*), Asiatic black bear (*Ursus thibetanus*), red panda (*Ailurus fulgens*), Himalayan musk deer (*Moschus chrysogaster*), tiger (*Panthera tigris*), and takin (*Budorcas taxicolor*). Of the existing 14 protected areas, six are transboundary in nature: the Kangchenjunga Conservation Area (KCA) (Nepal-India), Khangchendzonga Biosphere Reserve (KBR) (India-Nepal), Barsey Rhododendron Sanctuary (BRS) (India-Nepal), Singhalila National Park (SNP) (India-Nepal), Pangolakha Wildlife Sanctuary (PWS) (India-China-Bhutan), and Toorsa Strict Nature Reserve (TSNR) (Bhutan-India). Many of these protected areas are still unexplored and there is limited information on the biodiversity they harbour. Moreover, the landscape connects the Bhutan Biological Conservation Complex (B2C2) (Sherpa et al. 2004) with the Sacred Himalayan Landscape (SHL) (GoN/MoFSC 2006) forming an important corridor in the eastern Himalayas. Thus, this landscape is an important transboundary complex for biodiversity conservation. The protected areas in this landscape, however, are scattered as 'conservation islands' without the connectivity needed for species to thrive and sustain themselves. The natural corridors that were once intact are now facing degradation.

ICIMOD has been working in the southern half of the Kangchenjunga landscape to develop conservation corridors and address transboundary issues at the landscape level since 2002. During the last five years, a series of consultations, baseline surveys, and feasibility assessments were carried out on developing corridors and facilitating regional cooperation in the landscape. Six potential conservation corridors were identified.

The first section of the book gives an outline of the importance of the landscape in terms of biodiversity; the strategic processes followed and methods applied for developing the landscape and the corridors by systematic niche modelling for key mammals and rhododendrons to examine the potentials; and evidence of the presence of many globally significant species in the proposed corridors that are outside the protected area.

Socioeconomics and Livelihoods

Humans are an integral part of the landscape. There are more than 1.5 million people living within the landscape and 70% of them are fully or partially dependent on the services provided by the biodiversity of the landscape. The protected areas and corridors, and the landscape as

a whole, are the main source of ecosystem services to the local people and contribute to the livelihoods of three times as many people living downstream. Traditional agriculture is the main economic activity. Large cardamom is the most popular cash crop and play an important role in uplifting the economic status of the people. The people living in the corridors have adopted promising agroforestry systems consisting of mixed farming of large cardamom with nitrogen-fixing alder, and mixed forests with broom grass and a variety of fodder, fuelwood, and timber species within the system. Cultivation of tea, especially the world famous Darjeeling tea, accounts for large areas. Potatoes, ginger, chillies, mandarin oranges, and varieties of local vegetables are also cultivated as cash crops. Livestock farming supplements crop cultivation by providing compost and additional income from products such as milk, meat, butter, curd, and cheese to many of the households. Some of the areas, however, are remote and inaccessible lacking steady markets and infrastructure, depriving local people of economic development.

Livestock rearing and open grazing are traditional practices that provide livelihoods to people living in high altitude areas. Substantial numbers of livestock use transborder open pastures as the main source of forage. Transhumance with seasonal movements of livestock is a traditional practice. Such practices are now constrained by policy changes such as notifying pasture lands as protected areas, banning traditional transborder movements of herders, and conversion of pastures into forests. These changes are bringing challenges to the people dependent on livestock-based livelihoods, especially those living in high-altitude areas.

There is great potential for strengthening community-linked conservation activities based on the available biodiversity by enhancing agroforestry, organic farming, beekeeping, and medicinal and aromatic plant cultivation to minimise pressure on forest resources while providing opportunities for economic development. Such potentials need further exploration, especially on technologies and market support with, of course, policy backing. The example of *Cordyceps* from Bhutan is a successful model that demonstrates how local communities can be involved in conservation while practising sustainable resource use for economic development. Similarly, co-management of pastures and use of available resources through proper land-use planning with available land and forest resources by involving local communities could open new livelihood avenues that would improve the economy and reduce pressure on natural resources.

The landscape also has a great potential for tourism. The ever-increasing inflow of tourists concentrated in the towns and cities of Darjeeling, Gangtok, Kalimpong, Ilam, and Paro make the region susceptible to negative impacts of tourism in their surrounding environments. Based on the potentials of diversifying tourism to transboundary areas and corridors in the form of ecotourism (homestays, mountain tourism, village tourism, and adventure tourism), such negative impacts could be minimised and the people living in the corridors and the landscape could benefit. To promote such tourism at the transboundary level, however, the member countries sharing this landscape need a cooperative understanding, infrastructure, and policies. The initiatives taken by SNV (Government of the Netherlands' Assistance) and ICIMOD with regards to developing a Great Himalayan Trail through South Asian Sub-Regional Economic Cooperation (SASEC) has shown the potential for regional tourism and its benefit to the countries in the region (SNV and ICIMOD 2006). Such initiatives have opened up avenues for tapping the potentials of transboundary ecotourism.

In the second section of this publication, readers are given an overview of the challenges and opportunities for socioeconomic development in the landscape corridors. The communities living in the inaccessible area face numerous challenges to sustaining their livelihoods. There is great potential, however, to tap into the rich biodiversity and promote community-based approaches linking livelihoods with conservation. Facilitation of interventions by development communities through identification of niche products, market analysis, technology transfer, and capacity building is critical. All are dealt with in this section.

Policy Perspectives

Conservation initiatives in the landscape started as early as 1940 when Senchel Wildlife Sanctuary with an area of 39 sq.km was declared a game reserve for the protection of indigenous plants and animals. This was followed by establishment of a number of other protected areas in the 1970s and 1980s. These protected areas were governed by stringent rules and regulations with a 'protectionist' approach such as the National Park Act, 1934 (India); Wildlife (Protection) Act, 1972 (India); Forest Conservation Act, 1980 (India); National Parks and Wildlife Conservation Act, 1973 (Nepal); and Bhutan Forest Act, 1969 (Bhutan). These stringent protectionist approaches were not compatible with the many traditional practices in land use governed by customary laws. Examples are given in the contribution in this volume by Nrishima Khatri of how customary laws have been overshadowed by statutary laws. Over the last 20 years, however, these practices have seen devolutionary changes in which concepts of buffer-zone management and community-based forest management were promoted in the landscape by the Governments of Bhutan, India, and Nepal (Chettri et al. 2006).

As environmental consciousness grew about the importance of conservation for human well-being; the countries sharing this critical landscape began to realise why it was necessary to view biodiversity conservation from a broad perspective (Rastogi et al. 1997) and efforts have been made to make conservation as 'people inclusive' as proposed by the CBD (Secretariat of the CBD 2004, 2005). Such an approach has led to a 'paradigm shift' from a concept of species' focused conservation to a landscape approach (Chettri et al. 2007). The provisions for joint forest management through eco-development committees in India; the concept of community forestry, buffer zone management, and conservation areas and landscapes in Nepal; and the community-based natural resource management and landscape approach in Bhutan are bringing these 'paradigm shifts' into policies (Sharma et al. 2006). These 'shifts' were strengthened when the concept of a landscape approach to conservation was nationalised and implementation began (MoA 2002; NCD 2004; GoN/MoFSC 2006).

In the third section of this publication, readers are given an overview of the land tenure and conservation policies and practices from India and Nepal, and an analytical review of the conservation and development policies in all three countries, along with future prospects and recommendations.

Conclusion

The Kangchenjunga landscape has rich forest resources with diverse land-use types, rich traditions, and cultures. The landscape provides various forms of conservation from community-managed systems to strictly government-managed protected areas. The economic opportunities from tea, tourism, and large cardamom cultivation are enormous in terms of linking conservation and development among local communities. From the very beginning, the participatory and consultative processes adopted by ICIMOD were found to be important strategies for promoting need-based development and multi-stakeholder partnerships. Support from government agencies was one of the key pillars in the process of developing the landscape approach. The heavy dependency of local communities on landscape resources is the most important driver of habitat degradation; however, it is well-known that the solution will not be found by depriving the communities and introducing stricter regulations on access to the resources they rely on. This publication presents information about landscape ecology, including the human dimensions, to show how conservation of protected areas would be more effective if people-inclusive landscape approaches were practised.

To conclude, the efforts of ICIMOD and its partners are gradually bringing about a paradigm shift from a conventional 'people exclusionary' approach to 'integrative conservation' of transboundary landscapes and from a strictly 'protectionist' approach to 'livelihood-linked' conservation. This initiative is gradually making positive strides by applying many global conservation and development targets in the form of CBD objectives and the Millennium Development Goals. In other words, restoring forested connectivity to create a broader cultural landscape linking conservation with livelihoods is becoming acceptable to all three participating countries in the southern Kangchenjunga landscape.

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Section 2

Biodiversity Conservation

Protected Areas and Biodiversity Conservation in the Hindu Kush-Himalayan Region with Special Reference to the Kangchenjunga Landscape

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Effective biodiversity conservation relies to a significant degree on information about protected areas, their number, status, and components within and outside them.

Introduction

Protected Areas (PAs) have long been recognised as a significant form of land use (Chape et al. 2005) and an integral part of biodiversity conservation (Lovejoy 2006). The number of PAs worldwide grew significantly after the formation of the World Commission on Protected Areas (WCPA) which provided a framework for the establishment and effective management of PAs (Hamilton and McMillan 2004). There are now more than 110,000 PAs in the world covering nearly 19 million sq.km., and representing about 12% of the earth's land surface (IUCN/UNEP/WCMC 2005). In the eastern Himalayas, PAs in the form of national parks, conservation areas, wildlife reserves, wildlife sanctuaries, and biosphere reserves have been established to

protect species listed in the red list of the World Conservation Union (IUCN) and the appendices of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) (WWF and ICIMOD 2001). Conservation of the species within the protected area alone, however, does not ensure long-term conservation of species; this requires natural landscape linkages to provide sufficiently large connected habitat, migration possibilities, and interaction of population. Evidence of ongoing loss of species due to lack of connectivity has been reported from national parks in North America and Africa (Bennett 2003).

Long-term conservation of species needs conservation at the landscape level, covering wide ranging areas extending beyond even the political territory of each country. In turn a landscape approach requires an understanding of the overall elements of biodiversity in the entire landscape. ICIMOD's introduction to biodiversity conservation initiatives using this approach began with compilation and collation of information on PAs in the Hindu Kush-Himalayan Region (HKH). A computerised database was developed to organise the information covering those PAs falling within the HKH boundary coordinates as defined by ICIMOD (Box 1). The project on 'Developing Transboundary Biodiversity Conservation Corridors in the Kangchenjunga Landscape' (Sharma and Chettri 2005) was introduced using a landscape approach to facilitate biodiversity conservation in the southern part of the Kangchenjunga complex, which is shared by Bhutan, India, and Nepal. Information on PAs and adjoining areas was gathered so that potential conservation corridors could be identified. This paper provides a preliminary review of PAs in the HKH region in terms of number, area, altitudinal coverage, and IUCN management categories, together with an overview of the status of biodiversity in the Kangchenjunga landscape based on the information gathered.

Protected Areas in the HKH

The HKH covers an area of more than four million sq.km, which includes the whole of Bhutan and Nepal and some parts of Afghanistan, Bangladesh, China, India, Myanmar, and Pakistan. Elevation zones extend from tropical (<500m) to nival (>5,000m); principal vertical vegetation regimes consist of tropical and subtropical rain forest, temperate broad-leaved deciduous or mixed forest, and temperate coniferous forest including high cold shrub or steppe and cold desert (Guangwei 2002). All HKH member countries are signatories to the Convention on

Box 1: Database of protected areas in the Hindu Kush-Himalayas

The Protected Areas database serves as a repository for the vast and scattered information on protected areas (PAs) in the HKH. The main objective of the database is to collate and disseminate information on PAs in an accessible and comprehensive way. The major features include a detailed country profile of the eight ICIMOD member countries in the HKH; details of PAs; spatial data with a number of satellite images showing the precise location of the PAs within the HKH; profiles of flagship species; geographical, land use and climatic maps; references; and a glossary of general terms and IUCN conservation and management categories. The database has a simple keyword search facility. Specific searches based on genus, species, common name, or taxonomic groups such as mammals, birds, and amphibians can also be carried out.

Biological Diversity (CBD) and have designated protected areas valuable in terms of biodiversity. The PA data from the HKH database indicate that there are 488 PAs in the HKH covering a total area of more than 1.6 million sq.km, 39% of the total area. PAs in the region have grown exponentially in the last three decades in both number and area with an increase in total area from about 98,000 sq.km in 1987 to more than 1.6 million sq.km in 2007 (Figure 1). The rate of increase in the number of PAs has slowed since 2000.

IUCN has defined management categories for PAs (IUCN 1994). Of the 488 PAs in the HKH, 189 belong to management category V, that is areas mainly protected as landscape or seascape particularly to safeguard aesthetic, cultural, and ecological values. Less than one per cent of PAs are managed as Category I, that is strict nature reserves or wilderness areas. In Afghanistan, India, and Pakistan most PAs are in category IV, that is habitat/species management areas or protected areas ensuring maintenance of habitats to meet the requirements of specific species. About 15% of PAs in the HKH, mostly in China (11 PAs) and Pakistan (48 PAs), have yet to receive formal IUCN PA management categories. Ecologically, the majority of PAs are in alpine regions or areas above 4,000m, followed by subalpine areas at 3000-4000m. Temperate regions between 2,000-3,000m are comparatively less represented. Many important habitats, such as wetlands in Afghanistan, mixed evergreen and littoral ecosystems in Bangladesh, alpine dry steppe in Pakistan, and mangrove wetlands in Myanmar are well represented (Pei 1995).

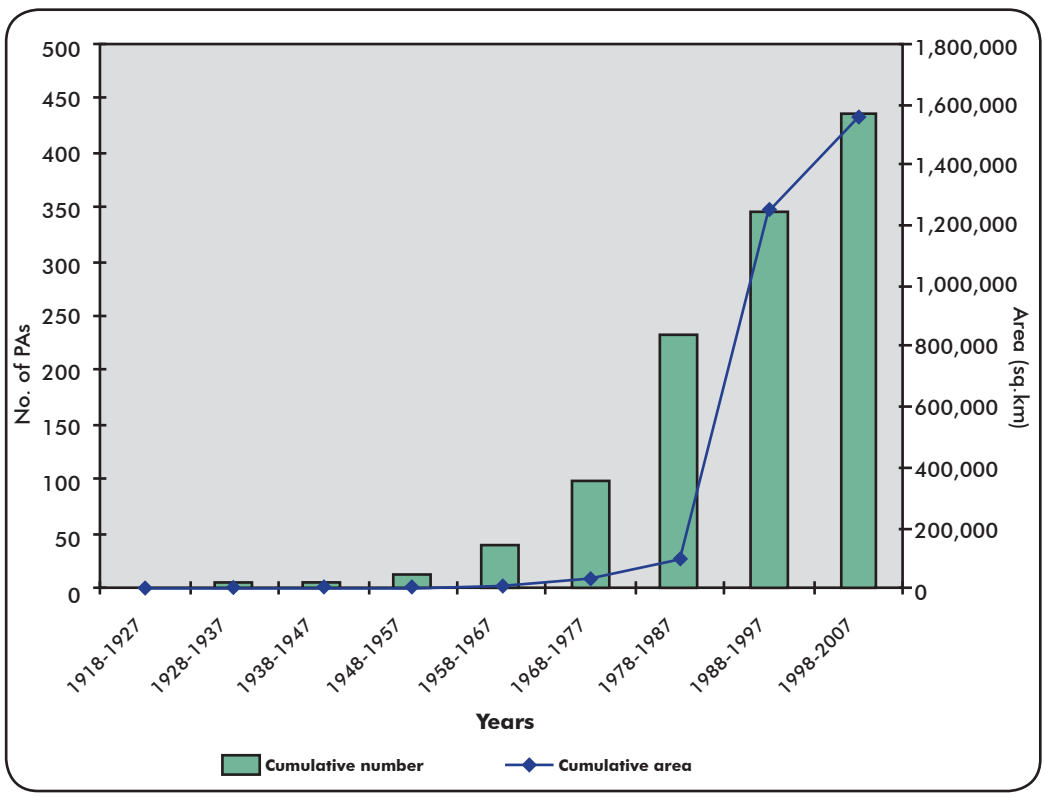

Figure 1: Cumulative growth in PAs in the HKH region from 1918 to 2007 (excludes 51 sites with unknown year of establishment)

PAs and the Status of Biodiversity in the Kangchenjunga Landscape

The work on developing a 'Kangchenjunga landscape' approach is a major initiative under ICIMOD's transboundary biodiversity conservation activities. The southern part of the landscape lies within the coordinates 87.5° to 90.5° E and 26.5° to 28.1° N and includes parts of eastern Nepal, western Bhutan, and Sikkim and Darjeeling in India. The landscape is one of six transboundary complexes identified by ICIMOD in the HKH region (Sharma and Chettri 2005). It includes important areas of the eastern Himalayan ecoregion which is comprised of temperate coniferous and broad-leaved forests (Wikramanayake et al. 2002), and includes fourteen PAs (Table 1). Nine of the PAs are connected by six proposed or implemented conservation corridors. The conservation corridors were identified by integrating layers of information on biology, climate, vegetation, landscape coverage, species' home range and viability of population, and sensitivity to the human population. The 14 PAs and 6 conservation corridors cover an area of 7754 sq.km. The protected areas in the landscape are habitats for many globally significant plant species such as rhododendrons (*Rhododendron nivale, R. sikkimensis, R. kesangiae, R. flinckii, R. maddenii*) and orchids (*Cypripedium elegans, Cymbidium hookerianum, Coelogyne treutleri*), and many endangered flagship species such as snow leopard (*Uncia uncia*), Asiatic black bear (*Ursus thibetanus*), red panda (*Ailurus fulgens*), Himalayan musk deer (*Moschus chrysogaster*), blood pheasant (*Ithaginis cruentus*), and chestnut-breasted partridge (*Arborophila mandellii*).

The twelve PAs in Sikkim and Darjeeling in India have been strictly managed for the protection of globally-threatened species. The two national parks Neora Valley and Singhalila are managed for both ecosystem protection and recreation. The Kangchenjunga Conservation Area (KCA) in eastern Nepal is the only PA in category VI, in other words managed by the local communities. The Khangchendzonga Biosphere Reserve (KBR) in Sikkim is the largest of the PAs, with 1,784 sq.km of core zone and four buffer zones with a total area of 836 sq.km giving 2620 sq.km in total. This PA alone has some 2,500 species of recorded flowering plants, 42 species of mammal, and 450 species of bird (Chettri and Singh 2005). The first of the PAs were established in 1976 (Senchel Wildlife Sanctuary and Mahananda Wildlife Sanctuary), and the most recent in 2000 (KBR and Pangolakha Wildlife Sanctuary).

Ecosystems and species' diversity

The PAs in the Kangchenjunga landscape cover various bioclimatic zones. The diversity of forest and vegetation differs from one protected area to another. KCA is comprised of subtropical evergreen forest, mixed broad-leaved forest, coniferous and rhododendron forest, and alpine scrub (Shrestha and Ghimire 1996). Some of the PAs in India, such as KBR in Sikkim, contain subtropical broad-leaved forest, moist temperate forest, subalpine rhododendron and coniferous forest, and alpine scrub (Department of Forest, Government of Sikkim 1997). Similarly, Singhalila National Park (SNP) supports lower temperate evergreen broad-leaved forest and upper temperate *Tsuga* forest and oak-hemlock forest (Pradhan and Bhujel 2000). Mahananda Wildlife Sanctuary (MWS) mostly contains deciduous hill forest, *Acacia-Dalbergia* riverine forest, sal forest, and riverine grassland (Pradhan and Bhujel 2000). The six proposed

Table 1: **Protected areas and proposed corridors in the Kangchenjunga landscape**

Protected area proposed corridor	Country	IUCN Category	Year Established	Area (sq.km)	No. of recorded species[a]		
					Flowering plants	Birds	Mammals
Kangchenjunga Conservation Area (KCA)	Nepal	VI	1998	2035	1026 (13)	207 (3)	22 (7)
Barsay Rhododendron Sanctuary (BRS)	India	IV	1998	104	141	113[b]	22[b]
Fambong Lho Wildlife Sanctuary (FWS)	India	IV	1984	52	(NA)	135 (6)	24 (4)
Jorepokhari Salamander Sanctuary	India	IV	1985	0.4	(NA)	40[b]	5[b]
Khangchendzonga Biosphere Reserve (KBR)	India	not set	2000	2620	2500	450[b]	42[b]
Kyongnosla Alpine Wildlife Sanctuary (KWS)	India	IV	1977	31	(NA)	120 (4)	16 (2)
Mahananda Wildlife Sanctuary (MaWS)	India	IV	1976	127	329	243[b]	35[b]
Mainam Wildlife Sanctuary (MWS)	India	IV	1987	35	(NA)	185 (5)	16 (4)
Neora Valley National Park (NVNP)	India	II	1992	88	172	19[b]	18[b]
Pangolakha Wildlife Sanctuary (PWS)	India	IV	2000	128	(NA)	(NA)	(NA)
Senchel Wildlife Sanctuary (SWS)	India	IV	1976	39	379	73[b]	22[b]
Shingba Rhododendron Sanctuary (SRWS)	India	IV	1992	43	(NA)	150 (6)	20 (3)
Singhalila National Park (SNP)	India	II	1992	79	383	156[b]	26[b]
Toorsa Strict Nature Reserve (TSNR)	Bhutan	Ia	1993	651	266	72[b]	15[b]
Corridor 1: Nepal side of KBR and BRS adjoining KCA	Nepal	Proposed		752	367 (20)	274 (28)	37 (25)
Corridor 2: Between SNP and SWS	India	Proposed		158	331 (8)	45 (5)	16 (10)
Corridor 3: Between SWS and MaWS	India	Proposed		46	498 (15)	29 (1)	17 (13)
Corridor 4: Between MaWS and NVNP	India	Proposed		292	575 (14)	17	25 (18)
Corridor 5: Between NVNP and TSNR	India	Proposed		169	21 (1)	19 (1)	13 (12)
Corridor 6: Between TSNR and JDNP	Bhutan	Proposed		147	129 (3)	141 (14)	16 (11)

[a] numbers in parentheses indicate globally significant species; [b] number of globally significant species not available; NA= data not yet available

corridors add about 1722 sq.km to the existing protected area system and could help ensure the survival and maintenance of a significant number of globally-threatened species of mammals, birds, and flowering plants protected by PA management (Table 1). The corridors are areas where there is structural connectivity in terms of vegetation and species' composition and minimum human intervention.

Of the approximate total of 3,038 recorded species of flowering plants in the protected areas and corridors (Chettri et al. 2006), about 20% were found in the three corridors in the Darjeeling district in India. As indicated in Table 1, the proposed conservation corridors, in particular the corridor on the Nepal side of the KBR and Barsey Rhododendron Sanctuary (BRS) adjoining KCA, and the corridor between MWS and Senchel Wildlife Sanctuary (SWS), host significant numbers of globally important species: they include spot-bellied eagle owl (*Bubo nepalensis*), wood snipe (*Gallinago nericola*), red-headed vulture (*Sarcogyps calvus*), black baza (*Leuphotes accipitidae*), Himalayan tahr, (*Hemitragus jemlahicus*), snow leopard (*Uncial uncia*), large Indian civet (*Viverra zibetha*), Himalayan goral (*Naemorhedus goral*), and rhesus macaque (*Macaca mulatta*). Similarly 12 of the 13 species of mammals recorded in the corridors between Neora Valley National Park (NVNP) and Toorsa Strict Nature Reserve (TSNR) are globally significant, as are 9 of the 18 species of mammals found in the TSNR-Jigme Dorji National Park (JDNP) conservation corridor.

Conservation challenges

The PAs in the Kangchenjunga landscape have faced various conservation threats including interference from outside the park and human activities on the fringes. The activities include forest encroachment, poaching of wildlife, overgrazing by livestock, illegal fuelwood collection and timber extraction, extensive collection of non-timber forest products (NTFP), and, often, unregulated tourism. Habitat fragmentation and transformation of natural habitats are aggravated by landslides, soil erosion, flooding, much shortened fallow cycle of shifting cultivation, deforestation, agricultural extension, and forest fires. Corridor areas were highly fragmented because of deforestation practices, overgrazing, and overexploitation of forest resources such as NTFP and medicinal plants.

Discussion

Conservation at the landscape level imply the protection of natural habitats so that all the ecosystem components are maintained. Extending biodiversity management beyond protected areas plays a significant role in delivering the three objectives of the Convention on Biological Diversity (CBD); conservation, sustainable use, and equitable sharing of benefits (Secretariat of the CBD 2005). The HKH region contains many globally significant ecosystems and species and isolated protected areas are inadequate for their conservation (CEPF 2005). In the Kangchenjunga landscape, six potential conservation corridors have been identified to provide landscape connectivity among the existing PAs and to ensure long-term conservation of entire elements of biodiversity in the region (Sharma and Chettri 2005). Establishment of such corridors implies the establishment of continuous habitats to not only preserve endangered and rare species of plants and animals, but also diverse ecosystems that provide significant services for the well-being of communities dependent on their resources.

Protected area management in recent years has been considered in the context of integrated development through which resource conservation is carried out along with sustainable economic opportunities for the local communities directly dependent on natural resources. It is evident from the PA database of the Hindu Kush-Himalayas that PAs in category VI have a greater area coverage than other PAs. They include predominantly unmodified natural areas meant for long-term protection and maintenance of biodiversity but in which sustainable use of natural resources by the community is permitted (Chettri et al. 2006). In Nepal, collaboration in forest management between the park authorities and local communities in buffer areas of PAs has brought economic benefits to the people (Oli 2005). Information collected about the PAs in the HKH region can be analysed to identify and prioritise areas for future protection and to facilitate development of effective management plans. The HKHPA can be revised with new information about various aspects of PA management such as socioeconomic status, indigenous knowledge, and information on associated corridors and buffer zones.

Conclusion

The PAs in the HKH are managed in a variety of ways, ranging from management as strict nature reserves and wilderness areas to community-based resource management, which transfers the responsibility for conserving biodiversity and sustainable harvesting of forest products to local people. Considering habitat connectivity, the number of species recorded in the corridor areas is significant enough for the areas to be designated biodiversity conservation corridors in the Kangchenjunga landscape. Transboundary protected area management in the Kangchenjunga landscape is an important initiative in terms of taking conservation beyond the PAs and beyond political boundaries in the HKH. National and regional collaboration is taking place to help establish effective and ecologically-managed biodiversity conservation corridors between selected PAs and the buffer zone system so that the rate of biodiversity loss can be significantly reduced and comprehensive participation of a wide range of stakeholders solicited to manage them. Learning from the Kangchenjunga landscape, gap analysis of protected area coverage should be carried out across the HKH to identify ecoregions and globally significant species and help establish an ecologically sound network of PAs and corridors in the whole Region.

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Feasibility Assessment for Developing Conservation Corridors in the Kangchenjunga Landscape

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Effective management of protected areas relies on connectivity between separated areas and maintenance of the area surrounding PAs, which together ensure that a wider conservation complex is established suitable for long-term sustainability of ecological processes.

Introduction

Fragmentation of habitats is one of the most commonly cited threats to species' survival and causes loss of biological diversity, making it perhaps the most important contemporary conservation issue (Fuller et al. 2006). Over the previous decades, it has become generally accepted that spatial configuration of a habitat plays a crucial role in the conservation of biodiversity. Connecting a good patch to neighbouring patches lowers the extinction risk of the population. In heavily fragmented landscapes, species are only likely to survive within networks of patches that are sufficiently connected by dispersing individuals (Bennett 2003). A direct assessment of landscape connectivity must, therefore, incorporate aspects of movement of

organisms through the landscape. Connectivity of habitat patches within a landscape has thus become a key issue in the conservation of biodiversity. Connectivity is a key concept of landscape ecology as it relates to flows and movements of organisms driven by landscape structure (Haddad et al. 2003). Several authors have promoted the idea that 'connectivity' of a landscape depends not only on the distance between habitat patches, but also on the presence of corridors and stepping stones and on the resistance of the surrounding matrix. In fragmented and heterogeneous landscapes, movement is a key process in the survival of plants and animals (Bennett 2003; Haddad et al. 2003; Dixon et al. 2006). Addressing fragmentation is one of the central concerns in the activities associated with the introduction of a landscape approach to support biodiversity conservation in the Kangchenjunga region (Sharma et al. 2007).

The proposed Kangchenjunga landscape is one of the richest landscapes in Asia; it is shared by Nepal, Bhutan, India, and China (Yonzon et al. 2000; WWF and ICIMOD 2001) and is a part of the Himalayan biodiversity hotspot, one of 34 hotspots in the world (Mittermeier et al. 2004). The part within Bhutan, India, and Nepal is situated between 87°40' and 89°19' N and 27°35' to 27°48' E, and covers an area of 14,432 sq.km from eastern Nepal through the Kangchenjunga region in Sikkim and Darjeeling in India to Toorsa Strict Nature Reserve (TSNR) in western Bhutan. There are 14 protected areas covering 6,032 sq.km within the landscape. Protected areas within reserves are essential for conserving biodiversity, but are often small and geographically scattered as 'conservation islands' (Table 1). Human-induced modifications such as monocultural farming, clear-cut forestry, and expanding urban developments (to name just a few) have rapidly altered the biodiversity levels of flora and fauna in the landscape. These alterations to the environment made the landscape more hospitable to aggressive species that could tolerate and even thrive in such disturbed habitats, in turn, reducing the amount of endemic flora and fauna and furthering the reduction of species. During the last four years of extensive research and consultation, the project identified potential conservation corridors (Sharma and Chettri 2005) and local and transboundary conservation and development issues (Chettri and Sharma 2006), and developed strategies for landscape planning that address potential social, economic, and political perspectives for developing corridors and the landscape (Chettri and Sharma 2006). This paper emphasises the participatory processes followed and the outputs of such processes in conceptualising corridors between the existing protected areas within the landscape.

The Corridor Concept

Corridors, as a conservation model, have gained acceptance over the past few years. The spatial scale of a corridor can range from very small to large in terms of the ground area covered. Many globally-threatened animals found in the Kangchenjunga landscape, such as the snow leopard (*Uncia uncia*), red panda (*Ailurus fulgens*), clouded leopard (*Neofelis nebulosa*), tiger (*Panthera tigris*), and takin (*Budorcas taxicolor*), are extremely susceptible to the effects of habitat fragmentation because of low population densities, wide-ranging movements, and the potential for conflicts with humans. The present protected area in the Kangchenjunga landscape is not enough for these charismatic species, however, and they use areas outside the existing protected areas as their habitat (CEPF 2005).

Table 1: **Protected areas in the Kangchenjunga landscape**

Protected Area	Location	Area (sq.km)
Kangchenjunga Conservation Area (KCA)	Taplejung, Nepal	2035
Khangchendzonga Biosphere Reserve (KBR)	Sikkim, India	2620
Barsey Rhododendron Sanctuary (BRS)	Sikkim, India	104
Fambong Lho Wildlife Sanctuary	Sikkim, India	52
Kyongnosla Alpine Sanctuary	Sikkim, India	31
Mainam Wildlife Sanctuary (MWS)	Sikkim, India	35
Singhba Rhododendron Sanctuary (SRS)	Sikkim, India	43
Pangolakha Wildlife Sanctuary	Sikkim, India	128
Jorepokhari Salamander Sanctuary	Darjeeling, India	0.4
Singhalila National Park (SNP)	Darjeeling, India	79
Senchel Wildlife Sanctuary (SWS)	Darjeeling, India	39
Mahananda Wildlife Sanctuary (MaWS)	Darjeeling, India	127
Neora Valley National Park (NVNP)	Darjeeling, India	88
Toorsa Strict Nature Reserve (TSR)	Bhutan	651
Total		**6032**

To be effective in the long term, the conservation of biodiversity on private and public lands needs to be addressed by integrated regional programmes (Dixon et al. 2006). The conservation value of reserves will increase significantly if they can be linked by environmentally-managed corridors beyond political boundaries. In addition to linking existing pieces of remnant vegetation and providing for wildlife movement, 'conservation corridors' can reduce soil and water degradation, provide a source of timber, provide shelter for stock, and contribute to recreational activities and tourism (Rouget et al. 2006).

Biological corridors can eliminate problems associated with island biogeography. These so-called 'islands' are created when distinct areas are placed into an environmental management plan while the surrounding environment is subject to the deleterious effects of human-induced pressures of non-management. The corridors proposed for the Kangchenjunga landscape connect individual protected places in order to place the management zone in a broader context.

The Strategic Process

During the last two decades, ICIMOD has been instrumental in developing consensus among various stakeholders on the need for transboundary landscapes and development of conservation corridors in the Southern part of the Kangchenjunga landscape, which covers parts of eastern Nepal, Darjeeling and Sikkim in India, and western Bhutan (Rastogi et al. 1997; WWF and ICIMOD 2001; Sharma and Chettri 2005; Chettri and Sharma 2006). The genesis of the process is illustrated in Figure 1. The initiative was inspired by a decision from the Conference

of Parties (COP 7) to the convention on Biological Diversity (CBD) that recommended an 'ecosystem approach' to biodiversity conservation, and was inspired and guided by the conservation corridor development process (Sanderson et al. 2003) and systematic planning (Margules and Pressey 2000). Based on these guiding principles, we followed strategic criteria (see Sharma and Chettri 2005) to identify this key transboundary complex and develop a process for achieving the CBD decision.

Consultation, participatory tools and approaches, and action research for baseline information were used to develop awareness of the need for and importance of developing conservation corridors within the landscape. The use of geographical information systems (GIS) and remote sensing (RS) tools to locate and facilitate spatial contexts became instrumental in delineating the proposed corridors. Corridors were identified by analysing forest cover, biodiversity status, species' presence and movement patterns, and potential connectivity, thereby identifying the 'gaps' in management (Figure 2).

Results

The criteria for corridor identification were based on the 'compatible land' found in the area. Initially, participatory research was carried out based on local knowledge from farmers, conservationists, and civil society. This showed that there was an adequate area of compatible land available covered with forests to develop corridors. The strategic process identified six potential corridors in the landscape: i) a corridor in eastern Nepal adjacent to the Khangchendzonga Biosphere Reserve (KBR) and Barsey Rhododendron Sanctuary (BRS) in Sikkim, India; ii) a corridor linking Singhalila National Park (SNP) and Senchel Wildlife Sanctuary (SWS), iii) a corridor linking SWS and Mahananda Wildlife Sanctuary (MWS), iv) a corridor linking MWS and Neora Valley National Park (NVNP), all in Darjeeling, India; v) a corridor linking NVNP and Toorsa Strict Nature Reserve (TSNR), and vi) a corridor linking Toorsa Strict Nature Reserve and Jigme Dorji National Park (JDNP), both in Bhutan.

The land-cover analysis showed that about 42% of the proposed landscape was already protected in some way; a further 11% of the land was proposed to be included in conservation corridors. The area identified as potential corridors is covered by community, reserve, and other forest; agricultural land; and pasture. Land-use cover analysis showed two-thirds (67%) of the area is under natural forests and about 18 % of the corridors are still under compatible land-use classes such as cardamoms, cinchona, tea gardens, and broom-grass cultivation (Table 2). The natural forests have contiguous forest patches that connect tropical to alpine zones. The forests are of a diverse type, however, especially in terms of tenure and land rights (Table 2). This diversity is mainly a result of land-use practices and the socio-political differences amongst the three countries. The proposed corridor in Nepal is mainly covered with private forests and agroforestry systems, whereas those in India and Bhutan are mainly covered by reserve forest under government ownership. There is great potential for connecting the existing protected areas in the landscape by enhancing compatible land use in the corridors.

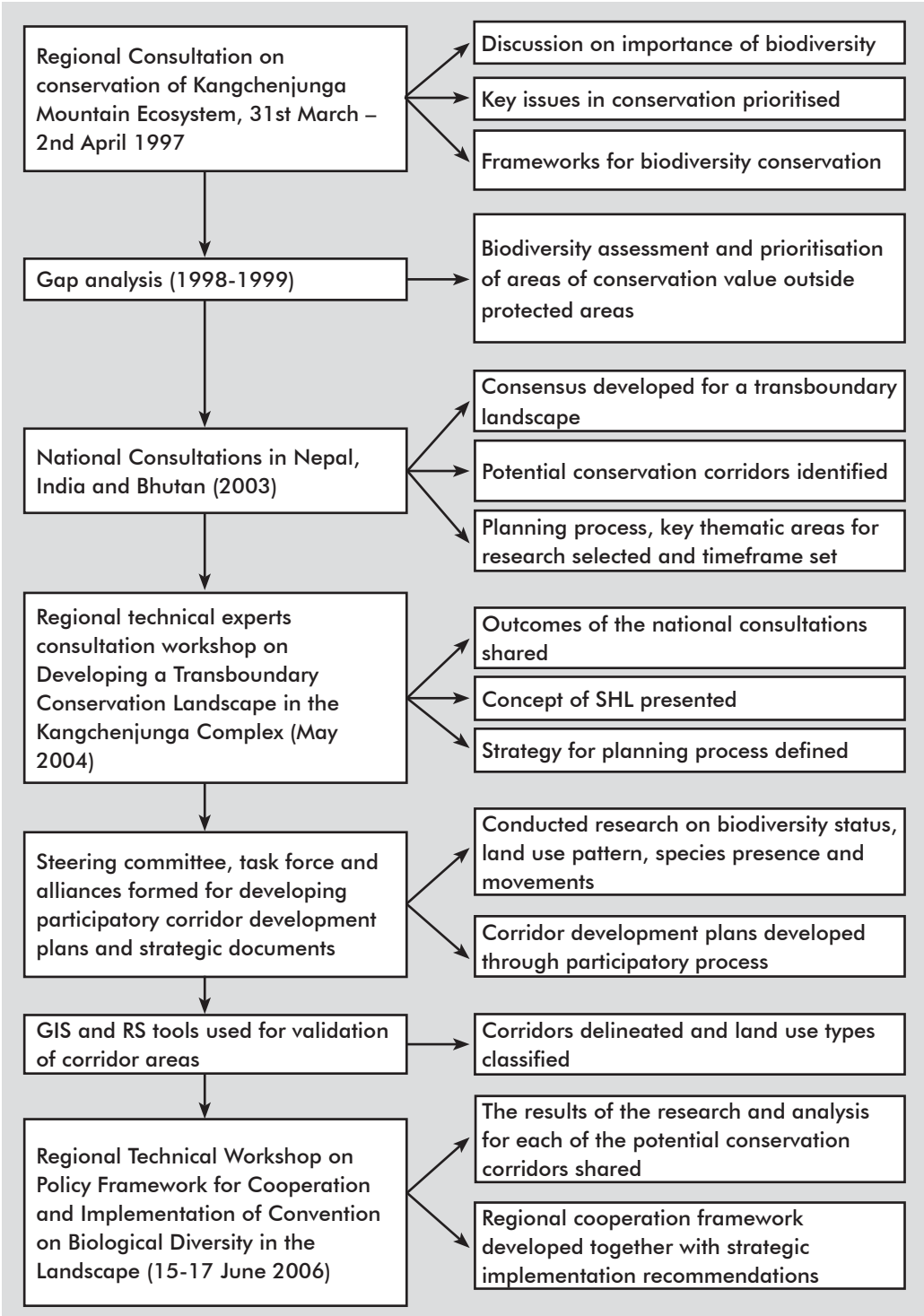

Figure 1: Chart showing the process adopted in the development of the Kangchenjunga landscape concept

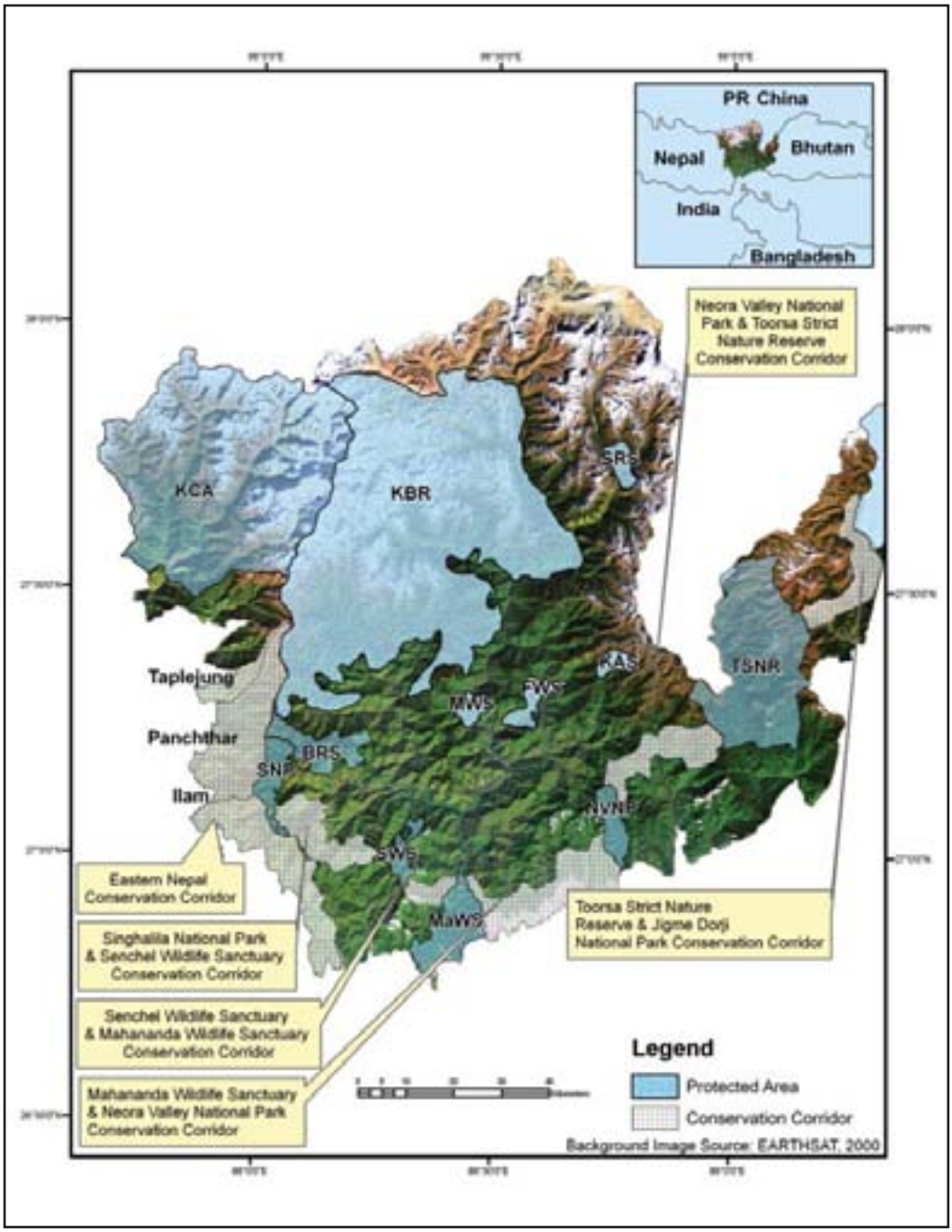

Figure 2: Protected areas and proposed conservation corridors in the Kangchenjunga landscape

KCA = Kangchenjunga Conservation Area, Nepal; KBR = Khanchendzonga Biosphere Reserve, BRS = Barsey Rhododendron Sanctuary, FWS = Fambong Lho Wildlife Sanctuary, SRS = Singba Rhododendron Sanctuary, MWS = Mainam Wildlife Sanctuary, KAS = Kyongnosla Alpine Sanctuary, Sikkim, India; SNP = Singhalila National Park, SWS = Senchel Wildlife Sanctuary, MaWS = Mahananda Wildlife Sanctuary, NVNP = Neora Valley Nationa Park, Darjeeling, India; and TSNR = Toorsa Strict Nature Reserve, JDNP = Jigme Dorji National Park, Bhutan

Table 2: **Land use and land cover of the potential conservation corridors**

Land use	Corridor (i)	Corridor (ii)	Corridor (iii)	Corridor (iv)	Corridor (v)	Corridor (vi)	Total area	%
Tea gardens	34.93	5.07	0.51	54.68			95	6.1
Broom-grass field	2.2	0.57	3.75				7	0.4
Cinchona plantation			1.68				2	0.1
Large cardamom	164				12		176	11.3
Agricultural land	132.1	2.14	0.99	60.5		5.64	201	12.6
Tropical forest	95.91		17.86	120.32			234	15.0
Pine forest	54.57	19.6	2.89		9.42	85	171	11.0
Temperate mixed forest	180	116.65	4.94	10.99	125.22	0.69	438	28.1
Shrubland	42.47	1.84	4.26	0.5	12.2	25.8	87	5.6
Alpine meadow	1.41				9.11		11	0.7
Settlement	9.03	1.01	0.7	1.04			12	0.8
Degraded, rock, and unused areas	34.62	11.12	8.22	42.35		29.6	126	8.1
Lakes and rivers	0.04			1.15	0.55	0.53	2	0.1
Snow and ice	0.35						0	0.1

Discussion

Enormous conservation measures have been undertaken in the Kangchenjunga landscape. Some 42% of the landscape is included in protected areas that range from 0.4 sq.km to 2,620 sq.km. However, these areas are scattered and isolated, and mostly represent the alpine region, (Sharma and Chettri 2005; Chettri et al. 2006). In the past, the focus of conservation has been on addressing the critical habitats of key species that are remotely located and economically unproductive. There is a major gap in understanding of the ecological process and the importance of areas that are valuable but under represented in biodiversity conservation measures (Margules and Pressey 2000). Protected areas are increasingly being complemented by reserves established principally for the protection of biodiversity, including ecosystems, biological assemblages, species, and populations, but holistic conservation targets, that is the ecological processes, are not considered. In such instances, it is evident that the basic role of reserves is to separate elements of biodiversity from processes that threaten their existence in the wild. This is done within the constraints imposed by large and rapidly increasing numbers of human settlements and their attendant requirements for space, resources, and infrastructure.

Many species occurring in productive landscapes or landscapes with development potential are not protected, even though disturbance, transformation to intensive uses, and fragmentation continue. This is mainly due to under representation of the extended habitat in the protected area regime (Chettri et al. 2006). The extent to which reserves protect all species depends on how well they meet two objectives: protected areas must have representation of all vegetation

and habitat types needed for population and persistence (Soule 1987) and reserves, once established, should promote the long-term survival of the species and other elements of biodiversity they contain by maintaining natural processes and viable populations and excluding threats (Margules and Pressey (2000). The proposed corridors, with their substantial areas under compatible land use, can definitely fill the gaps and enhance conservation not only by providing contiguous habitats for some of the charismatic species in the landscape but also by covering under-represented areas and naturalising the process of migration across political boundaries. Such international corridors foster new levels of transboundary conservation, elevating corridors from an ecological to a political and socioeconomic tool (Zimmerer et al. 2004). In additional, corridors that provide west-east, south-north, and altitudinal linkages might serve to provide routes and habitats for movement of organisms responding to climate change (Channell and Lomolino 2000). Further, most conservationists acknowledge that the purpose of corridors is to counter the effects of habitat loss and fragmentation, which are important causes of biodiversity loss worldwide, and they are expected to slow these effects down by increasing the movement of individuals among otherwise isolated populations, thereby rescuing populations from stochastic local extinction, maintaining genetic diversity, and retaining ecological processes (Bennett 2003; Chetkiewicz et al. 2006).

Conclusion

The realisation of conservation goals requires strategies for managing whole landscapes, including areas allocated to both production and protection. Reserves alone are not adequate for nature conservation, but they are the cornerstones on which regional strategies are built. Reserves have two main roles. They should be samples of, or represent, the biodiversity of each region, and they should buffer biodiversity from processes that otherwise threaten its persistence. Existing reserve systems throughout the world contain a biased sample of biodiversity, usually that of remote places and other areas that are unsuitable for commercial activities. A more systematic approach to connecting and designing reserves has been evolving, and this approach will need to be implemented if a large proportion of today's biodiversity is to exist in a future of increasing numbers of people and their demands on natural resources. The present initiative is moving in the right direction to counteract the 'isolation' of species and enhance conservation in the long run.

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Biodiversity Status in the Potential Conservation Corridors of the Kangchenjunga Landscape: a Distribution Model of Flagship and Indicator Species

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Conservation of biodiversity is contingent on maintaining the interconnectedness of the various types of ecosystems found in the Kangchenjunga landscape.

Introduction

The Kangchenjunga landscape stretches from Nepal through India, China, and Bhutan and forms a part of a biodiversity hotspot of global importance (Sharma and Chettri 2005). The Kangchenjunga complex is outstanding in terms of both species' richness and the level of endemism. This landscape plays an important role in maintaining altitudinal connectivity between the habitat types that make up the larger Himalayan ecosystem (Wikramanayake et al. 2001). The inhabitant species of birds and mammals exhibit altitudinal seasonal migrations and depend on contiguous habitat for unhindered movement (Chettri et al. 2001). Habitat continuity and intactness are essential in order to maintain the integrity of biodiversity values

and their services to humanity Conservation of biodiversity is contingent on maintaining the interconnectedness of the various types of ecosystems found in the region. Realising this, the World Wildlife Fund (WWF) Nepal Programme and the International Centre for Integrated Mountain Development (ICIMOD) carried out a regional consultation on conservation of the Kangchenjunga landscape in early 1997 in Kathmandu. The consultation arrived at a strong consensus that effective conservation of this important landscape was possible only through regional cooperation (Rastogi et al. 1997). This initiative was supported by various analyses and consultations, and the areas was unanimously identified as one of the most critical biodiversity conservation areas in the eastern Himalayas (WWF and ICIMOD 2001). This was taken further by ICIMOD which advocated for regional cooperation for the entire landscape through participation of stakeholders, and for developing conservation corridors to promote conservation at the landscape level (Sharma and Chettri 2005).

Biodiversity Overview

The Kangchenjunga landscape – a part of the eastern Himalayan ecoregion – is actually a complex of three distinct ecoregions, the eastern Himalayan broad-leaved and coniferous forests, the eastern Himalayan alpine meadows and the Terai-Duar savannas and grasslands (WWF and ICIMOD 2001). The eastern Himalayan broad-leaved and coniferous forests represent a band of temperate broad-leaved forest at 2,000 to 3,000m and are important both for their rich species' diversity and for their species' endemism. Four of the 125 mammalian species known to occur in this ecoregion are endemic (Table 1). Three of these species are also found in the adjacent ecoregions, but the Namdapha flying squirrel (*Biswamoyopterus biswasi*) is strictly endemic to this ecoregion with a range limited to the eastern Himalayan broad-leaved forests. Several threatened mammalian species, including the endangered tiger (*Panthera tigris*), red panda (*Ailurus fulgens*), takin (*Budorcas taxicolor*), and serow (*Capricornis sumatraensis*), and the vulnerable Vespertilionidae bat (*Myotis sicarius*), Assamese macaque (*Macaca assamensis*), stump-tailed macaque (*Macaca arctoides*), wild dog (*Cuon alpinus*), back-striped weasel (*Mustela strigidorsa*), clouded leopard (*Pardofelis nebulosa*), and Irrawaddy squirrel (*Callosciurus pygerythrus*) are found in this region (WWF and ICIMOD 2001). In addition, almost 500 bird species are found across the ecoregions of which eleven species are near-endemic, and one, the rufous-throated wren babbler, is strictly endemic, that is restricted to the eastern Himalayan broad-leaved forests (Table 2).

The bird assemblage also includes several threatened species of pheasants, tragopans, and hornbills that need mature forests and have low tolerance for disturbance. The presence of

Table 1: **Endemic and near-endemic mammalian species**

Common name	Species
Golden langur	*Semnopithecus geei*
Giant Flying Squirrel	*Petaurista magnificus*
Namdapha flying squirrel	*Biswamoyopterus biswasi*[*]
Brahma White-bellied Rat	*Niviventer brahma*

[*] species' range limited to this ecoregion

species like the globally threatened rufous-necked hornbill (*Aceros nipalensis*) and Sclater's monal (*Lophophorus sclateri*), and the threatened white-bellied heron (*Ardea insignis*), Blyth's tragopan (*Tragopan blythii*), and Ward's trogon (*Harpactes wardi*), is an indicator of habitat integrity that deserves conservation (Stattersfield et al. 1998).

Table 2: **Endemic and near-endemic bird species**

Common name	Species
Chestnut-breasted partridge	*Arborophila mandellii*
Hoary-throated barwing	*Actinodura nipalensis*
Ludlow's fulvetta	*Alcippe ludlowi*
Rusty-bellied shortwing	*Brachypteryx hyperythra*
Elliot's laughing thrush	*Garrulax elliotii*
Grey-headed parrotbill	*Paradoxornis gularis*
Immaculate wren-babbler	*Pnoepyga immaculata*
Grey-crowned prinia	*Prinia cinereocapilla*
Mishmi wren-babbler	*Spelaeornis badeigularis*
Rufous-throated wren-babbler	*Spelaeornis caudatus*[*]
Snowy-throated babbler	*Stachyris oglei*
Spiny babbler	*Turdoides nipalensis*

[*] species' range is limited to this ecoregion

Wetlands and Biodiversity

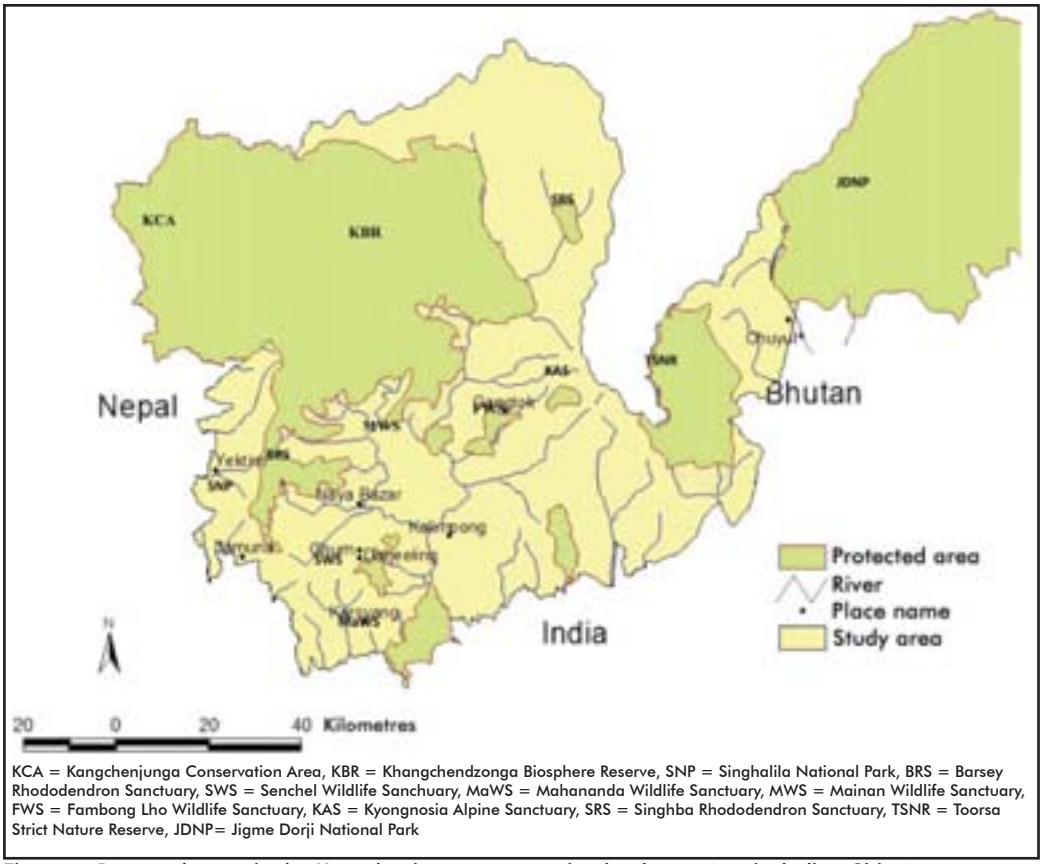
The whole of the Kangchenjunga landscape is rich in wetlands. Most of the wetlands lie at higher altitudes above 3000m and are as yet little explored for their values. The Lohnak Valley in north Sikkim is one of the richest areas in Sikkim as far as Trans-Himalayan biodiversity is concerned (Lachungpa 1998). There is a good breeding population of ruddy shelduck (*Tadornana ferruginea*) and common redshank (*Tringa tetanus*). A small population of less than 10 black-necked cranes regularly visits the valley, although their numbers have dropped in recent years. The wetlands at lower altitudes (below 3000m) are home to the Eurasian otter (*Lutra lutra*), smooth coated otter (*L. perspicillata*), oriental small-clawed otter (*Aonyx cinerea*), and Himalayan salamander (*Tylototriton verrucosus*). The entire wetlands of this landscape are rich storehouses of wild genetic materials as well as an important flyway for migratory wild fowl.

Protected Areas and Potential Conservation Corridors

The Kangchenjunga landscape is comprised of 14 protected areas of which six (Kangchenjunga Conservation Area (KCA), Khangchendzonga Biosphere Reserve (KBR), Singhalila National Park (SNP), Barsey Rhododendron Sanctuary (BRS), Pangolakha Wildlife Sanctuary (PWS), and Toorsa Strict Nature Reserve (TSNR)) have transboundary linkages cutting across parts of India, Nepal, and Bhutan. A portion of the complex lies within China but, for the purposes of this study, the area was excluded from the analysis. The protected areas included in the study are shown in Figure 1.

Selection and Delineation of Potential Conservation Corridors

Fourteen species (Table 3) of mammals and eight species of *Rhododendron* (Table 4) were used as indicator species based on the criteria of rarity and value in order to identify potential corridors and assess their feasibility. Potential areas for connectivity were identified based on the habitat requirements of the selected mammalian and rhododendron species. The distribution



KCA = Kangchenjunga Conservation Area, KBR = Khangchendzonga Biosphere Reserve, SNP = Singhalila National Park, BRS = Barsey Rhododendron Sanctuary, SWS = Senchel Wildlife Sanchuary, MaWS = Mahananda Wildlife Sanctuary, MWS = Mainan Wildlife Sanctuary, FWS = Fambong Lho Wildlife Sanctuary, KAS = Kyongnosia Alpine Sanctuary, SRS = Singhba Rhododendron Sanctuary, TSNR = Toorsa Strict Nature Reserve, JDNP= Jigme Dorji National Park

Figure 1: Protected areas in the Kangchenjunga conservation landscape (not including China)

Table 3: **Mammalian species used to identify potential corridors**

Common name	Species
Red panda	*Ailurus fulgens*
Wolf	*Canis lupus*
Takin	*Budorcas taxicolor taxicolor*
Serow	*Capricornis sumatraensis*
Blue sheep or Bharal	*Pseudois nayaur*
Snow leopard	*Uncia uncia*
Golden cat	*Felis temmincki temmincki*
Marbled cat	*Felis marmorata*
Leopard cat	*Felis bengalensis horsfieldi*
Brown bear	*Ursus arctos isabellina*
Himalayan black bear	*Ursus thibetanus*
Dhole	*Cuon alpinus primavus*
Musk deer	*Moshos charysogaster*
Clouded leopard	*Neofelis nebulosa*

Table 4: **Rare and endangered rhododendron species in the Sikkim Himalayas and their altitudinal distribution**

Species	Distribution range	Status[a]
R. fulgens	3,500-5,500	R
R. leptocarpum	2,500-4,000	E
R. maddenii	2,000-4,500	R
R. niveum	3,000-4,500	E
R. pendulum	3,000-4,500	R
R. pumilum	3,000-5,000	R
R. sikkimense	3,500-4,000	E
R. wightii	3,000-5,000	R

[a] *R = Rare, E = Endangered*

of the species was derived from previous reports and data of organisations such as the International Union for Conservation of Nature (IUCN), World Wild Fund for Nature (WWF), and World Conservation and Monitoring Centre (WCMC) of the United Nations Environment Programme (UNEP). The potential presence of each species was given a weighting of 1. Distribution maps were prepared for each of the fourteen mammalian species and then overlaid and the areas given a cumulative weighting for the species that could potentially be present in the area. A map showing the altitudinal species density of rhododendrons was prepared in a similar way. A final map was developed showing the potential conservation corridors for the Kangchenjunga landscape area with reference to the fourteen selected mammalian species and the altitudinal distribution of the eight rare and endangered species of Rhododendron (Figure 2).

Species' Distribution Model

A species' distribution account was prepared for the selected mammalian species based on conservation status, habitats used, home range, and habitat availability in the Kangchenjunga landscape. Of the 14 species, six were vulnerable, three endangered, one near threatened, and four insufficiently known (IUCN 2004). Temperate montane and rugged alpine forests were the major habitats for many of these species.

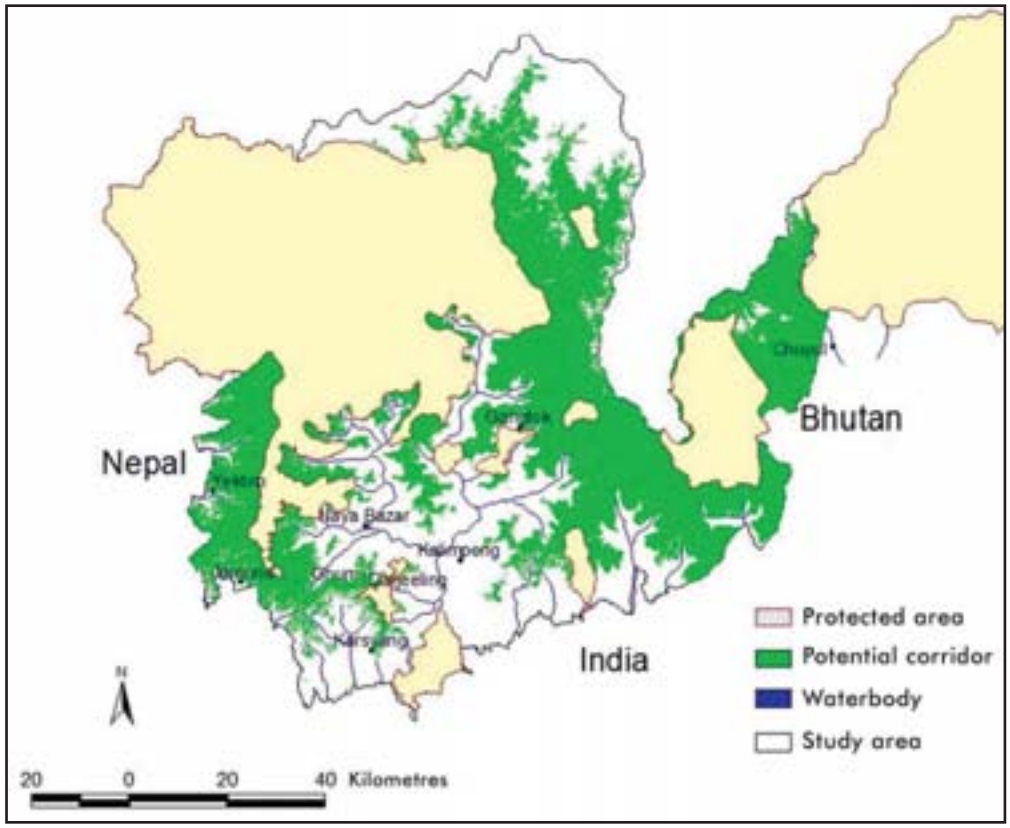


Figure 2: Potential corridor areas in the Kangchenjunga landscape based on the distribution pattern of indicator species

Land-cover analysis showed the potential habitat for the Asiatic black bear, clouded leopard, and dhole to be the region connecting the south of the Kangchenjunga Conservation Area (KCA) in Nepal along the Singhalila National Park and Senchel Wildlife Sanctuary to the Mahananda Wildlife Sancutaury. The map shows, however, that these potential habitats have now mostly been converted into agricultural or cultivated lands.

The areas connecting the Singba Rhododendron Sanctuary to the Kyongnosla Alpine Sanctuary in the south and further towards the Toorsa Strict Nature Reserve appear to form a potential habitat for species such as the red panda, Tibetan wolf, takin, and blue sheep. The habitat range for the blue sheep, however, is mostly restricted to the alpine meadows in these potential corridors. Beside this, red panda, takin, brown bear, snow leopard, Tibetan wolf, and blue sheep seem to extend as far up as the Jigme Dorji National Park and cover adjoining areas extending to many protected areas such as Khangchendzonga Biosphere Reserve, Singba Rhododendron Sanctuary, Kyongnosla Alpine Sanctuary, and Toorsa Strict Nature Reserve. The potential habitat connectivity for serow and clouded leopard, marbled cat, leopard cat, golden cat, and dhole also lies along the surrounding areas of Singhalila National Park, Barsey Rhododendron Sanctuary, Senchel Wildlife Sanctuary, Mahananda Wildlife Sanctuary, and Fambong Lho Wildlife Sanctuary.

Conservation Options

The landscape is under immense pressure from human activities. There are options for addressing such prevailing issues through alternative and sustainable means of livelihoods for the local communities living in the Kangchenjunga landscape area. Tourism based on wildlife could be one means whereby revenue from wildlife tourism can be used for wildlife conservation: similarly, sustainable use of wildlife, including trout, pheasant, deer, and butterfly farming, looks promising. The introduction of trout farms in the region will allow an increase in economic activities and will ensure maintenance of the quality of water within small rivers. There is a tremendous potential for harvesting non-timber forest products (NTFP); e.g., beekeeping and cultivation of associated bee flora, extraction of plant oils, cultivation of herbs and medicinal plants, and cultivation and sale of ornamental plants, orchids, rhododendron species, and bamboo. For all of these options, new cooperatives need to be developed in the local communities so that provision is made for collection, marketing, and sale.

Conclusion

The Kangchenjunga landscape, being located at the convergence of the Palaeartcic and Oriental zoogeographical realms, is well known for its biodiversity, especially the presence of many critical wildlife species. The distribution patterns of some of the flagship mammalion species indicate that maintaining or establishing connectivity between isolated protected areas is the primary step towards long-term protection of such species. Among the potential corridors identified in the studies, the adjoining area along the Barsey Rhododendron Sanctuary (104 sq.km) in Sikkim and Singhalila National Park (76.8 sq.km) in Darjeeling, continuing up to the Mahananda Wildlife Sanctuary through to the Senchel Wildlife Sanctuary area, is the most viable corridor area for the 14 mammals considered in this study. Moreover, Khangchendzonga

Biosphere Reserve, Singba Rhododendron Sanctuary, Kyongnosla Alpine Sanctuary, Toorsa Strict Nature Reserve, and Jigme Dorji National Park and their adjoining areas show great potential for developing conservation corridors. Biodiversity conservation at the landscape level, with definition and delineation of conservation corridors connecting the protected areas in the three countries, should be a priority for the conservation of biodiversity in this globally significant landscape.

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Biodiversity of Toorsa Strict Nature Reserve - Jigme Dorji National Park Proposed Conservation Corridor, Western Bhutan

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The corridor is an important watershed besides being the habitat of many endangered flora and fauna.

Introduction

Bhutan clings to the southern slopes of the Himalayas, a mountain range best known for containing the world's highest and youngest mountain peaks, including the highest on earth, Mount Everest. Bhutan, having abrupt altitudinal variation, has diverse ecosystems with rich biodiversity (Sherpa et al. 2004). Because of this rich biodiversity, Bhutan is included in several global priorities for biodiversity conservation. It is within a Global 200 ecoregion complex (Olson and Dinerstein 1998) and also part of the Himalayan hotspot (Mittermeier et al. 2005). With the recent paradigm shift in conservation approaches, Bhutan has conceptualised a new approach to conservation by developing the Bhutan Biological Conservation Complex (B2C2) with 26% of its land under a protected area network connected by an additional nine per cent

of land in corridors (Sherpa et al. 2004). The Toorsa Strict Nature Reserve (TSNR) to Jigme Dorji National Park (JDNP) corridor is an important connecting link to the proposed Kangchenjunga landscape. It is one of the six corridors identified by ICIMOD for re-establishing natural connectivity among the protected areas in the Kangchenjunga landscape (Sharma and Chettri 2005). A stakeholders' consultation on 'Planning and Improvement of Corridors between Protected Areas within the Kangchenjunga Landscape', held from 12th to 13th March, 2004 in Thimphu, recommended an immediate survey of biodiversity in the proposed corridor area. This report combines the findings of three individual rapid biodiversity surveys carried out for mammals, birds, and vegetation within the Toorsa Strict Nature Reserve-Jigme Dorji National Park conservation corridor.

Vegetation Analysis

Located between Haa and Paro districts, the corridor covers an area of 149 sq.km and encompasses 10 of the 14 ecosystem types classified (Sherub 2004). It has a continuous north-south mountain range and a topographic variation from 2,500 to 4,500m. The minimum and maximum temperature ranges from -3°C to 25°C in both the Paro and Haa valleys of the corridor. The Paro Valley has an average annual precipitation of 132 mm while the Haa has about 80 mm.

A total of 85 random points, falling within the spatial extent of the corridor, were stratified on the basis of ecosystem coverage and uploaded to a GPS unit and a topographical sheet. During the survey, the general forest type, ground and canopy level vegetation, altitude, topography, soil types, ecosystem, and tree details were recorded.

Ecosystem types and floral diversity

Ten of the 14 ecosystem zones classified for Bhutan are found in the corridor area (Figure 1). The results of the analysis indicated that 38% of the corridor area is covered by a temperate moist coniferous ecosystem, followed by 15% of temperate scrub forest and 12% of subalpine temperate coniferous ecosystem. A total of 208 plant species from 62 families were recorded including 39 tree species, 43 shrubs, and 113 herbs (Annex 1).

1. The cool broad-leaved forest ecosystem (CBFE) represents the transition between temperate conifers at higher elevations (3800m) and broad-leaved forests at lower elevations (2400m). *Quercus semecarpifolia* with *Picea spinulosa* and *Pinus wallichiana* form the dominant tree canopy. Other deciduous communities include *Quercus griffithii*, *Betula utilis, Acer campbellii, Gamblea ciliata, Sorbus cuspidata, Enkianthus deflexus*, and evergreen species such as *Pieris formosa, Ilex dipyrena*, and a few species of *Rhododendron*. The bamboo habitat of *Borinda grossa* and *Yushania* species is a potential habitat for wild ungulates and domestic cattle and yaks. The endangered red panda (*Ailurus fulgens*) is also associated with this ecosystem.
2. The temperate dry coniferous ecosystem (TDCE) is dominated by *Pinus wallichiana, Picea spinulosa*, and *Larix griffithiana*. Species such as *Acer cappadocicum, Rhododendron arboreum, Lyonia ovalifolia*, and *Populus rotundifolia* form the understory. Ground orchids

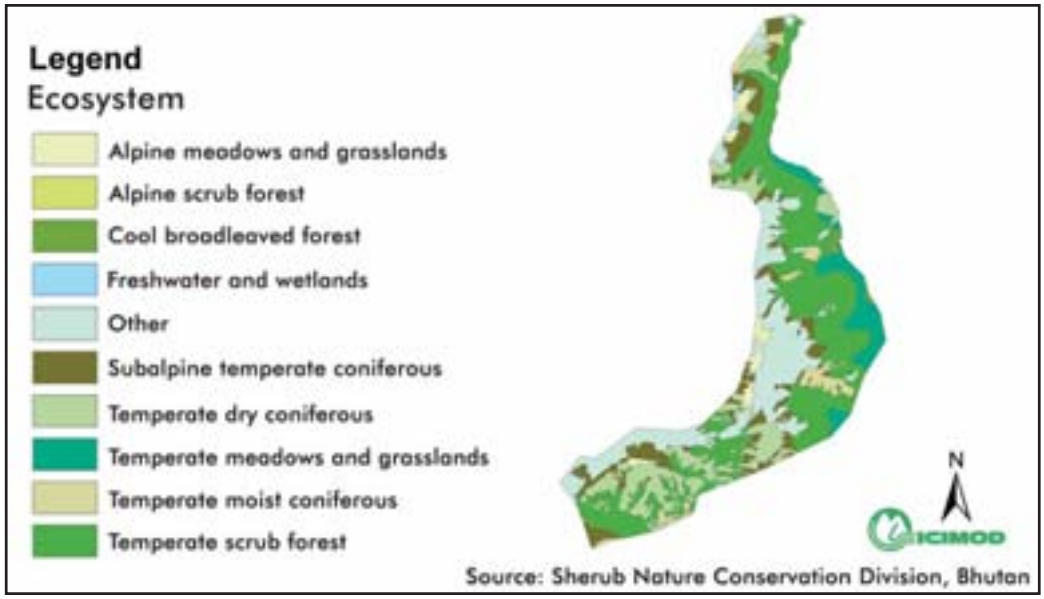

Figure 1: The 10 ecosystem types in the Toorsa Strict Nature Reserve-Jigme Dorji National Park corridor, Bhutan

along with abundant grass species comprise the bulk of ground vegetation where grazing is common. The ecosystem is prone to forest fires as the forest floor is covered with thick layer of pine needles and the soil has a very low moisture level.

3. The temperate moist coniferous ecosystem (TMCE) is comprised of comparatively wet habitats. *Abies densa* and *Tsuga dumosa* form the dominant tree canopy. *Larix* and *Picea spinulosa* occur in patches. The greatest number of ornamental Rhododendron species grows here. High humidity and unpolluted air support carpets of spongy *Sphagnum* and other mosses. The endangered musk deer (*Moschus chrysogaster*) uses this mossy habitat during winter.
4. The temperate scrub forest ecosystem is composed of dry short-stature shrubs and a variety of grass species. Plant species characteristic of the vegetation communities are *Desmodium elegans, Elaeagnus parviflora, Cotoneaster griffithii*, and *Quercus semecarpifolia*. The prevalent species include *Rosa sericea, Berberis cooperi, Rhododendron arboreum,* and *Artemesia* spp.
5. The temperate meadows and grasslands ecosystem is comprised of large patches of herbaceous glades and open grasslands with broad-leaved and temperate coniferous forests. Representative species include *Berberis cooperi, Agrostis micrantha, Arundinella hookeri, Brachypodium sylvaticum, Primula capitata, Gentiana polyanthes, Senecio diversifolia,* and *Aster* sp, all valued for their medicinal properties.
6. The subalpine temperate coniferous ecosystem occurs from 3,800 to 4,200m. Plant communities are comprised of *Rhododendron* sp, *Juniperus recurva, Juniperus pseudosabina, Morina nepalensis,* and *Pedicularis megalantha*.
7. The alpine scrub forest ecosystem is characterised by dwarf rhododendron, dwarf juniper, berberis, and willow shrubs. Snow forms a significant part of this ecosystem. Many

medicinally important herbs such as *Pedicularis* sp, *Neopicrorhiza scrophulariiflora,* and *Meconopsis paniculata* are present.

8. The alpine meadows and grassland ecosystem is characterised by species of grasses such as *Festuca, Agrostis, Poa,* and *Stipa* that provide palatable food resources for yak.
9. The freshwater and wetland ecosystem (FWWE) is comprised of marshes, alpine lakes, and swamps. Freshwater aquatic plants in the open lakes and rivers include *Ranunculus trichophyllus, Hydrilla verticillate,* and *Potamogeton crispus*. Open marshlands are characterised by *Acorus calalmus, Shenoplectus juncoides, Equisetum, Carex, Juncus,* and others.
10. The category 'other' includes exposed surfaces of bedrock and permanently snow-covered mountains and glaciers. Rocky cliffs, deep gorges, and a conglomerate of boulder rocks support species like *Frittilaria delavaye, Rheum australe, Corydallis species,* and *Saussurea gossipiphora* and many Bryophytes *and* Crustose lichens.

Bird Diversity

The survey of bird species' diversity was carried out using 85 pregenerated, stratified random points entered on GARMIN GPS etrex VISTA, and (mainly) the species-richness frequency method (MacKinnon and Philips 1993) corroborated by Inskipp et al. (1996). Species' identification was based on Inskipp et al. (1999). The survey data was used to determine species richness and species' habitat affinity. The survey was carried out in October/November 2004.

Species' richness

The survey recorded 108 species of birds representing five major ecoregions of the corridors; the annotated list raised the number to 143 (Annex 2). The temperate dry coniferous ecosystem had the most species, 89, followed by the cool broad-leaved forest ecosystem with 55. The freshwater and wetland ecosystem had the least diversity with 10 species (Table 1). Two totally protected bird species under the Bhutan Schedule I of the Forest and Nature Conservation Act 1995 were also found in the corridor, viz., the Himalayan monal (*Lophophorus impejanus*) and Tibetan snowcock (*Tetraogallus tibetanus*). Of the 15 globally-threatened species recorded in Bhutan, two species were found in the corridor, viz., the satyr tragopan (*Tragopan satyra*) and wood snipe (*Gallinago nemoricola*) and out of 11 birds from the restricted world-breeding range species recorded in Bhutan, one, viz., the hoary-throated barwing (*Actinodura nipalensis*), was found in the corridor. At least two of the bird species recorded were confirmed to breed in the survey corridor where juveniles of lammergeier (*Gypaetus barbatus*) and blue-fronted redstart (*Phoenicurus frontalis*) were observed. The survey also added to the district record.

Species' habitat affinity

The analysis of habitat affinity enabled us to understand which species used specific ecosystems during a particular time of the year. During autumn, the CBFE harbours species such as the black-faced laughing thrush (*Garrulax affinis*), long-tailed minivet (*Pericrocotus ethologus*), rufous-fronted tit (*Aegithalos iouschistos*), and many species of Garrulax. The TDCE is the richest habitat in terms of bird diversity with species such as rufus sibia (*Heterophasia capistrata*),

Table 1: **Bird species' richness in different ecosystems of the Toorsa Strict Nature Reserve-Jigme Dorji National Park corridor, west Bhutan**

Ecosystems	Total Count	Species Richness	Elevation Range
Cool broad-leaved forest (CBFE)	805	55	2,450-3,800
Freshwater and wetlands (FWWE)	92	10	2,700-3,600
Temperate dry coniferous (TDCE)	2394	89	2,550-3,600
Temperate moist coniferous (TMCE)	1046	49	2,900-3,650
Scrub and meadows[a]	406	29	3,050-4,300

[a] includes RTSFE, TMGE, ASFE, AMGE

red-billed chough (*Pyrrhocora pyrrhocorax*), white-collared blackbird (*Turdus albocinctus*), green-backed tit (*Parus monticolus*), and russet sparrow (*Passer rutilans*) being found. The TMCE supported spotted laughing thrush (*Garrulax ocellatus*), grey-crested tit (*Parus dichrous*), white-winged gross beak (*Mycerobas carnipes*), black-faced laughing thrush (*Garrulax affinis*), and rufous-fronted tit (*Aegithalos iouschistos*). The temperate and alpine scrub, alpine meadows, and grasslands are inhabited by blue-fronted redstart (*Pyrrhocorax pyrrhocorax*), plain mountain finch (*Leucosticte nemoricola*), common kestrel (*Falco tinnunculus*), and Himalayan griffon (*Gyps himalayensis*). The FWWE has species such as the plumbeous water redstart (*Rhyacornis fuliginosus*), blue-whistling thrush (*Myophonus caeruleus*), white-capped water redstart (*Chaimarrornis leucocephalus*), and brown dipper (*Cinclus pallasii*). The juniper and scrub forests of Sagala are an important habitat for blood pheasant (*Ithaginis cruentus*) and white-winged gross beak (*Mycerobas carnipes*). High rocky cliffs and gorges form the nesting sites for the lammergeier (*Gypaetus barbatus*) and Himalayan griffon (*Gyps himalayensis*).

Mammal Diversity

The survey on mammal diversity was carried out for 40 days covering about 30% of 85 randomised plots. Evidence (scats, kills, digging, wallowing, dung, feeding sites, nest sites, mud or tree markings, and remains) and sightings of free-ranging mammals were recorded along with the associated habitat type. Local people and herders were also approached for additional information.

List of mammals

A total of 18 mammalian species was recorded of which nine were globally threatened according to the IUCN categories (Table 2). The occurrence of sambar (*Cervus unicolor*) was the highest followed by wild pig (*Sus scrofa*), Himalayan serow (*Capricornis sumatraensis*), common leopard (*Panthera pardus*), blue sheep (*Pseudois nayaur*), and grey langur (*Presbytis entellus*). The other mammals include striped squirrel (*Funambulus species*), goral (*Nemorhaedus goral*), Himalayan black bear (*Selenarctos thibetanus*), musk deer (*Moschus chrysogaster*), tiger (*Panthera tigris*), wild dog (*Cuon alpinus*), and yellow-throated marten (*Martes flavigula*). Evidence of tiger was found at the remarkably high elevation of 3,371m. All 18 mammals were confined to an altitudinal range of 2,266m to 4,130m. The highest frequency of mammals was

Table 2: **Mammalian species recorded in the Toorsa Strict Nature Reserve-Jigme Dorji National Park corridor, west Bhutan**

Name	Scientific Name	Status		
		FNCA[a]	IUCN[b]	CITES[c]
Tiger	*Panthera tigris*	Totally protected	EN	App-I
Snow leopard	*Uncia uncia*	Totally protected	-	App-I
Clouded leopard	*Neofelis nebulosa*	Totally protected	VU	App-I
Common leopard	*Panthera pardus*	Totally protected		App-I
Himalayan black bear	*Selenarctos thibetanus*	Totally protected	VU	App-I
Musk deer	*Moschus chrysogaster*	Totally protected	NT	App-I/II
Blue sheep	*Pseudois nayaur*	-	-	-
Barking deer	*Muntiacus muntjac*	-	-	-
Goral	*Nemorhaedus goral*	-	NT	App-I
Grey langur	*Presbytis entellus*	-	NT	App-I
Three-striped squirrel	*Funambulus species*	-	-	-
Sambar	*Cervus unicolor*	-	-	-
Himalayan serow	*Capricornis sumatraensis*	Totally protected	VU	App-I
Pika	*Ochotona species*	-	NT	-
Wild dog	*Cuon alpinus*	-	VU	App-I
Wild pig	*Sus scrofa*	-		-
Yellow throated marten	*Martes flavigula*	-	-	App-III

[a] CITES = Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES undated); FNCA = Forest and Nature Conservation Act of Bhutan (FNCA 1995); IUCN = International Union for Conservation of Nature (IUCN 2004)

recorded between elevations of 2,600m to 3,600m. Interestingly, most of the species were found in the juniper-rhododendron forest, where pika (*Ochotona* sp) and sambar (*Cervus unicolor*) were the dominant species. Twelve mammalian species, including the tiger and Himalayan black bear, were recorded in the blue pine habitat.

Importance of the Corridor

Two hundred and eight plant species belonging to 62 families were identified within the corridor area, among which *Taxus baccata, Panax pseudoginseng,* and *Gentiana crassoloides* are protected as Schedule I plants under Bhutan's Forest and Nature Conservation Act 1995. The presence of globally-protected species such as *Rheum nobile* and *Podophyllum hexandrum* make the area desirable for conservation. In addition, the corridor also has high-value timber species such as *Pinus wallichiana, Picea spinulosa,* and *Tsuga dumosa* and many other medicinal herbs that are constantly in demand and overexploited. The corridor also hosts at least 108 bird species (identified in the rapid survey), and probably more than 143 species (according to the annotated list), including two of the 15 globally threatened bird species found in Bhutan, and two totally protected species. The bird diversity will be higher in summer when transborder migratory species and high-altitude migrants are present. The corridor is home to many

important mammals including some on the IUCN endangered species' list. Besides being the habitat of many endangered species of flora and fauna, the corridor serves as an important watershed. The two major tributaries of the Wangchu River system have their catchments here.

Conservation and Development Issues

Yaks form an integral part of the pastoral system and domestic biodiversity in Bhutan. The pastoral groups in Nubri village near Paro and communities of Bji geog in Haa keep yaks for meat and dairy products. Yak husbandry is, therefore, a major part of their livelihoods and economy. The corridor is under severe grazing pressure during the warm summer months when the herds return from the low pastures to the highlands. Degradation happens at times when plants are struggling to grow after the severe winter. The requirement here is for mitigation measures that integrate communal grazing rights with conservation issues.

Pastoralists, especially those living in the southwest, also pose a threat to the birds and other mammals, as evident from the piles of bird feathers dumped close to yak ranches, and the traps and snares encountered during the survey. The age-old 'tsamdro' (grazing right ownership) also seems to influence practices such as girdling of old trees. In the high-altitude area of dry alpine scrub, the population of blue sheep seems to compete with yaks. Snow leopards in these areas seem to exist in balance with the number of blue sheep and any reduction in the population of blue sheep poses a threat to the population of snow leopards.

Recommendation for Priority Action

A strong conservation measure needs to be adopted within the corridor to mitigate the degradation of biodiversity caused by grazing. Research on issues related to grazing should be a top priority for management. Within the corridor area, Shingkharap top, and Tatsilakham areas of Sagala, Takha, Damthang, Haala, and Lajab have good canopy cover, and can therefore be potential habitats for wildlife and their movement. Northeast of Tshomibjilam and north of Damthang, however, the connectivity of the corridor seems to be broken.

Regarding bird diversity, a second survey is highly recommended to cover those migratory species of birds which had already crossed the corridor area before the first survey. Opening of the primary hemlock, fir, and juniper forest for pasture expansion must be regulated and practices such as fire letting and slash and girdling should be restricted. Law enforcement is required to stop poaching of wild bird fauna.

The mammal distribution map showed that observations were mostly made on the eastern slope and at the upper and lower part of the corridor; another survey is required for a more detailed list of mammals. As some of the mammals were also recorded from the area adjoining the corridor, the boundary of the corridor might have to be revised or broadened. It is very important to save indicator species, such as wild pigs and sambar, because their predators, such as wild dogs and common leopards, would then not be interested in the human communities and their possessions around the corridor. In cases of conflict, however, compensation schemes

should be made clear to communities at the grass roots' level. Regular patrolling will be necessary to stop poaching of the endangered musk deer.

Conclusion

Improvement in the living standards of the local people would reduce pressure on the local natural resources, including wildlife. Therefore, alternative income-generating activities for the local communities are recommended, especially for communities dependent on rearing yaks and other cattle. A supply of improved breeds of cattle, and training in improved animal husbandry, would benefit local people. Ecotourism, controlled trekking, bird watching and so on can be planned through local initiatives so that the conservation issues are understood and acted upon at grass roots' level.

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Annex 1: Checklist of Plant Species

Plant species recorded from the corridor connecting Toorsa Strict Nature Reserve and Jigme Dorji National Park, Bhutan		
Latin name	**Life form**	**Family**
Abies densa	Tree	Pinaceae
Acanthus sp	Herb	Acanthaceae
Acer campbellii	Tree	Aceraceae
Acer cappadocicum	Tree	Aceraceae
Acer pectinatum	Tree	Aceraceae
Acer sikkimensis	Tree	Aceraceae
Acer sterculiaceum	Tree	Aceraceae
Aconitum sp	Herb	Ranunculaceae
Adonis sp	Herb	Ranunculaceae
Agrostis micrantha	Herb	Graminae
Allium hookeri	Herb	Liliaceae
Allium sp	Herb	Liliaceae
Amaranthus sp	Herb	Amaranthaceae
Anaphalis sp	Herb	Compositae
Ancanthus sp	Herb	Labiatae
Anemone vitifolia	Herb	Ranunculaceae
Ainsliaea aptera	Herb	Compositae
Argimonia pilosa	Herb	Rosaceae
Aristolochia sp	Shrub	Aristolochiaceae
Artemisia sp	Herb	Compositae
Aster neoelegans	Herb	Compositae
Aster sp	Herb	Compositae
Astilbe rivularis	Herb	Saxifragaceae
Berberis aristata	Shrub	Berberidaceae
Berberis cooperi	Shrub	Berberidaceae
Berberis griffithiana	Shrub	Berberidaceae
Berberis hookeri	Shrub	Berberidaceae
Berberis sp	Shrub	Berberidaceae
Betula utilis	Tree	Betulaceae
Bistortia sp	Herb	Polygonaceae
Borinda grossa	Shrub	Graminae
Brachypodium sylvaticum	Herb	Graminae
Brassiopsis sp	Tree	Araleaceae
Bromus himalaicus	Herb	Graminae
Calamagrostis sp	Herb	Graminae
Carex sp	Herb	Graminae
Cassiope flexusa	Herb	Ericaceae
Schisandra grandiflora	Herb	Chisendraceae
Circium sp	Herb	Compositae
Clematis montana	Herb	Ranunculaceae

Latin name	Life form	Family
Cobrasia sp	Herb	Graminae
Coriaria nepalensis	Shrub	Coriariaceae
Corylus ferox	Tree	Betulaceae
Cotonaster griffithii	Shrub	Rosaceae
Cremanthodium sp	Herb	Rosaceae
Cyananthus sp	Herb	Companulaceae
Dandelion sp	Herb	Compositae
Danthonia cumminsii	Herb	Graminae
Daphne bholua	Shrub	Thymeliaceae
Daphne sp	Shrub	Thymeliaceae
Desmodium elegans	Shrub	Leguminosae
Dryopteris sp	Herb	Ferns
Rubus sp	Herb	Rosaceae
Elaeagnus parvifolia	Shrub	Elaegnaceae
Elatostema sp	Herb	Urticaceae
Elsholtzia fructicosa	Shrub	Labiatae
Elymus nutans	Herb	Graminae
Enkianthus deflexus	Tree	Ericaceae
Epilobium sp	Herb	Onagraceae
Eragrostis sp	Herb	Graminae
Euonymous sp	Tree	Celastraceae
Euphorbia griffithiana	Shrub	Euphorbiaceae
Euphorbia ignipectus	Shrub	Euphorbiaceae
Euphorbia sp	Shrub	Euphorbiaceae
Eurya sp	Tree	Theaceae
Festuca sp	Herb	Graminae
Fragaria sp	Herb	Rosaceae
Fraxinus florubunda	Tree	Oleaceae
Gamblea ciliate	Tree	Araliaceae
Gaultheria fragrantissima	Shrub	Ericaceae
Gentiana capitata	Herb	Gentianaceae
Gentiana crassuloides	Herb	Gentianaceae
Gentiana urnula	Herb	Gentianaceae
Geranium polyanthes	Herb	Gereniaceae
Gnaphalium sp	Herb	Compositae
Hedera nepalensis	Shrub	Araliaceae
Halenia elliptica	Herb	Gentianaceae
Hemifragma heterophylla	Herb	Scrophulariaceae
Heracleum sp	Herb	Umbelliferae
Ilex dipyrena	Tree	Aquifoliaceae
Impatiens sp	Herb	Balsaminaceae
Inula sp	Herb	Compositae
Ipomoea sp	Herb	Convolvulaceae
Iris sp	Herb	Iridaceae

Latin name	Life form	Family
Jasminum sp	Herb	Oleaceae
Juncus sp	Herb	Juncaceae
Juniperus pseudosabina	Shrub	Cuppressaceae
Juniperus recurva	Tree	Cuppressaceae
Juniperus squamata	Tree	Cuppressaceae
Larix griffithiana	Tree	Pinaceae
Lepidiopodium sp	Herb	Graminae
Lilium sp	Herb	Liliaceae
Lindera sp	Tree	Lauraceae
Listera pinetorum	Herb	Orchidaceae
Lonicera sp	Herb	Caprifoliaceae
Lyonia ovalifolia	Shrub	Ericaceae
Meconopsis paniculata	Herb	Papavaraceae
Meconopsis superba	Herb	Papavaraceae
Microcloa sp	Herb	Graminae
Morina longifolia	Herb	Dipsacaceae
Onosma hookeri	Herb	Boraginaceae
Panax pseudoginseng	Herb	Araliaceae
Pedicularis megalantha	Herb	Scrophulariaceae
Fagopyrum sp	Herb	Polygonaceae
Phlomis tibetica	Herb	Labaitae
Phyllodendron tomentosa	Shrub	Hydringiaceae
Phytollacca sp	Herb	Phytollacaceae
Picea spinulosa	Tree	Pinaceae
Picrorhiza kurroa	Herb	Scrophulariaceae
Pieris formosa	Herb	Ericaceae
Pilea sp	Herb	Urticaceae
Pinus wallichiana	Tree	Pinaceae
Piptanthus nepalensis	Shrub	Leguminosae
Poa sp	Herb	Graminae
Podophyllum emodi	Herb	Polygonaceae
Podophyllum hexandrum	Herb	Rubiaceae
Polygonatum hookerii	Herb	Liliaceae
Populus rotundifolia	Tree	Salicaceae
Populus sp	Tree	Salicaceae
Potentilla sp	Herb	Rosaceae
Potentilla heterophylla	Herb	Rosaceae
Potentilla microphylla	Herb	Rosaceae
Primula capitata	Herb	Primulaceae
Primula denticulate	Herb	Primulaceae
Primula sikkimensis	Herb	Primulaceae
Prunus serrata	Tree	Rosaceae
Prunus sp	Tree	Rosaceae
Pueraria sp	Herb	Leguminosae

Latin name	Life form	Family
Pyrola sp	Herb	Pyrolaceae
Pyrolia sikkimensis	Herb	Pyrolaceae
Quercus griffithii	Tree	Fagaceae
Quercus semecarpifolia	Tree	Fagaceae
Rheum australe	Herb	Polygonaceae
Rheum nobile	Herb	Polygonaceae
Rhododendron arboreum	Tree	Ericaceae
Rhododendron ciliata	Shrub	Ericaceae
Rhododendron cinnabarinum	Shrub	Ericaceae
Rhododendron campanulatum	Shrub	Ericaceae
Rhododendron hodgsonii	Tree	Ericaceae
Rhododendron keysii	Shrub	Ericaceae
Rhododendron lanatum	Tree	Ericaceae
Rhododendron lepidotum	Shrub	Ericaceae
Rhododendron nivale	Shrub	Ericaceae
Rhododendron setosum	Shrub	Ericaceae
Rhododendron sp	Shrub	Ericaceae
Rhus sp	Tree	Anacardiaceae
Ribes sp	Shrub	Grossulariaceae
Rosa brunonii	Shrub	Rosaceae
Rosa macrophylla	Shrub	Rosaceae
Rosa sericea	Shrub	Rosaceae
Rosa sp	Shrub	Rosaceae
Rubia cordifolia	Herb	Rubiaceae
Rubia heterophylla	Herb	Rubiaceae
Rubus hypoleuca	Herb	Rosaceae
Rubus sp	Shrub	Rosaceae
Rumex nepalensis	Herb	Polygonaceae
Salix sp	Tree	Salicaceae
Saussurea gossypiphora	Herb	Compositae
Selinum sp	Herb	Umbelliferae
Senecio diversifolia	Herb	Compositae
Senecio sp	Herb	Compositae
Smilacina oleracea	Herb	Liliaceae
Smilax sp	Herb	Liliaceae
Sorbus cuspidata	Tree	Rosaceae
Sorbus microphylla	Tree	Rosaceae
Sphagnum sp	Herb	Bryophyte
Stipa sp	Herb	Graminae
Stycharis sp	Herb	Orchidaceae
Swertia sp	Herb	Gentianaceae
Taxus baccata	Tree	Taxaceae
Thalictrum sp	Herb	Ranunculaceae
Thamnolia vermicularis	Herb	Fungi

Latin name	Life form	Family
Tsuga dumosa	Tree	Pinaceae
Usnea sp	Herb	Lichen
Vaccinium nummularia	Shrub	Ericaceae
Vaccinium sp	Herb	Ericaceae
Veleriana sp	Herb	Velerianaceae
Verbascum thapsus	Herb	Scrophulariaceae
Vitis semicordata	Herb	Vitaceae
Viburnum nervosum	Tree	Sambucaceae
Viola sp	Herb	Violaceae
Yushiana sp	Shrub	Graminae
Zanthoxylum sp	Shrub	Rutaceae

Annex 2: Checklist of Bird Species

Bird species recorded from the corridor connecting Toorsa Strict Nature Reserve and Jigme Dorji National Park, Bhutan			
Species	**Common Name**	**Ecosystem[a]**	**Altitude range(m)**
GALLIFORMES			
Phasianidae			
Lerwa lerwa	Snow partridge	SM	4,200
Arborophila torqueola	Common hill partridge	TDCE	2,800-3,600
Ithaginis cruentus	Blood pheasant	CBFE,TDCE,TMCE	3,050-3,650
Tragopan satyra	Satyr tragopan	CBFE	3,600
Lophophorus impejanus	Himalayan monal	TMCE,SM	3,340-4,200
Lophura leucomelanos melanota	Kalij pheasant	TDCE	2,700
PICIFORMES			
Picidae			
Dendrocopos hyperythrus	Rufous-bellied woodpecker	TDCE,TMCE	2,700-3,600
Dendrocopos darleyensis	Darjeeling woodpecker	TDCE,TMCE	2,800
UPUPIFORMES			
Upupidae			
Upupa epops	Common hoopoe	TDCE	2,800-3,000
CORACIIFORMES			
Coraciidae			
Coracias benghalensis	Indian roller	TDCE	2,600
Cerylidae			
Megaceryle lugubris	Crested kingfisher	FWWE	2,700
COLUMBIFORMES			
Columbidae			
Columba leuconata	Snow pigeon	TMCE,SM	3,000-4,200
Columba hodgsonii	Speckled wood pigeon	CBFE	2,800-3,600
Streptopelia orientalis	Oriental turtle dove	CBFE,TDCE	2,600-3,000
CINCONIFORMES			
Charadriidae			
Recurvirostrinae			
Recurvirostrini			
Ibidorhyncha struthersii	Ibis bill	FWWE	2,800
Accipitridae			
Accipitrinae			
Gypaetus barbatus	Lammergeier	TDCE	2,800
Gyps himalayensis	Himalayan griffon	SM	3,300-4,300
Accipiter nisus	Eurasian sparrowhawk	CBFE,TDCE,TMCE	2,800-3,800
Buteo buteo	Common buzzard	TDCE	2,700-4,200
Ictinaetus malayensis	Black eagle	TDCE	2,700
Spizaetus nipalensis	Mountain hawk eagle	CBFE,TDCE,TMCE	2,700-3,600

Species	Common Name	Ecosystem[a]	Altitude range(m)
Falconidae			
Falco tinnunculus	Common kestrel	CBFE,TDCE,SM	2,700-4,200
PASSIRIFORMES			
Laniidae			
Lanius tephronotus	Grey-backed shrike	CBFE	2,800
Corvidae			
Garrulus glandarius	Eurasian jay	CBFE	2,800-3,600
Urocissa flavirostris	Yellow-billed blue magpie	TDCE,TMCE	2,700-3,500
Nucifraga caryocatactes	Spotted nutcracker	TDCE,CBFE,TMCE,SM	2,700-3,900
Pyrrhocorax pyrrhocorax	Red-billed chough	SM,TMCE,TDCE	2,700-4,200
Corvus macrorhynchos	Large-billed crow	TDCE,TMCE,SM	2,700-3,800
Pericrocotus ethologus	Long-tailed minivet	CBFE,TDCE,TMCE,SM	2,700-3,900
Rhipidura hypoxantha	Yellow-bellied fantail	CBFE,TDCE,TMCE	2,800-3,600
Dicrurus leucophaeus	Ashy drongo	TDCE	2,800
Cinclidae			
Cinclus cinclus	White-throated dipper	FWWE	3,200
Cinclus pallasii	Brown dipper	FWWE	2.700-3,600
Muscicapidae			
Monticola rufiventris	Chestnut-bellied rock thrush	CBFE,TDCE	2,700-3,200
Myophonus caeruleus	Blue whistling thrush	FWWE,TDCE,CBFE,TMCE	2,700-3,600
Zoothera dixoni	Long-tailed thrush	CBFE,TDCE	2,800-3,200
Zoothera mollissima	Plain-backed thrush	CBFE	3,100
Zoothera monticola	Long-billed thrush	TDCE	2,800
Turdus albocinctus	White-collared blackbird	CBFE	2,800-3,600
Turdus boulboul	Grey-winged blackbird	CBFE,TDCE	2,400-3,000
Brachypterix montana	White-browed shortwing	CBFE	3,500
Ficedula strophiata	Rufous-throated flycatcher	CBFE,TDCE,TMCE	2,700-3,600
Ficedula superciliaris	Ultramarine flycatcher	TDCE	
Ficedula t. tricolor	Slatey blue flycatcher	CBFE,TDCE	2,800-3,350
Niltava sundara	Rufous-bellied niltava	TDCE	2,750-2,900
Culicicapa ceylonensis	Grey-headed canary flycatcher	CBFE,TDCE	2,700-2,900
Tarsiger chrysaeus	Golden bush robin	CBFE,TDCE,TMCE	2,750-3,900
Tarsiger cyanurus	Orange-flanked bush robin	CBFE	2,750-3,200
Tarsiger indicus	White-browed bush robin	CBFE	3,250-3,800
Phoenicurus frontalis	Blue-fronted redstart	CBFE,TDCE,TMCE,SM	2,700-4,200
Phoenicurus hodgsoni	Hodgson's redstart	CBFE,TDCE	2,750-3,200
Chaimarrornis leucocephalus	White-capped water redstart	FWWE	2,700-3,600
Rhyacornis fuliginosus	Plumbeous water redstart	FWWE	2,700-3,600
Enicurus scouleri	Little forktail	FWWE	2,750-3,600
Enicurus maculatus	Spotted forktail	FWWE	3,200
Saxicola torquata	Common stonechat	TDCE	2,800
Saxicola ferrea	Grey bushchat	TDCE	2,660-2,800

Species	Common Name	Ecosystem[a]	Altitude range(m)
Certhiidae			
Certhia familiaris	Eurasian treecreeper	CBFE,TDCE,TMCE,SM	2,450-3,700
Certhia nipalensis	Rusty-flanked treecreeper	TDCE	2,800
Troglodytes troglodytes	Winter wren	TMCE	2,900-4,200
Paridae			
Parus rubidiventris	Rufous-vented tit	TMCE,SM	3,500-3,900
Parus ater	Coal tit	CBFE,TDCE,TMCE,SM	2,700-3,900
Parus dichrous	Grey-crested tit	CBFE,TDCE,TMCE	2,700-3,800
Parus monticolus	Green-backed tit	CBFE,TDCE,TMCE,SM	2,700-3,900
Aegithalidae			
Aegithalos iouschistos	Rufous-fronted tit	CBFE,TDCE,TMCE	2,800-3,900
Hirundinidae			
Delichon dasypus	Asian house martin	TDCE	2,800-3,600
Delichon nipalensis	Nepal house martin	TDCE	2,800-2,800
Zosteropidae			
Zosterops palpebrosus	Oriental white eye	TDCE	2,700-2,800
Sylviidae			
Tesia castaneocoronata	Chestnut-headed tesia	CBFE,TDCE,TMCE	2,800-3,388
Cettia brunnifrons	Grey-sided bush warbler	CBFE,TDCE,TMCE,SM	2,700-3,900
Phylloscopus affinis	Tickell's leaf warbler	TDCE,CBFE,TMCE,SM	2,700-3,500
Phylloscopus pulcher	Buff-barred warbler	CBFE,TMCE	2,900-3,800
Phylloscopus chloronotus	Lemon-rumped warbler	CBFE,TDCETMCE,SM	2,800-3,600
Phylloscopus magnirostris	Large-billed warbler	TDCE	2,800
Phylloscopus reguloides	Blyth's leaf warbler	CBFE,TDCE,TMCE	2,550-3,200
Phylloscopus maculipennis	Ashy-throated warbler	CBFE,TDCE,TMCE	2,450-3,600
Seicercus burkii	Golden-spectacled warbler	CBFE	2,450-3,200
Seicercus whistleri	Whistler's warbler	TDCE,TMCE	2,800
Seicercus poliogenys	Grey-cheeked warbler	CBFE,TDCE,TMCE	2,450-3,600
Garrulax albogularis	White-throated laughing thrush	CBFE,TDCE	2,660-3,000
Garrulax ocellatus	Spotted laughing thrush	CBFE	2,450-3,900
Garrulax affinis	Black-faced laughing thrush	CBFE,TDCE,TMCE,SM	2,450-3,900
Garrulax erythrocephalus	Chestnut-crowned laughing thrush	CBFE	2,700-3,100
Pnoepyga albiventer	Scaly-breasted wren babbler	CBFE,TDCE,TMCE	2,450-3,250
Pnoepyga pusilla	White-throated wren babbler	TDCE	2,900
Actinodura nipalensis	Hoary-throated barwing	TDCE	2,800
Leiothrix lutea	Red-billed leiothrix	CBFE,TDCE	2,700-2,900
Minla strigula	Chestnut-tailed minla	CBFE,TDCE	2,700-3,600
Alcippe vinipectus	White-browed fulvetta	CBFE,TDCE,TMCE,SM	2,450-3,600
Heterophasia capistrata	Rufous sibia	CBFE	2,700-2,900
Yuhina gularis	Stripe-throated yuhina	CBFE,TDCE,TMCE	2,700-3,600
Yuhina occipitalis	Rufous-vented yuhina	TDCE	2,700-2,800
Paradoxornis sp.	Parrot bill	TDCE	2,800

Species	Common Name	Ecosystem[a]	Altitude range(m)
Nectariniidae			
Aethopyga gouldiae	Mrs Gould's sunbird	TDCE	2,450-3,000
Passeridae			
Passer rutilans	Russet sparrow	TDCE	2,700
Passer montanus	Eurasian tree sparrow	TDCE	2,800
Motacilla alba	White wagtail	FWWE,TDCE	2,660-2,900
Anthus hodgsoni	Olive-backed pipit	CBFE,TDCE,SM	2,450-3,450
Prunella strophiata	Rufous-breasted accentor	TDCE	2,700-4,300
Fringillidae			
Carduelis spinoides	Yellow-breasted greenfinch	TDCE	2,700
Leucosticte nemoricola	Plain mountain finch	SM	3,100-4,200
Carpodacus thura	White-browed rose finch	TMCE, SM	3,200-4,200
Carpodacus nipalensis	Dark-breasted rose finch	CBFE	3,100-3,250
Loxia curvirostra	Red crossbill	TDCE	2,700-2,800
Pyrrhula erythrocephala	Red-headed bullfinch	TMCE	3,650
Pyrrhula nipalensis	Brown bullfinch	TDCE,TMCE	2,800-3,600
Mycerobas affinis	Collared gross beak	TMCE	3,500
Mycerobas carnipes	White-winged gross beak	TMCE,SM	3,350-4,200

[a] CBFE - cool broad-leaved forest, TDCE - temperate dry coniferous, TMCE - temperate moist coniferous, SM - scrubs and meadows, FWWE - freshwater and wetlands'

Plant Resources in the Protected Areas and Proposed Corridors of Darjeeling, India

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The proposed corridors in Darjeeling are rich in flora, many of which are threatened. Substantial numbers of species are endemic to the region.

Introduction

Among the nine botanical provinces in the Indian sub-continent, the eastern Himalayas are unique globally because of the diversity of plants and animals found there, and this has drawn the attention of many plant and animal scientists from different corners of the world (Das 1995). The Himalayan region, influenced by various climatic factors, soil characteristics, diversified landforms, and altitudinal variations has a rich and diverse forest structure and an abundant composition of species.

The district of Darjeeling is one of the most pleasant and beautiful places in India. It has a blend of nature, culture, wildlife, and adventure. Covering an area of 3,255 sq.km, the district

is located between 26°31′ and 27°13′ N and 87°59′ and 88°53′ E. The district has three subdivisions: Kalimpong is the largest (1,057 sq.km) followed by Darjeeling (936 sq.km) and Kurseong (425 sq.km). The district shares its boundaries with Nepal to the west, Sikkim to the north, and Bhutan to the east. The climate is extremely variable with a nearly tropical climate prevailing in the foothills and terai regions and subalpine conditions in the areas above 3,000m. The annual rainfall is around 3,000 mm. A wide range of vegetation structures with extremely rich plant and animal diversity has developed due to the extreme climatic, edaphic, and physiographic variations. Dash (1947), Champion and Seth (1968), Bhujel (1996), and Rai and Das (2002) have variously classified the vegetation of Darjeeling.

Table 1: **Estimated number of vascular flora in Darjeeling**

Taxa	Estimated number of species
Angiosperms (dicots)	1,900
Angiosperms (monocots)	750
Gymnosperms	12
Pteridophytes	250

The 'plants of Darjeeling' have attracted many botanists and explorers in the last three centuries. The estimated vascular flora for Darjeeling district is 2,912 (Table 1). Plants of diverse forms, such as trees, shrubs, climbers, lianas, annual and perennial herbs, geophytes, epiphytes, parasites, and saprophytes, are evenly distributed. Das (1986) and Bhujel and Das (2002) estimated a considerable proportion of endemism for this region. The region is equally rich in non-timber forest products (NTFP), and the local inhabitants, especially the forest-village dwellers, use numerous plants in their daily lives. These include edibles, fodder plants, plants for house building, medicinal and aromatic plants, ornamentals, poisonous, and religious plants.

There are five protected areas in the district and they are important repositories of the rich biodiversity of the region (Table 2). The Government of West Bengal has been managing above 10% of the total geographical area of the district of Darjeeling as protected areas. These protected areas, however, are scattered as 'islands' of conservation without the connectivity needed for the long-term survival of species. In 2003, the International Centre for Integrated Mountain Development (ICIMOD) introduced a landscape approach to conservation focusing

Table 2: **Protected areas and their important species in Darjeeling**

Name	Division	Area (sq.km)	Important species
Singhalila National Park	Darjeeling	79	red panda, leopard cat, serow, clouded leopard, Himalayan thar, Himalayan black bear, tragopan, monal pheasants, spiny babbler
Senchel Wildlife Sanctuary	Darjeeling	39	goral, serow, Himalayan black bear, pangolin, barking deer
Mahananda Wildlife Sanctuary	Kurseong	127	serow, Himalayan black bear, gaur, elephant
Neora Valley National Park	Kalimpong	88	elephant, red panda, goral, serow, Himalayan thar, tiger, spotted leopard, clouded leopard, leopard cat
Jorepokhari Salamander Sanctuary	Darjeeling	0.04	salamander

on developing connectivity and transboundary cooperation (Sharma and Chettri 2005). Consultations with experts, conservation authorities, and civil society took place. Research showed that there is an urgent need to establish forested pathways or conservation corridors between the different protected areas in this rich pocket of biodiversity in the eastern Himalayas (Sharma and Chettri 2003). Following the consultations and recommendations for research, small-scale research projects on different aspects of biodiversity conservation were commissioned involving partners and institutions. This paper discusses the research carried out in the three potential conservation corridors identified through the consultation and research coordinated by ICIMOD.

Protected Areas in Darjeeling

Darjeeling district is divided into three administrative forest divisions: the Kurseong, Kalimpong, and Darjeeling hill divisions, which together have above 22% of the area under forests. There are five protected areas – two national parks and three sanctuaries. The biodiversity elements of these protected areas are presented in the following sections.

Singhalila National Park (SNP)

With an area of 79 sq.km, Singhalila National Park lies between 22°01′ 46″ and 27°13′ 15″ N and between 88° 01′ 51″ and 88° 07′ 54″ E in the extreme northwestern part of Darjeeling district. The altitude ranges from 2,400 to 3,660m. The eastern side of the range lies in Sikkim in the north; whereas the western side is the valley of the Tamur River, one of the tributaries of the river Kosi. The Singhalila ridge rises from Maneybhanjyang to Tonglu to Sandakphu and Phalut in Darjeeling district and continues higher up into Singhalila National Park and thereafter in the north joins the Khangchendzonga Biosphere Reserve (KBR) in Sikkim.

With wide altitudinal variations, the vegetation of this park is diverse. Subalpine rhododendron forest, fir-hemlock-oak mixed forest, oak forest and moist temperate forest, *Tsuga dumosa* forest, subalpine coniferous forest, and bamboo scrub are found at higher altitudes (2400m and above), while temperate evergreen broad-leaved forest predominates at lower altitudes (2400m).

The park is home to about 22 species of mammals, of which three are threatened; there are more than 250 species of birds, of which four are threatened. Some of the important wildlife include red panda (*Ailurus fulgens*), leopard cat (*Prionailurus bengalensis*), serow (*Naemorhedus sumatraensis*), common leopard (*Panthera pardus*), Himalayan thar (*Hemitragus jemlahicus*), Himalayan black bear (*Ursus thibetanus*), tragopan (*Tragopan satyra*), and monal pheasant (*Lophophorus impejanus*). Floristic exploration of the park is now in progress; preliminary assessments indicate a high proportion of endemics.

Neora Valley National Park (NVNP)

This park is located between 88° 28′ and 88° 56′ E and between 26° 51′ and 27° 12′ N, covering an area of 88 sq.km and with altitudinal variation from 300 to 3,150m. The national park is bordered in the east by West Bhutan. It is divided into four beats: Rachela, Thosum,

West Ner, and East Ner. NVNP is the least penetrated and the least explored protected area in the region and it is believed to have the richest biodiversity. The park meets the borders of Sikkim and Bhutan at Rachela danda, the highest point at 3,150m. The Neora River, the major water source of Kalimpong town originates here. 'Jaributti', one of the most beautiful places in NVNP is a repository of several important medicinal plants and also an ideal spot to witness wildlife movements. The park is also home to the endangered red panda (*Ailurus fulgens*). The recent discovery of around 19 royal Bengal tigers (*Panthera tigris*) by the Tiger Census of 2002 has listed the park among the most sensitive wildlife zones in the country.

Rai and Das (2002) recorded the rich floristic diversity in the park and are summarised in this section. The lower altitudinal zone or foothills (500 to 1,700m) displays characteristic subtropical vegetation. The dominant tall tree species (10-30m) include *Duabanga grandiflora, Michelia champaca, Terminalia alata, Gmelina arborea, Schima wallichii, Castonopsis indica, Phoebe hainesiana, Ficus subincisa, Quercus glauca, Erythrina stricta, Syzygium formosum, Phyllanthus emblica*, and others. The undergrowth includes *Pandanus nepalensis, Maesa indica, Garuga pinnata*, and *Holmskioldia sanguinea*. The common herbs are *Ageratum conyzoides, Oxalis corniculata, Urnea lobata, Pouzolzia sanguinea, Mimosa pudica*, *Eranthemum pulchellum, and others*. Above this zone, lies a small subtemperate zone (1,700-1,900m), characterised by *Ostodes paniculata, Ficus oligodon, Syzygium claviflorum, Catunregam longispina, Ehretia serrata, Morinda angustifolia*, and *Solanum erianthumc*. The ecological zone between 1,900 and 3,150m receives comparatively more rainfall and has higher humidity than the tropical area and therefore harbours rich vegetation with wide ranging biodiversity. The 15-25m high trees form a dense, closed canopy, and include *Michelia dolorosa, Magnolia campbellii, Alnus nepalensis, Rhododendron arboreum, Acer thomsonii, Juglans regia, Betula alnoides, Cotoneaster griffithii, Elaeocarpus lanceifolicus, Larix griffithiana, Juniperus pseudosabina, Abies densa, Tsuga dumosa, Taxus baccata, Pinus roxburghii*, and *Cryptomeria japonica*. The rich biodiversity of this zone is displayed in the occurrence of natural virgin forests, dense bamboo grooves, and a colourful canopy of rhododendron trees and green valleys. In addition the forests hold a number of epiphytes, mainly orchids. The common climbers are *Thunbergia lutea, Clematis nepalensis, Lonicera macrantha, Jasminum dispermum, Schiandra grandiflora*, and *Parthenocissus semicordata*, and the rich undergrowth is comprised of *Rubus paniculata, Arundinaria maling, Viburnum erubescens, Agapetes hookeri, Astilbe rivularis, Strobilanthus thomsonii*, and *Hedychium coccinium*. Herbaceous flora are represented by *Primula listeri, Swertia dulata, Galinsoga parviflora, Anaphalis contorta, Aconitum spicatum, Meconopsis nepalensis, Gentiana capitata, Rumex nepalensis*, and *Polygonum orientale*. Except in the very high altitude areas (above 3000m) the trees and shrubs are festooned with thick growths of epiphytic flora such as bryophytes, pteridophytes, and angiosperms. Heterophytic angiospermic flora such as *Viscum, Loranthus, Balanophora, Ropalocnema himalaica, Aeginetia indica*, and many others are also abundant.

Mahananda Wildlife Sanctuary (MWS)

The most important sanctuary in North Bengal, covering an area of 127 sq.km, Mahananda Wildlife Sanctuary, is situated between 26°44' and 26°56' N and 88°19' and 88°53' E with an elevation from 200 to 1,000m. It includes nine major forest ranges; namely, Kalijhora,

Latpanchor, Punding, Sukuna, Gulma, Toribari, Sevoke, Seventh Mile, and Laltong. It was started as a game sanctuary in 1955 with a view to protecting gaur or Indian bison (*Bos gaurus*). In 1959, its status was changed to that of a wildlife sanctuary because of its rich biodiversity. The sanctuary is bounded by Teesta River in the east and Hill Cart Road leading to Darjeeling in the west. The forest area in the terai or plains is typical riverine forest with a dense growth of tall trees (more than 30m high). In terms of wildlife, gaur, sambar (*Cervus unicolor*), spotted deer (*Axis axis*), leopard (*Panthera pardus*), tiger (*Panthera tigris*), and elephant (*Elephas maximus*) are the important species. The Terai belt of the sanctuary is an important corridor for elephants that migrate through Nepal to Jaldapara in West Bengal and Assam. The endangered Royal Bengal tiger (*Panthera tigris*) is also a resident of the sanctuary. A diverse habitat ensures a wide variety of animals such as the red jungle fowl (*Gallus gallus*), red breasted parakeet (*Psitacula alexandri*), peacock (*Polyplectron bicalcaratum*), minivets (*Pericrocotus* species), great hornbill (*Buceros bicornis*), and many other birds. The sanctuary is equally known for its diverse insects. Many colourful butterflies, moths, beetles, and dragonflies can be seen in abundance.

Shrubs, lianas, climbers, and epiphytes are abundant but grasses and herbaceous growth are scarce. The major deciduous species include *Shorea robusta, Tectona grandis, Lagerstroemia parviflora, Terminalia alata, Albizia procera, Phyllanthus urinaria, Alstonia scholaris, Litsea monopeltata*, and *Macaranga pustulatac*. The subtropical zone (500-1,000m) contains forest affected by a seasonal climate of dry winter and wet monsoon. The forests are deciduous and semi-evergreen and the dominant species are *Duabanga grandiflora, Schima wallichii, Terminalia alata, Michelia champaca, Mallotus philippensis, Phyllanthus emblica, Quercus glauca, Cinnamomum bejolghota, Phoebe lanceolata, Litsea cubeba, Pterospermum acerifolum*, and many others.

Senchel Wildlife Sanctuary (SWS)

Established in 1940, the Senchel Wildlife Sanctuary covers 39 sq.km of dense forests, and is one of the oldest protected areas in West Bengal. It is located between 26°56′ and 27°00′ N and 88°18′ - 88°20′ E. The altitude of the sanctuary ranges from 1,100 to 2,600m. It is also known as the oasis of Darjeeling as it is the catchment area that provides the population of Darjeeling with drinking water. The Himalayan black bear is the main animal here. In addition, there are leopards, barking deer, wild boar, and numerous species of birds.

The area is important because it is the 'type locality' for many species collected at different times by different researchers during the last three centuries and has an interesting floristic composition. The background vegetation is temperate broad-leaved forest with dominant species such as, *Rhododendron arboreum, Rhododendron grande, Castanopsis hystrix, Ilex sikkimensis, Magnolia campbellii, Alcimandra cathcartii, Exbucklandia populnea*, and *Prunus cerasoides*. Climbers and scramblers include *Rubus paniculatus, Senecio diversifolius, Rubia manjith, Codonopsis viridis*, and *Edgaria darjeelingensis*. The undershrubs and herbs are dominated by *Aconogonum molle, Cautleya lutea, Globba hookeri, Artemisia vulgaris, Urtica dioica*, and *Gerardiana heterophylla*. The secondary grassland on Tiger Hill is home to innumerable sun-loving herbaceous plants. Being an area with very high humidity, almost all

trees, including planted conifers, are covered with thick epiphytic vegetation, including *Begonia gemipara, Agapetes serpens, A. hookerii, Pilea ternifolia, Chamabainia cuspidata*, and *Hymenodictyon flaccidum*. The sanctuary is also home to numerous medicinal plants such as *Swertia chirayita, S. pedicillata, Panax pseudoginseng, Hypericum uralaum*, and *Valleriana hardwickii*.

Jorepokhari Salamander Sanctuary

Jorepokhari Salamander Sanctuary was established in 1985 on an area of 0.04 sq.km. The main objective was to protect a threatened salamander (*Tylototriton verrucosus*). The sanctuary is surrounded by some intact patches of oak and temperate broad-leaved forest and is home to numerous mammals, birds, and reptiles.

Conservation corridors and their floristic diversity

Three potential conservation corridors, namely a) SNP to SWS, b) SWS to MWS and c) MWS to NVNP in Darjeeling were identified through participatory research with the local people and formal botanical research. A comprehensive floristic survey was carried out in these corridors during 2005. The complete list of recorded species in provided in the Annex. The survey revealed that these areas are rich in floral diversity and contain as many as 707 species belonging to 145 families. Among the total number of species, more than 50% were recorded in the first corridor, 80% in the second, and 90% in the third (Table 3). Many species were common to all three corridors but some corridors had specific species. The most dominant families were Rosaceae, Poaceae, and Asteraceae followed by Lauraceae and Ericaceae. Among the species, 28.6% were trees followed by annual herbs; the smallest group were the geophytic climbers (0.3%) (Table 4). Similarly, 32.8% of the species were found to be common to the area, 26.3% less common, and 20.4% abundant (Table 5). Interestingly, about 18% of the species were rare and threatened, among which quite a few of them are found only in the corridors (Table 3), and more than 16% were endemic to the region.

Table 3: **Number of species in the corridors**

Variables	All three corridors	Corridor 1	Corridor 2	Corridor 3
Total recorded species	707	353 (50%)	567 (80%)	646 (90%)
Species only recorded in one corridor	-	46	7	32
Endemic species	115	57	82	96

Conservation Issues and Challenges

The increasing human population and the resultant establishment of new human settlements in different parts of the district are the main threats to the flora and wildlife. Many forested paths linking the protected areas have been encroached upon and fragmented because of construction work, cultivation, extensive grazing associated with an increased number of cattle, collection of fuelwood and timber, removal of humus from the forest floor, an increased number of vehicles and rising pollution, spread of pollutants even deep inside the forests, and disturbance and

damage to the forest in the name of ecotourism. Modification of the forest structure by felling and subsequent planting of exotic species and introduction of innumerable exotic species and their release are matters of utmost concern in terms of the conservation of flora and vegetation.

In most of the terai and in certain foothill zones, the plantation of selected species such as *Tectona grandis, Ailanthus integrifolia, Shorea robusta, Lagerstroemia parviflora*, and *Terminalia alata* were promoted in the past. This practice created a niche favourable for the growth of tolerant species such as *Emperata cylindrica, Arundo donax*, and *Eragrostis*. The situation is slightly different in the temperate zone, where coniferous forests have been developed artificially over wide areas making the habitat unsuitable for survival of the majority

Table 4: **Life form type of recorded plant species**

Life form/habit	No.	%
Tree	202	28.6
Annual herb	133	18.8
Shrub	105	14.9
Perennial herb	81	11.5
Shrubby climber	50	7.1
Epiphyte	43	6.1
Geophytic herb	31	4.4
Liana	17	2.4
Annual climber	16	2.3
Undershrub	14	2.0
Perennial climber	6	0.8
Suffructescent shrub	4	0.6
Geophytic climber	2	0.3
Root parasite	2	0.3
Saprophyte	1	0.1

Table 5: **Status of plants recorded in the corridors**

	All corridors		Corridor 1	Corridor 2	Corridor 3
	No.	%	No.	No.	No.
Common	232	32.8	10	-	-
Less common	186	26.3	14	-	6
Abundant	144	20.4	1	1	2
Rare	125	17.7	20	4	24
Endangered	20	2.8	1	2	-

of local species of plants and animals. In many cases, the construction of motorable roads and recreational spots inside the forest has raised concerns for conservation. Most of the terai and some parts of the foothills are important corridors for elephant migration. People have used most of the migratory corridors and the vicinity areas for tea plantation, construction of roads, and railway tracks, and this has deprived big animals of their natural migratory routes. In such circumstances, their entry to human settlements with subsequent damage to houses and agricultural fields and attacks on villagers further exacerbates human-wildlife conflict.

Overall conservation of the Kangchenjunga landscape requires the establishment of conservation corridors between the five protected areas in Darjeeling. These could play a significant role in providing contiguous habitats for many important plants and animals. The disturbed and fragmented areas along the lines of the proposed corridors must, however, be restored.

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Annex 1: Checklist of Plant Species

Plant species recorded from the three corridors In Darjeeling					
Plants	**Families**	**Corridors where present**	**Habita**	**Availability status**	**Endemic Status**
Abrus pulchellus	Leguminosae	II, III	SC	Less common	
Abies densa	Pinaceae	I, III	Tree	Abundant	Endemic
Acacia gageana	Mimosaceae	II, III	Tree	Less common	
Acacia lugata	Mimosaceae	III	Tree	Common	
Acacia pennata	Mimosaceae	II, III	Tree	Abundant	
Acer campbellii	Aceraceae	I, II, III	Tree	Rare	
Acer caudatum	Aceraceae	I	Tree	Rare	
Acer hookeri	Aceraceae	I, II, III	Tree	Less common	Endemic
Acer pectinatum	Aceraceae	I	Tree	Rare	Endemic
Acer sterculiaceum	Aceraceae	I, III	Tree	Rare	Endemic
Acer thomsonii	Aceraceae	II, III	Tree	Common	
Acmella calva	Asteraceae	I, II, III	PH	Abundant	
Aconitum bisma	Ranunculaceae	I, III	PH	Rare	
Aconitum heterophyllum	Ranunculaceae	I	PH	Rare	
Aconitum spicatum	Ranunculaceae	I, III	PH	Rare	
Aconogonum campanulatum	Polygonaceae	I	US	Common	
Aconogonum molle	Polygonaceae	I, II, III	Shrub	Abundant	
Acorus calamus	Acoraceae	II, III	GH	Common	
Acrocarpus fraxinifolius	Leguminosae	II, III	Tree	Less common	
Actinidia strigosa	Actinidiaceae	I, II, III	SC	Common	Endemic
Actinodaphne sikkimensis	Lauraceae	II, III	Tree	Common	Endemic
Adiantum oblunatum	Adiantaceae	I, II, III	AH	Abundant	
Aeginetia indica	Orobanchaceae	I, II, III	RP	Rare	
Aerides multiflora	Orchidaceae	II, III	Epiphyte	Common	
Aeschynanthes acuminatum	Gesneriaceae	II, III	Epiphyte	Common	
Aeschynanthes bracteatus	Gesneriaceae	I, II, III	Epiphyte	Less common	
Aeschynanthes gracilis	Gesneriaceae	I, III	Epiphyte	Rare	Endemic
Aeschynanthes sikkimensis	Gesneriaceae	II, III	Epiphyte	Less common	Endemic
Agapetes hookeri	Ericaceae	I, III	Epiphyte	Less common	Endemic
Agapetes serpens	Ericaceae	I, II, III	Epiphyte	Common	
Ageratum conyzoides	Asteraceae	I, II, III	AH	Abundant	
Ageratum houstonianum	Asteraceae	II, III	AH	Abundant	
Aglaia spectabilis	Meliaceae	II, III	Tree	Less common	Endemic
Ailanthus excelsa	Simaroubaceae	II, III	Tree	Common	
Ailanthus grandis	Simaroubaceae	II, III	Tree	Common	Endemic
Ainslea latifolia	Asteraceae	I, II, III	AH	Common	
Ajuga macrosperma var. *breviflora*	Lamiaceae	I, II	AH	Endangered	Endemic
Alangium alpinum	Alangiaceae	II, III	Tree	Less common	Endemic
Albizia chinensis	Mimosaceae	II, III	Tree	Common	
Albizia gamblei	Mimosaceae	II, III	Tree	Rare	
Albizia lebbeck	Mimosaceae	II, III	Tree	Common	
Albizia lucidor	Mimosaceae	II, III	Tree	Less common	
Albizia procera	Mimosaceae	II, III	Tree	Less common	
Alcimandra cathcartii	Magnoliaceae	II, III	Tree	Less common	
Alectra arvensis	Scrophulariaceae	I, II, III	RP	Less common	

Plants	Families	Corridors where present	Habita	Availability status	Endemic Status
Alocasia fallax	Araceae	II, III	GH	Less common	
Alnus nepalensis	Betulaceae	I, II, III	Tree	Abundant	
Alpinia calcarata	Zingiberaceae	II, III	PH	Less common	
Alstonia nerifolia	Apocynaceae	II, III	Tree	Rare	Endemic
Alstonia scholaris	Apocynaceae	II, III	Tree	Abundant	
Amaranthus spinosus	Amaranthaceae	II, III	AH	Abundant	
Amaranthus viridis	Amaranthaceae	II, III	AH	Abundant	
Ampelocissus barbata	Vitaceae	II, III	SC	Less common	
Ampelocissus sikkimensis	Vitaceae	I, II, III	SC	Common	Endemic
Anaphalis busua	Asteraceae	I, II, III	AH	Common	
Anaphalis contorta	Asteraceae	I, II, III	PH	Abundant	
Anaphalis margaritacea	Asteraceae	I, II, III	AH	Abundant	
Anaphalis triplinervis	Asteraceae	I, II, III	PH	Abundant	
Anemone obtusiloba	Ranunculaceae	I	PH	Less common	
Angiopteris evencta	Angiopteridaceae	I, II, III	Shrub	Endangered	
Anisomeles indica	Lamiaceae	II, III	AH	Common	
Antidesma acidum	Euphorbiaceae	II, III	Tree	Less common	
Aphanamixis polystachya	Meliaceae	II, III	Tree	Less common	
Aporosa octandra	Euphorbiaceae	II, III		Rare	
Aralia cachemerica	Araliaceae	I, III	Shrub	Less common	
Aralia foliolosa	Araliaceae	I, II, III	Shrub	Less common	Endemic
Ardisia macrocarpa	Myrsinaceae	II, III	Shrub	Less common	
Ardisia solanacea	Myrsinaceae	II, III	Shrub	Common	
Argyreia roxburghii	Convolvulaceae	II, III	SC	Abundant	Endemic
Arisaema concinum	Araceae	I, II, III	GH	Common	
Arisaema costatum	Araceae	I, II, III	GH	Common	Endemic
Arisaema flavum	Araceae	III	GH	Rare	
Arisaema griffithii	Araceae	I	GH	Less common	
Arisaema speciosum	Araceae	I, II	GH	Less common	
Arisaema tortuosum	Araceae	II, III	GH	Common	
Aristolochia griffithii	Aristolochiaceae	I, III	SC	Less common	Endemic
Aristolochia platanifolia	Aristolochiaceae	II, III	SC	Endangered	Endemic
Aristolochia saccata	Aristolochiaceae	II, III	SC	Endangered	
Artemisia vulgaris	Asteraceae	I, III	PH	Abundant	
Arthromeris sp	Polypodiaceae	I	PH	Less common	
Artocarpus chama	Moraceae	II, III	Tree	Less common	
Artocarpus lacucha	Moraceae	II, III	Tree	Common	
Arundina graminifdolia	Orchidaceae	II, III	Shrub	Endangered	
Arundinaria aristata	Poaceae	II, III	Shrub	Less common	
Arundinaria maling	Poaceae	I, II, III	Shrub	Common	
Asplenium sp.	Aspleniaceae	I, II, III	PH	Common	
Astilbe rivularis	Saxifragaceae	I, II, III	US	Common	
Asystasia macrocarpa	Acanthaceae	I, II, III	US	Less common	Endemic
Bauhinia scandens	Leguminosae	II, III	Liana	Rare	
Bauhinia vahlii	Leguminosae	II, III	Liana	Abundant	
Bauhinia variegata	Leguminosae	II, III	Tree	Common	
Bauhinia wallichii	Leguminosae	II, III	Liana	Endangered	Endemic
Beaumontia grandiflora	Apocynaceae	II, III	Liana	Rare	Endemic
Begonia dioica	Begoniaceae	II, III	PH	Less common	Endemic
Begonia gemmipara	Begoniaceae	I, II, III	Epiphyte	Rare	Endemic

Plants	Families	Corridors where present	Habita	Availability status	Endemic Status
Begonia picta	Begoniaceae	II, III	AH/ PH	Common	
Begonia sikkimensis	Begoniaceae	II	PH	Rare	Endemic
Beilschmiedia clarkei	Lauraceae	II, III	Tree	Rare	Endemic
Beilschmiedia roxburghiana	Lauraceae	II, III	Tree	Rare	Endemic
Berberis aristata	Berberidaceae	I, III	Shrub	Less common	
Berberis insignis	Berberidaceae	I, II	Shrub	Less common	Endemic
Berberis umbellata	Berberidaceae	I	Shrub	Less common	
Betula alnoides	Betulaceae	I, II, III	Tree	Less common	
Betula cylindrostachya	Betulaceae	II, III	Tree	Less common	
Betula utilis	Betulaceae	I, III	Tree	Rare	
Bidens pilose	Asteraceae	I, II, III	AH	Abundant	
Biophytum sensitivum	Oxalidaceae	I, II, III	AH	Common	
Bischofia javanica	Euphorbiaceae	II, III	Tree	Common	
Bistorta amplexicaule	Polygonaceae	I, III	AH	Less common	
Boehmeria glomerulifera	Urticaceae	I, III	Shrub	Common	
Boehmeria penduliflora	Urticaceae	II, III	Shrub	Less common	
Boehravia diffusa	Nyctaginaceae	II, III	PH	Abundant	
Boeninghousenia albiflora	Rutaceae	I, II, III	US	Rare	
Bombax ceiba	Bombacaceae	II, III	Tree	Abundant	
Borreria alata	Rubiaceae	II, III	AH	Abundant	
Borreria ocimoides	Rubiaceae	II, III	AH	Abundant	
Botrychium sp	Ophioglossaceae	I	GH	Endangered	
Brassaiopsis mitis	Araliaceae	II, III	Shrub	Less common	Endemic
Brassiaopsis alpina	Araliaceae	I	Shrub	Rare	
Brassiaopsis hainla	Araliaceae	I, II, III	Tree	Common	
Bridelia retusa	Euphorbiaceae	II, III	Tree	Common	
Bridelia sikkimensis	Euphorbiaceae	II, III	Shrub	Less common	
Bridelia stipularis	Euphorbiaceae	III	Tree	Less common	
Bulbophyllum affine	Orchidaceae	II, III	Epiphyte	Less common	
Bulbophyllum reptans	Orchidaceae	II, III	Epiphyte	Less common	
Burmannia coelestis	Burmanniaceae	II, III	AH	Endangered	
Butea buteiformis	Leguminosae	II, III	SS	Rare	Endemic
Calamus acanthospathus	Arecaceae	II, III	SC	Rare	
Calamus erectus var. *Schizosanthus*	Arecaceae	II, III	SC	Less common	
Calamus erectus	Arecaceae	II, III	SC	Common	
Calamus inermus	Arecaceae	III	SC	Rare	
Calamus leptocalyx	Arecaceae	II, III	SC	Rare	
Callicarpa aborea	Verbenaceae	II, III	Tree	Abundant	
Camellia kissi	Theaceae	II, III	Tree	Rare	
Capsella bursa-pastoris	Brassicaceae	I, II, III	AH	Abundant	
Cardamine hirsuta	Brassicaceae	I, II, III	AH	Abundant	
Cardamine impatiens	Brassicaceae	I, III	AH	Less common	
Carex filicinus	Cyperaceae	I, II, III	PH	Abundant	
Carex baccans	Cyperaceae	I, II, III	PH	Less common	
Carex cruciata	Cyperaceae	I, II, III	PH	Less common	
Casearia glomerata	Flacourtiaceae	II, III	Shrub	Common	
Casearia graveolens	Flacourtiaceae	II, III	Tree	Abundant	
Cassia alata	Leguminosae	II, III	Shrub	Abundant	
Cassia sophera	Leguminosae	II, III	AH	Abundant	
Cassia tora	Leguminosae	II, III	AH	Abundant	

Plants	Families	Corridors where present	Habita	Availability status	Endemic Status
Castanopsis hystrix	Fagaceae	I, II, III	Tree	Common	
Castanopsis indica	Fagaceae	II, III	Tree	Common	
Castanopsis lanceifolia	Fagaceae	III	Tree	Rare	Endemic
Castanopsis tribuloides	Fagaceae	I, II, III	Tree	Common	
Catunaregam longispina	Rubiaceae	III	Shrub	Rare	
Cautleya cathcartii	Zingiberaceae	I, II, III	Epiphyte	Rare	
Cautleya lutea	Zingiberaceae	I, II, III	Epiphyte	Abundant	
Cautleya spicata	Zingiberaceae	I, II, III	GH	Rare	
Cephalostachyum latifolium	Poaceae	II, III	Shrub		
Cestrum aurantiacum	Solanaceae	I, II, III	Shrub	Abundant	
Cestrum elegans	Solanaceae	I, II, III	Shrub	Common	
Chamabainia cuspidata	Urticaceae	I, II, III	PH	Abundant	
Cheilanthus farinosa	Pteridaceae	II, III	PH	Common	
Chirita macrophylla	Gesneriaceae	I, II, III	PH	Less common	
Chirita uticifolia	Gesneriaceae	II, III	PH	Common	
Chisocheton cumingianus	Meliaceae	II, III	Tree	Less common	Endemic
Chukrasia tabularis	Meliaceae	II, III	Tree	Common	
Cinnamomum bejolghota	Lauraceae	I, II, III	Tree	Common	
Cinnamomum glaucescens	Lauraceae	I, III	Tree	Less common	Endemic
Cinnamomum impressinervium	Lauraceae	II, III	Tree	Rare	
Cinnamomum tamala	Lauraceae	II, III	Tree	Common	Endemic
Cissampelos pareira	Menispermaceae	II, III	SC	Common	
Citrus medica	Rutaceae	II, III	Shrub	Rare	
Clematis buchananiana	Ranunculaceae	I, II, III	SC	Common	
Clematis connata	Ranunculaceae	I, III	SC	Rare	
Clematis montana	Ranunculaceae	I, III	SC	Rare	
Clematis nepalensis	Ranunculaceae	II, III	SC	Rare	
Clematis similaciflia	Ranunculaceae	I, II, III	SC	Rare	
Clerodendrum indicum	Verbenaceae	II, III	Shrub	Abundant	
Clerodendrum japonicum	Verbenaceae	II, III	SS	Abundant	
Clerodendrum serratum	Verbenaceae	II, III	SS	Common	
Clerodendrum viscosum	Verbenaceae	II, III	SS	Abundant	
Clinopodium umbrossum	Lamiaceae	I, II, III	AH	Abundant	
Coccinia grandis	Cucurbitaceae	II, III	PC	Abundant	
Codonopsis affinis	Campanulaceae	I	AC	Less common	Endemic
Codonopsis viridis	Campanulaceae	I, II, III	AC	Common	
Colocasia affinis	Araceae	I, II, III	GH	Abundant	
Combretum decandrum	Combretaceae	II, III	Liana	Abundant	
Commelina bengalensis	Commelinaceae	II, III	AH	Common	
Commelina paludosa	Commelinaceae	I, II, III	PH	Common	
Commelina suffruticosa	Commelinaceae	II, III	PH	Common	
Commelina nudiflora	Commelinaceae	II, III	PH	Common	
Corydalis meifolia	Fumariaceae	I	AH	Rare	
Costus speciosus	Costaceae	II, III	GH	Abundant	
Cotoneaster frigidu	Rosaceae	I	Shrub	Common	
Cotoneaster griffithii	Rosaceae	I, III	Shrub	Common	
Cotoneaster microphyllus	Rosaceae	I, III	Shrub	Common	
Crawfurdia speciosa	Gentianaceae	I, II, III	AC	Common	
Cremanthodium nepalense	Orchidaceae	I	GH	Less common	

Plants	Families	Corridors where present	Habita	Availability status	Endemic Status
Crotalaria albida	Leguminosae	II, III	AH	Common	
Crotalaria mucronata	Leguminosae	II, III	AH	Common	
Crotolaria ferrugineanum	Leguminosae	II, III	AH	Common	
Croton cadautus	Euphorbiaceae	II, III	Shrub	Abundant	
Cryptocaria amygdalina	Lauraceae	I, II, III	Tree	Less common	Endemic
Cryptochilus lutea	Orchidaceae	III	Epiphyte	Rare	Endemic
Cryptochillus sanguinea	Orchidaceae	III	Epiphyte	Rare	
Cryptomeria japonica	Taxodiaceae	I, II, III	Tree	Abundant	
Curculigo orchioides	Hypoxidaceae	II, III	GH	Less common	
Curculigo recurvata	Hypoxidaceae	I, II, III	PH	Common	
Curcuma aromatica	Zingiberaceae	II, III	GH	Common	
Cyanotis barbata	Commelinaceae	I, II, III	AH	Common	
Cyanotis vaga	Commelinaceae	I, II, III	AH	Common	
Cyathea spinulosa	Cyatheaceae	I, III	Tree	Endangered	
Cyclea bicristata	Menispermaceae	II, III	SC	Less common	Endemic
Cymbidium aloifolium	Orchidaceae	II, III	Epiphyte	Common	
Cymbidium eriaeflorum	Orchidaceae	II, III	Epiphyte	Common	
Cymbopogon nardus	Poaceae	I, II, III	PH	Common	
Cynodon dactylon	Poaceae	II, III	PH	Abundant	
Cyperus compressus	Cyperaceae	II, III	AH	Abundant	
Dactylorhiza hatagirea	Orchidaceae	I	PH	Rare	Endemic
Daemonorops jenkensiana	Arecaceae	III	SC	Rare	Endemic
Dalbergia sissoo	Leguminosae	II, III	Tree	Abundant	
Dalbergia stipulacea	Leguminosae	II, III	Liana	Abundant	
Daphne bholua	Thymeliaceae	I, II, III	Shrub	Abundant	
Daphne sureil	Thymeliaceae	III	Shrub	Rare	Endemic
Daphniphyllum hemalense	Daphniphyllaceae	I, III	Tree	Rare	
Debregeasia longifolia	Urticaceae	II, III	Shrub	Less common	
Dendrobium candidum	Orchidaceae	I, II, III	Epiphyte	Less common	
Dendrobium devonianum	Orchidaceae	I, II, III	Epiphyte	Less common	
Dendrobium falconeri	Orchidaceae	I, II, III	Epiphyte	Less common	
Dendrobium longiflorum	Orchidaceae	II, III	Epiphyte	Less common	
Dendrocalamus hookeri	Poaceae	I, II, III	Shrub	Less common	
Dendrocnide sinulata	Urticaceae	II, III	Shrub	Common	
Desmodium triflorum	Leguminosae	II, III	AH	Abundant	
Dicentra paucinervia	Fumeriaceae	II, III	AC	Rare	Endemic
Dicentra scandens	Fumeriaceae	I, II, III	AC	Common	
Dichroa febrifuga	Saxifragaceae	I, II, III	Shrub	Common	
Dicliptera roxburghii	Acanthaceae	II, III	AH	Common	
Didymocarpus albicalyx	Gesneriaceae	II, III	AH	Rare	Endemic
Didymocarpus podocarpus	Gesneriaceae	I, II, III	AH	Rare	Endemic
Digitaria ciliaris	Poaceae	I, II, III	AH	Common	
Dillenia indica	Dilleniaceae	II, III	Tree	Common	
Dillenia pentagyna	Dilleniaceae	II, III	Tree	Common	
Dioscorea spp.	Dioscoreaceae	II, III	GH	Less common	
Dioscorea spp.	Dioscoreaceae	II, III	GH	Less common	
Diplazium esculentum	Dryopteridaceae	I, II, III	PH	Abundant	
Dischidia indica	Asclepiadaceae	II, III	AH	Abundant	
Dobinia vulgaris	Anacardiaceae	I, II, III	Shrub	Less common	Endemic
Docynia indica	Rosaceae	I	Tree	Rare	Endemic

Plants	Families	Corridors where present	Habita	Availability status	Endemic Status
Drosera burmannii	Droseraceae	II, III	AH	Common	
Drymaria cordata	Caryophyllaceae	I, II, III	PH	Abundant	
Drymaria villosa	Caryophyllaceae	I, II, III	PH	Abundant	
Dryopteris sp.	Dryopteridaceae	I, II, III	PH	Common	
Drypetes assamica	Euphorbiaceae	II, III	Tree	Rare	Endemic
Duabanga grandiflora	Sonneratiaceae	II, III	Tree	Common	
Duchesnea indica	Rosaceae	I, II, III	AH	Common	
Dumasia villosa	Leguminosae	I, II, III	AC	Common	
Dysoxylum excelsum	Lamiaceae	II, III	AC	common	Endemic
Edgaria darjeelingensis	Cucurbitaceae	I, II, III	AC	Abundant	
Edgwarthia gardneri	Thymeliaceae	II, III	Tree	Less common	
Ehretia serrata	Ehretiaceae	II, III	Tree	Less common	
Elaeocarpus lancaefolius	Elaeocarpaceae	I, III	Tree	Less common	
Elatostema hookerianum	Urticaceae	I, II, III	AH	Common	
Elatostema sessile	Urticaceae	I, II, III	AH	Abundant	
Elatostema sikkimense	Urticaceae	I, II, III	AH	Less common	Endemic
Eleusine indica	Poaceae	I, III	AH	Abundant	
Elsholtzia blanda	Lamiaceae	I, II, III	AH	Common	
Elsholtzia fruticosa	Lamiaceae	I, III	PH	Common	
Engelhardtia spicata	Juglandaceae	I, II, III	Tree	Common	
Entada rheedii	Mimosaceae	II, III	Liana	Less common	
Epilogium roseum	Onagraceae	I, II, III	AH	Abundant	
Equisetum debile	Equisetaceae	I, II, III	PH	Abundant	
Eragrostis nigra	Poaceae	II, III	AH	Less common	
Eranthemum pulchellum	Acanthaceae	II, III	Shrub	Less common	
Eria convallaria	Orchidaceae	I, II, III	PH	Less common	
Eria dasyphylla	Orchidaceae	II, III	Epiphyte	Rare	Endemic
Eriobotrya dubia	Rosaceae	II	Tree	Rare	Endemic
Eriobotrya petiolata	Rosaceae	I, II, III	Tree	Common	Endemic
Erythrina arborescens	Leguminosae	I, II, III	Tree	Common	
Erythrina stricta	Leguminosae	II, III	Tree	Common	
Eugenia bracteata	Myrtaceae	II, III	Tree	Rare	
Eupatorium adenophorum	Asteraceae	I, II, III	Shrub	Abundant	
Eupatorium odoratum	Asteraceae	II, III	Shrub	Abundant	
Euphorbia hirta	Euphorbiaceae	II, III	AH	Abundant	
Euphorbia orbiculata	Euphorbiaceae	II, III	AH	Abundant	
Eurya acuminata	Theaceae	I, II, III	Tree	Abundant	
Eurya cerassifolia	Theaceae	I, II, III	Tree	Common	
Eurya theafolia	Theaceae	I, III	Tree	Less common	
Evodia fraxinifolia	Theaceae	I, II, III	Tree	Less common	
Exbucklandia populnea	Hamamelidaceae	I, II, III	Tree	Common	
Fallopia convolvulus	Polygonaceae	I, II, III	AH	Common	
Ficus cunia	Moraceae	II, III	Tree	Common	
Ficus drupacea	Moraceae	II, III	SC	Common	
Ficus semicordata	Moraceae	II, III	Tree	Common	
Ficus subincisa	Moraceae	II, III	SC	Rare	
Ficus virens	Moraceae	II, III	Tree	Common	
Flueggea virosa	Euphorbiaceae	II, III	Shrub	Less common	
Fragaria nilotica	Rosaceae	I, III	PH	Common	
Fragaria rubiginosa	Rosaceae	I, II, III	PH	Common	

Plants	Families	Corridors where present	Habita	Availability status	Endemic Status
Fumaria indica	Fumariaceae	I, II, III	AH	Common	
Galinsoga parviflora	Asteraceae	I, II, III	AH	Abundant	
Garuga pinnata	Burseraceae	II, III	Tree	Rare	
Gaultheria fradrantissima	Ericaceae	I	PH	Less common	Endemic
Gaultheria hookeri	Ericaceae	I	Shrub	Rare	
Gaultheria nummularia	Ericaceae	I, II, III	Shrub	Abundant	
Gentiana capitata	Gentianaceae	I, III	AH	Common	
Gentiana pyroloides	Gentianaceae	I, III	AH	Less common	
Gentiana pedicellata	Gentianaceae	I, III	AH	Abundant	
Gentiana bryoides	Gentianaceae	I, III	AH	Less common	
Girardiana heterophylla.	Urticaceae	I, II, III	Shrub	Common	
Gleichenia glauca	Gleicheniaceae	I, II, III	Shrub	Common	
Globba hookeri	Zingiberaceae	I, II, III	GH	Common	
Globba racemosa	Zingiberaceae	II, III	GH	Common	
Gmelina arborea	Verbenaceae	II, III	Tree	Common	
Gnaphalium affine	Asteraceae	I, II, III	AH	Abundant	
Goldfussia capitata	Acanthaceae	II, III	US	Common	Endemic
Gouania leptostachya	Rhamnaceae	II, III	SC	Common	
Grangea maderaspatana	Asteraceae	II, III	AH	Common	
Grewia eriocarpa	Tiliaceae	II, III	Tree	Less common	
Grewia sapida	Tiliaceae	II, III	Tree	Less common	
Gynocardia odorata	Flacourtiaceae	II, III	Tree	Less common	Endemic
Gynura cusimbua	Asteraceae	I, II, III	AH	Common	
Habenaria densa	Orchidaceae	I, II, III			
Hedychium acuminatum	Zingiberaceae	I, II, III	GH	Common	
Hedychium coccinium	Zingiberaceae	II, III	GH	Rare	
Hedychium spicatum	Zingiberaceae	I, II, III	GH	Rare	
Hedyotis scandens	Rubiaceae	I, II, III	SC	Common	
Hedyotis stipulacea	Rubiaceae	I, II, III	AH	Less common	
Helenia elliptica	Gentianaceae	I	AH	Common	
Helwingia himalaica	Helwingiaceae	I, II, III	Shrub	Common	
Hemiphragma heterophyllum	Scrophulariaceae	I, II, III	PH	Common	
Heraclium wallichii	Apiaceae	I, II, III	AH	Less common	Endemic
Herpetospermum pedunculosum	Cucurbitaceae	I, III	AC	Rare	
Hibiscus surattensis	Malvaceae	II, III	AH	Rare	
Himalayacalamus hookerianus	Poaceae	III	Liana	Rare	Endemic
Holarrhena pubescens	Apocynaceae	II, III	Tree	Abundant	
Holboelia latifolia	Lardizabalaceae	I, II, III	SC	Common	
Holmskioldia sanguinea	Verbenaceae	II, III	Shrub	Common	
Horsfieldia kingii	Myristichaceae	II, III	Tree	Rare	Endemic
Hoya edeni	Asclepiadaceae	II, III	Epiphyte	Less common	
Hoya parasitica	Asclepiadaceae	II, III	Epiphyte	Abundant	
Hoya longifolia	Asclepiadaceae	I, II, III	Epiphyte	Abundant	
Hoya serpens	Asclepiadaceae	III	Epiphyte	Rare	Endemic
Hydrangea aspera	Saxifragaceae	II, III	SC	Less common	
Hydrangea robusta	Saxifragaceae	I, II, III	Shrub	Common	
Hydrocotyl himalaica	Apiaceae	I, II, III	PH	Abundant	Endemic
Hydrocotyle nepalensis	Apiaceae	I, II, III	PH	Common	

Plants	Families	Corridors where present	Habita	Availability status	Endemic Status
Hydrocotyle sibthorpioides	Apiaceae	II, III	AH	Abundant	
Hygrophila phlomoides	Acanthaceae	II, III	AH	Common	
Hygrophila polysperma	Acanthaceae	II, III	AH	Common	
Hygrophila spinosa	Acanthaceae	II, III	AH	Less common	
Hymenodictylon excelsum	Rubiaceae	II, III	Epiphyte	Rare	
Hymenophyllum parasiticum	Rubiaceae	I, II, III	Epiphyte	Less common	
Hypericum gracilipes	Hypericaceae	II	AH	Rare	Endemic
Hypericum japonicum	Hypericaceae	II, III	AH	Abundant	
Hypericum nepalensis	Hypericaceae	I, II, III	AH	Less common	
Hypericum petiolatum	Hypericaceae	II	AH	Abundant	
Hypoestis triflora	Acanthaceae	I, II, III	AH	Abundant	
Hypoxis aurea	Hypoxidaceae	II	GH	Rare	
Hyptianthera stricta	Rubiaceae	II, III	Shrub	Rare	
Ichnocarpus frutescens	Apocynaceae	II, III	SC	Abundant	
Ilex depyrina	Aquifoliaceae	I, III	Tree	Less common	
Ilex fragilis	Aquifoliaceae	I, III	Tree	Less common	
Ilex hookeri	Aquifoliaceae	I	Tree	Rare	Endemic
Ilex insignis	Aquifoliaceae	I, II, III	Tree	Less common	
Ilex sikkimensis	Aquifoliaceae	I, III	Tree	Rare	
Impatiens cathcartii	Balsaminaceae	I, II, III	AH	Less common	Endemic
Impatiens discolor	Balsaminaceae	I, II, III	AH	Less common	Endemic
Impatiens longipes	Balsaminaceae	I, II, III	AH	Less common	Endemic
Impatiens kingii	Balsaminaceae	I, II, III	PH	Rare	Endemic
Impatiens pulchra	Balsaminaceae	I, II, III	AH	Less common	Endemic
Impatiens radiata	Balsaminaceae	I, II, III	AH	Less common	Endemic
Impatiens stenantha	Balsaminaceae	I, II, III	Shrub	Endangered	Endemic
Imperata cylindrica	Poaceae	I, II, III	PH	Abundant	
Inula cappa	Asteraceae	I, II, III	US	Less common	
Ipomoea carnea	Convolvulaceae	II, III	Shrub	Abundant	
Ipomoea quamoclit	Convolvulaceae	II, III	AC	Common	
Ipomoea purpurea	Convolvulaceae	II, III	AC	Common	
Isachne albens	Poaceae	I, II, III	AH	Less common	
Ixora undulata	Rubiaceae	III	Shrub	Less common	Endemic
Jasminum dispermum	Oleaceae	I, II, III	SC	Less common	
Juglans regia	Juglandaceae	II, III	Tree	Rare	
Juniperus pseudosabina	Cupressaceae	I, III	Tree	Rare	
Justicia procumbens	Acanthaceae	II, III	AH	Less common	
Knema tenuineriyia	Myristichaceae	II, III	Tree	Rare	Endemic
Kydia calcycina	Malvaceae	II, III	Tree	Less common	
Lagerstroemia hirsuta	Lythraceae	II, III	Tree	Rare	
Lagerstroemia parviflora	Lythraceae	II, III	Tree	Common	
Lantana camara	Verbenaceae	II, III	Shrub	Abundant	
Larix griffithiana	Pinaceae	I, III	Tree	Rare	
Lasiococca symphylliifolia	Euphorbiaceae	II, III	Tree	Rare	
Leea asiatica	Leeaceae	II, III	Shrub	Common	
Leea compatiflora	Leeaceae	II, III	Shrub	Less common	
Leea guinensis	Leeaceae	II, III	Shrub	Common	
Leea indica	Leeaceae	III	Shrub	Rare	Endemic
Lepisorus spp.	Polypodiaceae	I, II, III	Epiphyte	Abundant	
Leucas indica	Lamiaceae	II, III	AH	Abundant	

Plants	Families	Corridors where present	Habita	Availability status	Endemic Status
Leucas mollisima	Lamiaceae	II, III	PH	Less common	
Leycesteria formosa	Caprifoliaceae	I, II, III	Shrub	Common	
Lindera assamica	Lauraceae	III	Tree	Rare	Endemic
Lindera latifolia	Lauraceae	II, III	Tree	Rare	
Liparis resupinnata	Orchidaceae	I, II, III	Epiphyte	Endangered	
Lithocarpus elegans	Fagaceae	I, II, III	Tree	Less common	Endemic
Lithocarpus fenestratus	Fagaceae	II, III	Tree	Less common	
Lithocarpus pachyphyllus	Fagaceae	I, II, III	Tree	Common	Endemic
Litsea citrata	Lauraceae	I, II, III	Tree	Common	
Litsea cubeba	Lauraceae	I, II, III	Tree	Common	
Litsea elongata	Lauraceae	I, II, III	Tree	Common	
Litsea hookeri	Lauraceae	II, III	Tree	Less common	Endemic
Litsea monopetala	Lauraceae	II, III	Tree	Common	
Litsea polyantha	Lauraceae	II, III	Tree	Common	
Litsea sericea	Lauraceae	II, III	Tree	Less common	
Lobelia seguinii	Lobeliaceae	I	AH	Less common	
Lonicera glabra	Caprifoliaceae	I, II, III	SC	Common	
Lonicera macrantha	Caprifoliaceae	I, III	SC	Less common	
Luculia gratissima	Rubiaceae	I, II, III	Shrub	Common	
Lycopodium clavatum	Lycopodiaceae	I, II, III	PH	Common	
Lycopodium sernuum	Lycopodiaceae	II, III	PH	Less common	
Macaranga pustulata	Euphorbiaceae	II, III	Tree	Less common	
Machillus odoratissima	Magnoliaceae	I, II, III	Tree	Common	
Macropanax dispermus	Araliaceae	III	Tree	Rare	
Maesa chisia	Myrsinaceae	I, II, III	Shrub	Abundant	
Maesa indica	Myrsinaceae	II, III	Shrub	Common	
Maesa rugosa	Myrsinaceae	III	Shrub	Less common	
Magnolia campbellii	Magnoliaceae	I, II, III	Tree	Common	
Mahonia napaulensis	Berberidaceae	I, II, III	Shrub	Common	Endemic
Mallotus nepalensis	Euphorbiaceae	I, II, III	Tree	Abundant	
Mallotus phillippensis	Euphorbiaceae	II, III	Tree	Abundant	
Mallotus roxburghianus	Euphorbiaceae	II, III	Tree	Less common	Endemic
Mazus surculosus	Scrophulariaceae	I, II, III	AH	Common	
Meconopsis nealensis	Papaveraceae	I, III	PH	Less common	
Meconopsis paniculatus	Papaveraceae	I, III	PH	Less common	
Melastoma malabathricum	Melastomataceae	II, III	Shrub	Abundant	
Melastoma normale	Melastomataceae	II, III	Shrub	Less common	
Melilotus indica	Leguminosae	II, III	AH	Less common	
Mesua ferrea	Clusiaceae	II, III	Tree	Less common	
Mesua floribunda	Clusiaceae	III	Tree	Rare	
Michelia champaca	Magnoliaceae	II, III	Tree	Common	
Michelia doltosopa	Magnoliaceae	I, II, III	Tree	Common	
Michelia lanuginosa	Magnoliaceae	I, II, III	Tree	Less common	
Mikania micrantha	Asteraceae	II, III	SC	Abundant	
Mimosa himalayana	Mimosaceae	II, III	Shrub	Abundant	
Mimosa pudica	Mimosaceae	II, III	AH	Abundant	
Mimulus nepalensis	Scrophulariaceae	I, II, III	AH	Abundant	
Monotropa uniflora	Monotropaceae	II, III	Saprophyte	Rare	
Morinda anguistifolia	Rubiaceae	II, III	Tree	Common	Endemic
Mucuna macrocarpa	Leguminosae	II, III	Liana	Less common	

Plants	Families	Corridors where present	Habita	Availability status	Endemic Status
Mucuna pruriens	Leguminosae	II, III	SC	Common	
Mussaenda roxburghii	Rubiaceae	II, III	Shrub	Common	
Musa balbisiana	Musaceae	I, II, III	PH	Abundant	
Naravelia zeylanica	Ranunculaceae	II, III	SC	Common	
Neanotis gracilis	Rubiaceae	I, II, III	AH	Less common	Endemic
Neilia thyrsiflora	Rosaceae	I, II, III	Shrub	Common	
Neillia rubiflora	Rosaceae	I, III	Shrub	Less common	
Nervillea macroglossa	Orchidaceae	II, III	GH	Rare	
Neolamarckia cadamba	Rubiaceae	II, III	Tree	Abundant	
Neyraudia arundinacea	Poaceae	I, III	Tree	Less common	
Notochete hamosa	Lamiaceae	I, II, III	PH	Common	
Ophiopogon intermedius	Liliaceae	I, II, III	PH	Common	
Ophiorrhyza nutans	Rubiaceae	I, II, III	AH	Common	
Ophiorrhyza succirubra	Rubiaceae	I, II, III	AH	Common	Endemic
Ophiorrhyza treutlerii	Rubiaceae	I, II, III	AH	Common	Endemic
Oplismenus compositus	Poaceae	I, II, III	AH	Abundant	
Oplismenus burmannii	Poaceae	I, II, III	AH	Abundant	
Oberonia mucronata	Orchidaceae	II, III	Epiphyte	Endangered	
Oroxylum indicum	Bignoniaceae	II, III	Tree	Abundant	
Oryza meyeriana	Poaceae	II	AH	Endangered	Endemic
Oryza minuta	Poaceae	II	AH	Endangered	Endemic
Osbeckia muralis	Melastomataceae	II, III	Shrub	Rare	
Osbeckia nepalensis	Melastomataceae	II, III	Shrub	Common	
Osbeckia crinita	Melastomataceae	I, II, III	Shrub	Less common	
Osbeckia stellata	Melastomataceae	I, II, III	Shrub	Common	
Oxalis acetocella	Oxalidaceae	I	PH	Rare	
Oxalis corniculata	Oxalidaceae	I, II, III	AH	Abundant	
Oxalis corymbosa	Oxalidaceae	II, III	GH	Abundant	
Oxalis latifolia	Oxalidaceae	II, III	GH	Common	
Oxyspora paniculata	Melastomataceae	I, II, III	Shrub	Common	
Pandanus nepalensis	Pandanaceae	II, III	Tree	Abundant	
Panisea parviflora	Orchidaceae	III	Epiphyte	Rare	
Pantapanax racemosus	Araliaceae	I, II, III	Epiphyte	Rare	
Parasassafrans confertiflora	Saxifragaceae	I, III	PH	Less common	
Paris polyphylla	Liliaceae	I, II, III	GH	Common	
Parochitus communis	Leguminosae	I, II, III	AH	Abundant	
Parthenocissus semicordata	Vitaceae	II, III	SC	Less common	
Paspalum dilatatum	Poaceae	II, III	AH	Less common	
Paspalum scrobiculatum	Poaceae	II, III	AH	Common	
Peliosanthes macrophylla	Haemodoraceae	II, III	PH	Less common	
Pentapanx fragrans	Araliaceae	I, II, III	Tree	Less common	
Peperomia heyniana	Piperaceae	I, III	Epiphyte	Less common	
Peperomia pellucida	Piperaceae	I, III	Epiphyte	Common	
Peperomia tetraphylla	Piperaceae	I, III	Epiphyte	Common	
Pericampylus glaucus	Menispermaceae	II, III	SC	Common	
Persea fructifera	Lauraceae	II, III	Tree	Less common	
Persea odoratissima	Lauraceae	I, II, III	Tree	Less common	
Persicaria capitata	Polygonaceae	I, II, III	PC	Abundant	
Persicaria runcinata	Polygonaceae	I, II, III	AH	Abundant	
Phlogacanthus thyrsiformis	Acanthaceae	II, III	Shrub	Abundant	

Plants	Families	Corridors where present	Habita	Availability status	Endemic Status
Phoebe haineana	Lauraceae	II, III	Tree	Less common	
Phoebe lanceolata	Lauraceae	I, III	Tree	Less common	
Phoenix acaulis	Arecaceae	II, III	Shrub	Rare	
Phyllanthus embelica	Euphorbiaceae	II, III	Tree	Common	
Phyllanthus urinaria	Euphorbiaceae	II, III	AH	Abundant	
Pieris formosa	Ericaceae	I	Tree	Rare	Endemic
Pilea cordifolia	Urticaceae	I, II	PH	Less common	Endemic
Pilea glaberrima	Urticaceae	II, III	AH	Less common	
Pilea bracteata	Urticaceae	I, II, III	AH	Less common	Endemic
Pilea ternifolia	Urticaceae	I, III	PH	Less common	Endemic
Pilea symmeria	Urticaceae	I, II, III	AH	Abundant	
Pinus longifolia	Pinaceae	I, II, III	Tree	Common	
Pinus roxhburghii	Pinaceae	I, II, III	Tree	Common	
Piper chyvya	Piperaceae	II, III	US	Common	Endemic
Piper longum	Piperaceae	II, III	PC	Common	
Piper pedicellatum	Piperaceae	I, II, III	PC	Common	
Piper mullesua	Piperaceae	I, II, III	PC	Common	
Plantago erosa	Plantaginaceae	I, II, III	PH	Abundant	
Plectocomia himalayana	Arecaceae	II, III	Liana	Endangered	
Pogostemon amaranthoides	Lamiaceae	II, III	US	Common	
Pollinia ciliata	Urticaceae	II, III	PH	Less common	
Polyalthia simiarum	Annonaceae	II, III	Tree	Less common	Endemic
Polygala arillata	Polygalaceae	I, II, III	Shrub	Less common	
Polygala glomerata	Polygalaceae	II, III	PH	Less common	
Polygonum orientale	Polygonaceae	II, III	AH	Common	
Polypodium spp.	Polypodiaceae	I, II, III	PH	Common	
Porana grandiflora	Convolvulaceae	I, II, III	AC	Less common	
Porana paniculata	Convolvulaceae	II, III	SC	Common	
Portulacca oleracea	Portulaccaceae	II, III	AH	Common	
Potentilla fruticosa	Rosaceae	I, II, III	PH	Rare	
Potentilla fulgens	Rosaceae	I, II, III	PH	Common	
Potentilla polyphylla	Rosaceae	I, II, III	PH	Common	
Pothos cathacartii	Araceae	II, III	Epiphyte	Common	
Pouzolzia hirta	Urticaceae	I, II, III	PH	Abundant	
Pouzolzia sanguinea	Urticaceae	II, III	AH	Less common	
Pouzolzia zeylanica	Urticaceae	II, III	AH	Abundant	
Premna bracteata	Verbenaceae	II, III	Tree	Less common	
Premna scandens	Verbenaceae	III	Shrub	Rare	
Primula denticulata	Primulaceae	I, II, III	Tree	Common	
Primula listeri	Primulaceae	I, III	PH	Rare	
Primula scapigera	Primulaceae	I	PH	Rare	
Primula petiolata	Primulaceae	I	PH	Less common	
Primula capitata	Primulaceae	I	PH	Common	
Prunella vulgaris	Lamiaceae	I, II, III	AH	Abundant	
Prunus cerasoides	Rosaceae	I, II, III	Tree	Abundant	
Pseudostachyum polymorphum	Poaceae	III	Shrub	Rare	Endemic
Pteridium sp	Dennstaedtiaceae	II, III	PH	Common	
Pteris	Pteridaceae	I, II, III	PH	Common	
Pterospermum acerifolium	Sterculaceae	II, III	Tree	Common	

Plants	Families	Corridors where present	Habita	Availability status	Endemic Status
Pueraria lobata	Leguminosae	III	SC	Rare	
Puereia phaseoloides	Leguminosae	II, III	PC	Abundant	
Puereia sikkimensis	Leguminosae	II, III	Liana	Less common	Endemic
Pyrularia edulis	Santalaceae	II, III	Tree	Endangered	
Quecus thomsoniana	Fagaceae	II, III	Tree	Less common	Endemic
Quercus glauca	Fagaceae	II, III	Tree	Less common	
Quercus lamellosa	Fagaceae	I, II, III	Tree	Abundant	
Quercus lineata	Fagaceae	I	Tree	Common	
Randia dumetorum	Rubiaceae	II, III	Tree	Common	
Ranunculus diffusus	Ranunculaceae	I, II, III	AH	Abundant	
Ranunculus laetus	Ranunculaceae	I	PH	Rare	
Raphidophora glauca	Araceae	I, II, III	Epiphyte	Less common	
Reevesia pubescens	Sterculiaceae	II, III	Tree	Rare	
Reissantia arborea	Hippocrateaceae	III	Tree	Rare	
Rhododendron arboreum	Ericaceae	I, II, III	Tree	Abundant	
Rhododendron campanulatum	Ericaceae	I	Tree	Less common	
Rhododendron cinnabarinum	Ericaceae	I	Tree	Common	
Rhododendron dalhousie	Ericaceae	I, II	Shrub	Common	Endemic
Rhododendron decipiens	Ericaceae	I, III	Tree	Less common	Endemic
Rhododendron falconeri	Ericaceae	I, III	Tree	Less common	Endemic
Rhododendron grande	Ericaceae	I, II, III	Tree	Rare	
Rhododendron hodgsonii	Ericaceae	I, III	Tree	Less common	
Rhus chinensis	Anacardiaceae	II, III	Tree	Less common	
Rhus succedanea	Anacardiaceae	I, II, III	Tree	Common	
Ricinus communis	Euphorbiaceae	I, II, III	Shrub	Common	
Rorippa indica	Brassicaceae	I, II, III	AH	Common	
Rosa sericea	Rosaceae	I	Shrub	Less common	
Rubia manjith	Rubiaceae	I, II, III	AC	Abundant	
Rubia wallichiana	Rubiaceae	I	AC	Less common	
Rubus acuminatus	Rosaceae	III	Shrub	Less common	
Rubus calycianus	Rosaceae	I, II, III	US	Common	
Rubus efferatus	Rosaceae	I, II, III	Shrub	Less common	
Rubus lineatus	Rosaceae	I, II, III	Shrub	Common	
Rubus paniculatus	Rosaceae	I, II, III	Shrub	Common	Endemic
Rubus rugosus	Rosaceae	I, II	Shrub	Abundant	
Rubus senchalensis	Rosaceae	I, II	Shrub	Rare	Endemic
Rubus splendidissimus	Rosaceae	I, III	Shrub	Rare	Endemic
Rumex nepalensis	Polygonaceae	I, III	PH	Abundant	
Rungia pectinata	Acanthaceae	II, III	AH	Abundant	
Saccharum aurundinaceum	Poaceae	II, III	PH	Common	
Saccharum langesetosum	Poaceae	I, II, III	PH	Common	
Saccharum spontaneum	Poaceae	I, III	PH	Abundant	
Salix salwinensis	Salicaceae	III	Tree	Rare	
Salix tetrasperma	Salicaceae	II, III	Tree	Rare	
Sambucus canadensis	Sambucaceae	I, II, III	Shrub	Common	
Sambucus hookeri	Sambucaceae	I	Shrub	Less common	
Sapindus mukorossii	Sapindaceae	III	Tree	Less common	
Sapium eugeniifolium	Euphorbiaceae	II, III	Tree	Less common	
Sarcochlamys pulcherrima	Urticaceae	III	Shrub	Rare	Endemic

Plants	Families	Corridors where present	Habita	Availability status	Endemic Status
Satyrium nepalense	Orchidaceae	I, II, III	GH	Less common	
Saurauja nepalensis	Actinidaceae	II, III	Tree	Common	
Saurauja roxburghii	Actinidaceae	II, III	Tree	Less common	Endemic
Sauropus quadrangularis	Euphorbiaceae	II, III	Shrub	Common	
Schefflera bengalensis	Araliaceae	I, II, III	Epiphyte	Abundant	
Schefflera elata	Araliaceae	II, III	Epiphyte	Less common	
Schima wallichii	Theaceae	II, III	Tree	Abundant	
Schisandra grandiflora	Schisandraceae	I, III	SC	Rare	
Schisandra neglecta	Schisandraceae	I, III	SC	Common	
Schisandra propinqua	Schisandraceae	I, II, III	SC	Common	
Scrophularia uticacefolia	Scrophulariaceae	III	AH	Less common	Endemic
Sechium edule	Cucurbitaceae	I	GC	Abundant	
Sedum multicaule	Crassulaceae	I	PH	Common	
Selinum tenuifolium	Apiaceae	I, III	AH	Less common	
Semecarpus anacardium	Anacardiaceae	II, III	Tree	Less common	
Senecio chrysanthemoides	Asteraceae	I	AH	Less common	
Senecio diversifolius	Asteraceae	I	AH	Common	
Senecio scandens	Asteraceae	I, II, III	AH	Common	
Setaria pulmifolia	Poaceae	I, II, III	AH	Abundant	
Setaria glauca	Poaceae	II, III	AH	Abundant	
Shorea robusta	Dupterocarpaceae	II, III	Tree	Abundant	
Shuteria hirsuta	Leguminosae	II, III	AC	Less common	
Sida acuta	Malvaceae	II, III	AH	Abundant	
Sida rhomboidea	Malvaceae	II, III	PH	Abundant	
Sida spinosa	Malvaceae	II, III	AH	Less common	
Smilax ferox	Smilacaceae	I, II, III	SC	Common	
Smilax minutiflora	Smilacaceae	I	US	Rare	
Smilax rigida	Smilacaceae	I	US	Rare	
Smilax zeylanica	Smilacaceae	II, III	SC	Common	
Solanum erianthum	Solanaceae	II, III	AH	Common	
Solanum myriacanthum	Solanaceae	II, III	AH	Abundant	
Solanum nigrum	Solanaceae	I, II, III	AH	Common	
Solanum torvum	Solanaceae	II, III	Shrub	Common	
Sorbus cuspidata	Rosaceae	I	Tree	Common	
Sorbus microphylla	Rosaceae	I	Tree	Common	
Spiranthes australis	Orchidaceae	I, II, III	GH	Common	
Spirea micrantha	Rosaceae	I	Shrub	Rare	Endemic
Stellaria lanata	Caryophyllaceae	I	AH	Rare	Endemic
Stellaria media	Caryophyllaceae	I, II, III	AH	Abundant	
Stellaria sikkimensis	Caryophyllaceae	I, II, III	AH	Common	Endemic
Stellaria vestita	Caryophyllaceae	II, III	AH	Rare	
Stephania hernandifolia	Menispermaceae	II, III	GC	Common	
Stercula villosa	Sterculiaceae	II, III	Tree	Common	
Stereospermum chelonodes	Bignoniaceae	II, III	Tree	Less common	
Stereospermum colais	Bignoniaceae	III	Tree	Common	
Streptolirion volubile	Commelinaceae	I, II, III	AC	Common	
Strobilanthes capitata	Acanthaceae	II, III	US	Common	
Strobilanthes roseus	Acanthaceae	I, III	US	Less common	
Strobilanthes thomsonii	Acanthaceae	II, III	US	Less common	Endemic

Plants	Families	Corridors where present	Habita	Availability status	Endemic Status
Swertia chirayita	Gentianaceae	I, II	PH	Endangered	
Swertia dilatata	Gentianaceae	II, III	AH	Rare	
Symplocos cochinchinensis	Symplocaceae	II, III	Tree	Common	
Symplocos theaefolia	Symplocaceae	I, II, III	Tree	Common	
Syzgium operculatum	Myrtaceae	II, III	Tree	Common	
Syzigium claviflorum	Myrtaceae	II, III	Tree	Rare	
Syzigium formosum	Myrtaceae	II, III	Tree	Less common	
Talauma hodgsonii	Magnoliaceae	II, III	Tree	Common	
Taxus baccata ssp wallichiana	Taxaceae	I, III	Tree	Endangered	Endemic
Tectona grandis	Verbenaceae	II, III	Tree	Abundant	
Terminalia alata	Combretaceae	II, III	Tree	Abundant	
Terminalia arjuna	Combretaceae	II, III	Tree	Abundant	
Terminalia bellirica	Combretaceae	II, III	Tree	Abundant	
Terminalia chebula	Combretaceae	II, III	Tree	Rare	
Terminalia myriocarpa	Combretaceae	II, III	Tree	Common	
Tetrameles nudiflora	Datiscaceae	II, III	Tree	Rare	
Tetrasera sermentosa	Dilleniaceae	II, III	SC	Rare	
Tetrastigma bracteolatum	Vitaceae	I, II, III	SC	Abundant	Endemic
Tetrastigma campylocarpum	Vitaceae	II, III	Liana	Common	
Tetrastigma planicaule	Vitaceae	II, III	Liana	Endangered	
Thunbergia coccinea	Acanthaceae	I, II, III	SC	Common	
Thunbergia fragrance	Acanthaceae	II, III	SC	Abundant	
Thunbergia lutea	Acanthaceae	II, III	SC	Less common	Endemic
Thysanolaena maxima	Poaceae	I, II, III	PH	Abundant	
Toona ciliata	Meliaceae	II, III	Tree	Common	
Toona sureni	Meliaceae	III	Tree	Rare	
Torenia penducularis	Scrophulariaceae	I, II, III	AH	Abundant	
Trachycarpus martianus	Arecaceae	II, III	Tree	Common	
Trewia nudiflora	Euphorbiaceae	II, III	Tree	Common	
Trichosanthes lepiniana	Cucurbitaceae	I, II, III	Liana	Abundant	
Trichosanthes tricuspidata	Cucurbitaceae	I, II, III	Liana	Less common	
Tridax procumbens	Asteraceae	II, III	AH	Common	
Trifolium repens	Leguminosae	I, II, III	AH	Abundant	
Tsuga dumosa	Pinaceae	I, III	Tree	Less common	
Turpina pomifera	Staphyleaceae	I, II, III	Tree	Less common	
Uncaria sessilifructus	Annonaceae	II, II	SC	Less common	Endemic
Urnea lobata	Malvaceae	II, III	AH	Abundant	
Urtica dioica	Urticaceae	I, II, III	Shrub	Abundant	
Urtica parviflora	Urticaceae	I, II, III	Shrub	Abundant	
Uvaria lurida	Annonaceae	II, III	Shrub	Less common	
Vaccinium pedata	Vacciniaceae	I	Shrub	Rare	
Vaccinium retusum	Vacciniaceae	II, III	Shrub	Common	Endemic
Vaccinium serratum	Vacciniaceae	I, II, III	Epiphyte	Common	
Valeriana hardwickii	Valerianaceae	I, II, III	AH	Common	
Vallaris solanacea	Apocynaceae	II, III	SC	Common	
Vanda teres	Orchidaceae	II, III	Epiphyte	Common	
Vandopsis undulata	Orchidaceae	I, II, III	Epiphyte	Less common	
Ventilago denticulata	Rhamnaceae	II, III	Liana	Rare	
Vernonia lobata	Asteraceae	III	Shrub	Rare	

Plants	Families	Corridors where present	Habita	Availability status	Endemic Status
Veronica javanica	Scrophulariaceae	I, II, III	AH	Abundant	
Viburnum erubescens	Caprifoliaceae	I, III	Tree	Abundant	
Viburnum paniculatus	Caprifoliaceae	I	Tree	Rare	
Viola diffusa	Vialaceae	II, III	AH	Common	
Viola hookeri	Vialaceae	I, III	PH	Endangered	Endemic
Viola serpens	Vialaceae	I, II, III	PH	Abundant	
Vitex negundo	Verbenaceae	II, III	Shrub	Abundant	
Vitex quinata	Verbenaceae	III	Tree	Rare	
Wallichia densiflora	Arecaceae	II, III	Shrub	Less common	
Wallichia disticha	Arecaceae	II, III	Shrub	Rare	
Wendlandia coriacea	Rubiaceae	II, III	Tree	Less common	Endemic
Wendlandia wallichii	Rubiaceae	II, III	Tree	Less common	Endemic
Wrightia arborea	Apocynaceae	II, III	Tree	Common	
Wrightia speciosissima	Apocynaceae	II, III	Tree	Rare	
Yushania maling	Poaceae	I, II, III	Shrub	Common	
Zanthoxylum acanthopodium	Rutaceae	I, II, III	Shrub	Common	
Zanthoxylum armatum	Rutaceae	II, III	Liana	Rare	
Zeuxine affine	Orchidaceae	I, II, III	GH	Rare	
Zeuxine goodyearoides	Orchidaceae	I	GH	Rare	

[a] AH= annual herb, AC= annual climber, GC= geophytic climber, GH= geophytic herb, PC= perennial climber, PH= perennial herb, RP= root parasite, SC= shrubby climber, SS= suffrutescent shrub, US= undershrub

Section 3

Socioeconomic and Livelihoods Aspects

Bandana Shakya

Landscape Elements and Agricultural Issues in the Border Villages of Eastern Nepal

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Eco-restructuring of the landscape with conservation-friendly interventions is the best compromise between ecological and economic needs and should be emphasised to strengthen ecosystem functioning and improve the economy.

Introduction

The eastern Himalayan regions of Nepal are bordered by India to the east and south and China to the north. This is an important transboundary area which needs immediate attention in terms of effective conservation measures (Pei and Sharma 1998; HMGN/MFSC 2002). Due to the extremely rugged and remote terrain on the northern border, there is less interaction with local people in China compared to the interaction with India. The balanced geographic and topographic conditions in eastern Nepal have led to the formation of extensive vegetation (WWF and ICIMOD 2001). Commercial exploitation of forest and agricultural land, however, has put pressure on the natural resources in the area. The major objective of this work was to collect and analyse field-based data about landscape elements, focusing mainly on land-use

patterns, agroforestry, and livestock management practices and the associated transboundary conservation and management issues.

The study was carried out in 12 village development committee areas (VDCs) in Ilam and Panchthar districts representing border corridors between India and Nepal. Seven of the 12 VDCs were selected from Ilam districts: Maipokhari, Maimajuwa, Maabu, Jamuna, Pyang, Gorkhe, and Sri Antu. Five VDCs were chosen from Panchthar district: Memeng, Siding, Prangbung, Changthapu, and Falaicha. Extensive field and household level surveys, focus group discussions, and a literature review were carried out for the data collection.

Landscape Elements

The landscape elements described here broadly include vegetation types, population characteristics, land-use patterns, and agricultural and livestock productivity in the two districts.

Vegetation

Ilam and Panchthar are similar in altitude and the following categories of vegetation apply to both districts (DFO/Ilam 2001 and DFO/Panchthar 2003).

The tropical zone extends up to 1,000 masl with mixed tropical forest dominated by sal (*Shorea robusta*). The subtropical zone extends from 1,000 to 2,000m with mixed forest mainly dominated by *Machilus, Castanopsis*, and *Michelia*. The temperate zone extends from 2,000 to 3,000m and includes forest with *Machilus, Quercus, Pinus*, and *Rhododendron*. The subalpine zone extends from 3,000 to 3,700m. Forest vegetation in this zone includes *Rhododendron, Betula, Pinus*, and *Juniper*.

Demography and land-use pattern

The two districts are home to about 58 ethnic groups with diverse and rich cultures and traditions. The cultural integrity amongst these diverse communities and their vast knowledge about natural resources are indicative of rich indigenous knowledge and technologies. Functionally, traditional institutions such as 'kiduk' (among the Sherpas) and 'kipat' (among the Limbus) are most notable. The 'kipat' system is a form of communal land ownership through which families hold land titles. This system is still prevalent in terms of regulating pastures and the use of forest products (Kollmair et al. 2003).

The pattern of land use shows a greater proportion of land under forest use (about 47%) in Ilam district and of arable lands (51.83%) in Panchthar district. The lower farmlands (1000-2000m) in Ilam were observed in relation to the conversion of arable land into community forest. The area is rich in natural water resources with plenty of lakes, streams, and freshwater river systems. The land-use pattern has been gradually changing in both districts. In Ilam, the area of 'khet' (irrigated arable land) land is decreasing giving way to unirrigated arable land under cash crops such as large cardamom, broomgrass, and tea. The area under 'kharbari' or private forest has nearly doubled. The local practice of converting maize fields into rice fields

wherever water is available has helped increase land fertility by limiting sheet and rill erosion. With the emergence of community forestry, alder and pine trees have been planted on barren land. Land cultivated with bamboo is also increasing due to its religious association and multiple uses.

Cropping system

As these are agrarian districts, the agricultural system forms an integral part of local livelihoods. Agricultural and horticultural crops in this region include rice, wheat, maize, legumes, oilseed, jackfruit, pineapples, and mangoes. Commonly-cultivated crops and fruits and their corresponding productivity in the two districts (DADO/Ilam 2002 and DDC/Pancthar 2002) are shown in Table 1.

There is a clear indication that the cropping areas and productivity of cereals and potatoes are higher in Ilam than in Panchthar, whereas Panchthar district shows a better potential for fruit cultivation. Farmers are gradually avoiding exhaustible and labour-intensive crops like wheat and finger millet and are more inclined towards growing cash crops, such as large cardamom, alongside the irrigated rice fields. The border villages have also begun growing vegetables and flowers on a commercial scale.

Table 1: **Commonly cultivated crops and fruit and their productivity in the two districts**

Crops	Ilam		Panchthar	
	Area (ha)	Productivity (t/ ha)	Area (ha)	Productivity (t/ ha)
Rice	1,090	2.62	505	1.5
Irrigated rice	19,365	1.89	5,400	1.6
Non-irrigated rice	12,875	183	831	1.5
Maize	31,330	181	17,282	1.57
Wheat	4,592	1.69	4,094	1.4
Millet	3,290	1.04	5,959	1.03
Barley	71	1.0	525	1.03
Pulses	1,238	0.93	2,060	0.59
Oil crops	718	0.92	849	0.62
Sugarcane	13	35.5	65	33
Fruit	565	8	1,540	10.8
Orange	235	10.25	296	12
Vegetables	2,005	10.56	619	12
Potato	6,595	12.85	85	12
Cardamom	2,750	0.5	2,150	0.6
Ginger	1,976	14.25	132	12
Tea	1,951	2.87	403	1.2

Livestock production systems

Livestock form an integral part of the farming system in these two districts. Common locally-bred livestock breeds include cattle, buffalo, goats, sheep, pigs, fowl, horses, and yaks. Among the livestock-based products, cow's milk brings the highest income. Other favoured products are live animals, eggs, butter, and cheese. Grazing is reported on lands above 2,500m. These pastures are deteriorating in terms of area and pastoral species due to the increase in land used for private and community forestry practices and overgrazing by animals.

Agroforestry system

The communities living in the study area are extremely dependent on forest resources for their subsistence (Box 1). Many communities living in and around the protected areas are fully or partially dependent on such resources. In many cases, however, they are practising agroforestry on their own farmland, private forestland, and community forests. Many species are recorded from these agroforestry systems in which fodder (*Ficus nemoralis, Saurauria nepalensis, Dendrocalamus species,* and *Arundanaria* species); timber (species of *Michelia, Castanopis,* and *Alnus nepalensis*); and fuelwood (*Alnus nepalensis, Schima wallichii,* and *Macaranga pustulata*) are all found in the same system. Apart from these, many medicinal plants, large cardamom, broom grass, and tea are planted as cash crops.

Box 1: Forests under pressure

According to the Ilam District Development Committee (DDC) in 2001, the heavy pressure on forests is due to illegal cutting and export of timber as well as dependency on firewood for rural energy, and extensive collection of fodder, green manure, and non-timber forest products (NTFP). The encroachment by people converting these forest areas to agricultural land is also significant.

Agricultural and agroforestry products and their marketing channel

The major agricultural products are cereals, vegetables, cash crops (large cardamom, ginger, potatoes, local chillies, and brooms), and fruit. In addition, livestock and livestock products, herbal products, and timber also are in demand in the market. The trade in cereals is negligible due to their meagre, subsistence-level production. Farmers make efforts to sell their goods to local market centres as far as possible, thereafter reaching outside markets in urban centres and across the border in Darjeeling and Siliguri in India where they earn more profit (Figure 1).

Governance and management needs

The communities are asking for training in both agroforestry and livestock management. For agroforestry, the training required is on seed production and collection, nursery management, harvesting, and pruning of fodder vegetation. Regarding livestock development, the felt need is for training in feeding requirements, disease control, breed improvement, housing, forage production, fodder enrichment, and training for women in livestock management and time-saving technologies. The prevailing government management practices also give very little incentive for harnessing local potential.

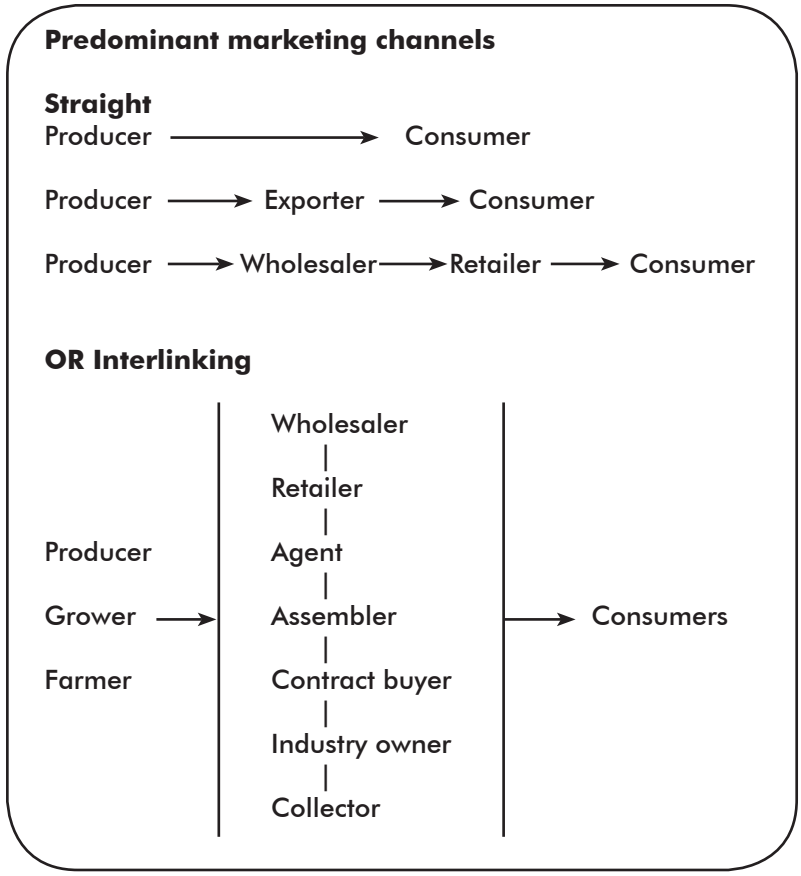

Figure 1: predominant market channels for goods in the study area

Ecosystem services

The whole study area is an important watershed for people downstream. It is the source of irrigation and clean drinking water. Assessing the potential of agroecosystems, it appears that small farmers are unable to meet their farm and household requirements due to limited access to resources and lack of other income-generating activities. As a result, the whole watershed is deteriorating at an unprecedented rate. The local communities are experiencing acute shortages in availability of natural resources. Hence, there is an urgent need for an integrated approach to resource management. This might improve ecosystem services in the study area.

Transboundary conservation and management issues

Rich vegetation of economic importance and the open border situation make these two districts a very important transboundary area for conservation and management of the landscape. Some of the major transboundary issues related to agroforestry, agriculture, and livestock activities include the excessive use of fertilizer and pesticides, declining agricultural production, poor management of cash crops, cultivation on marginal lands, biodiversity degradation, deforestation, declining livestock productivity, overgrazing in the upper belt, erosion due to

road construction, illegal trade in herbal plants and timber, poaching of animals, uncertain markets due to heavy reliance on the international market, and problems in the formation of local and regional cooperatives. Many local institutions are working in the area for conservation but with limited success (Box 2).

Box 2: Local institutions

There are 225 NGOs registered in Panchthar, among which only a few such as, Durdimba Jnachetana Samuha; Amapur Yuva Bikash Mancha; Hariyali Samaj Sewa Bikash Club; Chiya Krishak Samuha, and a few others have agricultural initiatives. In Ilam, important agriculture-based NGOs include Namsaling Samudaik Bikas Kendra; Nepal Resham Sangh; Mahila Jagaran Sangh; Ilam Sahayog Parishad; and Jun Tara Yuva Club.

Potential for Eco-restructuring the Landscape

Based on current land-use practices, it is essential to focus on agricultural development through improvements in irrigation, agricultural extension, timely input and credit supplies, and development of infrastructure to address the issues of poverty and the depletion of resources. The four important foci for eco-restructuring – entrepreneurship development, provision of reliable marketing, an integrated approach to conservation, and judicious use of natural resources – are essential. The following recommendations are made for eco-restructuring of the landscape in the two districts.

- Plant vegetation, such as broom grass and bamboo, to reduce soil erosion on sloping, marginal land
- Adopt mixed cropping to increase soil fertility and agricultural productivity
- Encourage integrated pest management
- Encourage organic farming
- Design an agroforestry policy to upgrade the economy and the environment
- Provide training on modern techniques to raise productivity in farming, agroforestry, forestry, and animal husbandry
- Establish rural development committees or organisations to facilitate credit systems and market flows.

Conclusion

The distinct features of these two districts, which are an important part of the proposed Kangchenjunga landscape, indicate the potential for high agricultural productivity in agroforestry and forest and livestock products. These areas have great scope for increasing farm and agroforestry productivity on individual farmers' land, provided issues related to land tenure and ownership, marketing mechanisms, and decision-making processes are improved. The conversion of degraded government forests into community forest plots is encouraging. Improvement in animal breeding and grazing systems will facilitate livestock management and increase productivity. The beautiful forest cover and scenic landscape also have prospects for ecotourism which can provide employment opportunities for local people and encourage local enterprises.

Most farmers, although illiterate and lacking in modern skills and knowledge, have been using their local knowledge since time immemorial. Special attention needs to be paid to harness such local potential and knowledge. A good mix of local potential and support from government, non-government and international organisations are needed for sustainable development of the local community, the two districts, and the eastern Himalayan corridors as a whole.

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Pasture, Livestock, and Conservation: Challenges in the Transborder Areas of Eastern Nepal

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The challenge lies in improving the livelihoods of mountain people without increasing pressure on pastures.

Introduction

Kangchenjunga landscape has a vast extent of open meadows, traditionally used by both wild and domestic herbivores. It is an important transboundary area in terms of conservation (LRMP 1986; Pei and Sharma 1998; HMGN/MFSC 2002). This study looks into biodiversity in the context of grazing and livelihood issues (Box 1) and their impact on pastureland in Ilam, Panchthar, and Taplejung districts, especially in the transborder areas within 10km of the international eastern border of Nepal. These transborder areas include 10 village development committee areas or VDCs in Ilam (Maimajhuwa, Mabu, Jamuna, Pyang, Jogmai, Ghorkje, Pashupatinagar, Shree Antu, Samalbung, and Jirmale), nine VDCs in Taplejung (Lelep, Olanchungola, Papung, Mamanhake, Khawang, Yamphudin, Susrungkhim, Kalikhola, and Sadawa), and five VDCs in Panchthar (Parangbung, Memeng, Chyangthapu, Phalicha, and Siding). The total area of approximately 2,975 sq.km covered by the transborder VDCs account for 44% of the total land area in the three districts.

Box 1: Transhumance migration

The annual cycle of transhumance migration of grazing animals begins from mid March, moving from sub-tropical grazing areas to temperate pasture or 'lekhali kharka' by mid May. The cattle and 'pahadi' (temperate) goats remain at the higher altitudes until September, while sheep, 'lekhali' (subalpine) goats, and yaks are moved further up to 'himali' (subalpine and alpine pastures). During the colder months, yak and sheep are wintered in the temperate pastures and the other species are brought back to subtropical areas.

The crop and livestock system includes several ruminants (cattle, buffaloes, sheep, and goats) and other monogastric animals (poultry and pigs). Almost all the farms in the three districts and adjoining transborder areas are small family-run private farms that raise both crops and livestock. Livestock in the areas are extremely mobile and follow a transhumance pattern of movement between the villages of origin and the northern and eastern borders. With the development of a livestock extension service system, many exotic animal breeds, such as Hill Zebu cross and Taurine cattle breeds, and Pahadi Bakhro and cross Jamuna Pari Sindal goat breeds, have been reared along with a large population of native species.

The livestock are fed on crop residues, native forage, tree fodder, and pasture grasses. Pastures in the area can be divided into alpine and subalpine pastures or 'himali kharka' (at 3,500-5,000m), temperate pastures or 'lekali kharka' (at 2,000-3,500m), and subtropical rangelands (at 1,500-2,000m). The highest proportion of pasture is in Taplejung (13%) and the lowest in Ilam (3%). The proportion of agricultural land varies from 1.5% in Taplejung to 42% in Ilam (Table 1).

Table 1: **Major land uses in the transborder area (%)**

Land-use category	Ilam	Panchthar	Taplejung
Agriculture	42	26	1.5
Forest	36	54	19
Shrub	18	11	10
Pasture	3	8	13
Permanent snow	0	0	20
Other	1	1	37

Source: Calculated from LRMP1979 data, ICIMOD

The agricultural system is complex and labour intensive as it integrates irrigated and rainfed farmland, livestock rearing, use of forest products, and household labour. The cropping system depends on three growing seasons: pre-monsoon (February-March), monsoon (June-September), and winter (October-January). About 60% of farmers grow local crop cultivars of rice, maize, barley, buckwheat, and other minor crops and legumes; but improved cultivars have been slowly replacing economically less promising crops.

The process of land ownership and tenancy rights followed the 'kipat' system (Box 2) until the Birta Unmulan Act of 1965 and the Pastureland Nationalisation Act of 1975. The 'de jure' right of 'kipatiyas' or other locals to pastures were then vested in the government. In some remote mountain areas, a 'de facto' kipat system is still prevalent.

Box 2: Land ownership in east Nepal

There was a practice among the early settlers to claim rights to the land they cleared for cultivation and regeneration known as 'kipat'. Ownership of most of the land resources was given to the 'kipatiyas' commonly designated as 'jimmawal' among higher castes such as the Chhetris and Brahmins, 'subba' among the Limbus, and 'goba' among the Sherpas. They were also commonly known as 'mukhias'. The transfer of land ownership from 'kipatiyas' to new settlers was complex and needed a final signature from the 'subba' and other locally-established functionaries.

Conservation and Development Issues

Livestock management

In the three districts, livestock constitute a formidable part of the rural economy, helping people cope with inflation, crop failure, and expenses related to children's education, health, and marriage. The communities depend on local breeds of animals for their subsistence (Table 2). Intensive animal husbandry involves various feeding practices that are ultimately related to the availability of pastures and open meadows. Among the three districts, stall feeding is more prevalent in Ilam, partial stall feeding in Panchthar, and partial stall and migratory feeding in Taplejung (Table 3).

The traditional transhumance grazing method is practised throughout much of the high-altitude grazing lands. The grazing lands are constantly subjected to changes affecting their succession processes. The aggressive growth of weeds resulting from heavy grazing of palatable species has caused loss of pasture biodiversity and livestock productivity.

Table 2: **Species of livestock in the three districts (%)**

Animal species	Ilam	Panchthar	Taplejung
Local cattle	64	97	96
Improved cattle	36	3	4
Local buffalo	79	96	96.4
Improved buffalo	21	4	3.6
Local goats	76	97	97
Improved goats	24	3	3
Local sheep	94	100	99
Improved sheep	6	-	<1
Local pigs	77	94	40
Improved pigs	23	6	60
Local poultry	85	99	70
Improved poultry	15	1	30

Sources: Anonymous 2001a,b; Anonymous 2002

Table 3: **Animal rearing system in the study area (%)**			
Rearing system	**Ilam**	**Panchthar**	**Taplejung**
Stall feeding	62	27	20
Partial stall feeding	24	57	44
Scavenging	5	7	9
Migratory	9	9	27
Source: Field survey 2003			

Landslides in some areas have caused loss of the original pasture giving way to vegetation with less forage value. In addition, grazing results in continuous defoliation of palatable species rendering the habitat open to invasive weed species.

Land Tenure and Pasture Management

Alpine and subalpine pastures are important common property resources for grazing, mainly transhumance grazing. Warm temperate rangelands, however, are used extensively by both transhumance and stall feeders without resting periods or regeneration of pasture species. Similarly, subtropical rangelands are used extensively in the winter months. Implementation of the community forestry policy has brought about conversion of open pastures at lower elevations to forests, suppressing the growth of desirable pasture species under the forest canopy. The community forestry policy and the new legislation on land administration have dismantled traditional pasture management practices.

In some areas, community forestry user groups (CFUGs) forbid the use of traditional migratory routes by animal herders. With the abolition of kipat and customary arrangements, the sense of ownership and affection of the traditional community for their inherited pastoral resources weakened, leading to haphazard grazing and mismanagement of pastures.

Protected areas and transborder grazing system

The ban of transborder use of pastureland by the Chinese and Nepalese governments in 1978 had the greatest impact on Taplejung and parts of Chyangthapu and Phalaincha VDCs in Panchthar districts. It forced the opening of inaccessible and fragile high-altitude areas for animal grazing. Further, with the increase in conservation areas in India (Box 3), options for yak

Box 3: Transborder issues and the national parks

The notification of Singhalila National Park in Darjeeling (India), adjacent to Panchthar and Ilam districts, imposed intensive grazing pressure on the pasturelands of Nepal. In addition, community forest management is failing in transborder areas due to growing market incentives on the other side of the border and willingness of user groups to support illegal harvesting and transport of forest products across the border. With every incentive for using pasture and other forest resources on the weaker non-vigilant side of the Nepalese border, the traditional transboundary resource sharing system is weakening. The landscape demands appropriate government guidelines and awareness at local, regional, national, and international levels.

grazing became limited, and yaks were brought to 'lekali kharka' in Nepal, where grazing sites were already overstocked, for wintering. Traditionally, herders from the transborder area have enjoyed the privilege of an open border that allowed local herders to graze their animals on pastures within 10 km of the border in either country. Sociocultural integrity among the communities living in border areas has provided opportunities for sharing resources on both sides of the border. The system is breaking down because of dual citizenship and property rights. This issue is becoming more conspicuous among the communities living on either side. Departure from the traditional sharing of transborder resources took place when the increasing problem of dual citizenship and property rights led to improper and unequal management of forest and grazing resources.

Some of the early migrants from Tibet, who managed to acquire citizenship in both Nepal and India, brought along Tibetan culture and knowledge about rearing yaks and hunting for high-altitude wildlife, herbs, and medicinal plants. Over time, these settlers migrated to urban centres of Nepal and India, but still invested in settlement of newcomers along the transborder areas, leading to continuing pressure on pastures. To ensure the continued flow of yak products for their businesses, wealthy people from urban centres hired middlemen who were in charge of rearing herds across transborder areas. Similarly, rich people from either side provided incentives to traditional mobile hunters to capture and hunt barking deer, wild boar, and red panda in such areas: these fetched high prices in the urban markets of India. The illegal harvest of fresh small bamboo shoots, other non-timber forest products, and medicinal plants by mobile hunters has also been rising.

Recommendations: Ensuring Environmental and Livelihood Sustainability

Pastureland management

Pastures are managed as common property resources and ownership is mainly in the hands of government agencies. This should be reverted in favour of local communities. This means revamping existing policies and the legal apparatus in favour of the people. For the conservation of pastoral biodiversity in these areas, transboundary areas within Nepal need to be brought under an appropriate legislative framework of conservation area management in conformity with the traditional knowledge and customary laws of local institutions.

Discussions about transborder cooperation have already started between PR China, India, and Nepal to frame a common policy towards bringing potential border areas into the transboundary conservation landscape (WWF and ICIMOD 2001). Rehabilitation of degraded pasturelands needs to be carried out with modern techniques of pasture management such as rotational grazing, differed grazing, mechanical weed control, turf planting, reseeding with palatable native plant species, and co-management and multiple-use concepts.

Livelihood options

In the three districts, where earnings from livestock are crucial, ensuring livelihood sustainability without deterioration in pastoral resources is a challenge to both the local community and

development agencies. Well-planned co-management and multiple-use initiatives involving local communities could open up new livelihood options and, at the same time, reduce pressure on pastoral resources. One example is farming under forest canopies. Cardamom plantation under alder trees is an ecologically-stable farming system that has greatly improved the local economy. Similarly, broom grass, Napier, and molasses planted along terrace risers have provided fodder for livestock in the mid-hills. Conservation of native animal species and their genetic resources by rearing the threatened local black hill pigs, local goats such as 'sindhal' and the cross-bred mid-hill 'phadi' has potential for significant economic gains. Lastly, the three districts in eastern Nepal, despite many shortfalls in the planning and management of land, still receive tourists because of their panoramic mountain views and pristine culture. Organising the tourism industry in line with environmental conservation will bring about improvements in living standards.

Conclusion

The fundamental problem associated with growth in the livestock industry in Ilam, Panchthar, and Taplejung districts in eastern Nepal is poor animal nutrition caused by high-stocking density and poor management of pastoral biodiversity. Extensive and illegal harvesting of pastoral resources from fragile mountain pastures are grave issues that need prompt attention. Regarding the management of natural resources through protected areas, Taplejung, Panchthar, and Ilam districts present strong evidence about how PAs situated along the border of a neighbouring country, if not extended to areas in the other country, can exert tremendous pressure on pasture and fodder biodiversity in non-protected landscapes. These PAs in themselves are not enough to ensure sustainable management of environmental resources and an integrated approach is needed in which environment, wildlife, livestock, and local human communities co-exist in harmony.

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Vegetable Production as a Potential Enterprise for Sustainable Livelihoods in the Border Villages of Eastern Nepal

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There is a great potential for vegetable production as an enterprise in the study area but improved technology in micro-irrigation and off-season vegetable seed production, along with development of marketing channels and infrastructure, are needed.

Introduction

The livelihoods of a majority of the people in Nepal revolve around agriculture. The agricultural sector accounts for about 39% of the gross domestic product and provides employment to more than 80% of the labour force. Agricultural production, however, is to a great extent subsistence oriented. The cultivable land area is estimated to be 26,533 sq.km, roughly 18% of the total land area of the country; the terai region accounts for the major share of agricultural land (HMGN/MFSC 2002). A variety of agroclimatic regions and fertile soils permits the production of a wide variety of vegetables of good quality in Nepal. At present 200 varieties of vegetables are grown, out of which only about 50 are cultivated on a commercial scale.

Vegetables can, in fact, give a much higher return per unit of land than cereals and are worth growing even in small quantities. The difficulties arise over marketing. The transport of delicate, perishable goods grown in remote and hilly terrain is a difficult task. For individual growers cultivating vegetables on a small plot of land, the quantity ready for sale at any one time is limited and, if the trek to market is long and difficult, then it will not be worthwhile. Hence, access to roads and markets is most important if vegetable production is to be established on a commercial scale. There is also great potential for seed production; lhe pockets of microclimates separated by high mountains provide an ideal environment for this. In remote places without road access, vegetable seed production is a promising option for poverty reduction as the volume to be transported is much less than for fresh vegetables but of higher value. Good potential exists in Nepal for the establishment of vegetable seed farms catering to both domestic and foreign markets.

Most people in the Ilam and Panchthar districts of eastern Nepal earn their living from agriculture. To a great extent, agricultural production is for subsistence only. About 60% of the households in Jirmale, Samalbung, Sriantu, and Swoyang VDCs are completely self-sufficient in terms of producing their own food. In the remaining VDCs, self-sufficiency in food ranged from rather insufficient to around 50%. The situation in other remote VDCs of Panchthar and Taplejung is very bad. Due to remoteness and inaccessibility there are limited opportunities for people to overcome acute poverty. To examine these issues, comprehensive research was undertaken covering 15 VDCs in Ilam and Panchthar districts in 2003.

The overall objective of the research was to assess the present status and future potentials of vegetable production as an enterprise in the study sites. Special emphasis was given to understanding a) land use and size of landholdings in the communities in the selected VDCs; b) current seasonal and off-seasonal vegetable cultivation and household incomes; c) present market linkages for farm produce (vegetables and other produce like cardamom and broom grass) and the challenges; d) potential for crop diversification with a focus on vegetable and vegetable seed production as an opportunity for enterprise development ; and e) identification of issues and challenges.

Land Use and Size of Land Holdings

Ilam has a total geographical area of 1,717 sq.km of which more than 50% is covered by forest. Only about 26% of the area is cultivated. In Panchthar district, out of 1,246 sq.km, forest cover is about 46% and about 33% of the area is cultivated. The details are given in Table 1. Out of the total cultivated land available in the two districts (860 sq.km), only 15% (132 sq.km) is used for cultivation of vegetables, the remainder is used for paddy rice or agroforestry (Table 2). The highest amount of cultivated land was recorded in Chyangthapu (17.5 sq.km), followed by Jamuna (16.6 sq.km) and Pashupati Nagar (14.1 sq.km). The size of holdings is high (>2ha) among farmers in Maipokhari, Jogmai, Jirmale, and Sriantu VDCs whereas among other farmers the size was between one and two hectares per household. Irrigated land ('khet') was available only in limited places whereas unirrigated ('bari') was more predominant. The system of private land leasing amongst agricultural communities is not very common in this area.

Table 1: **Land-use patterns of the study districts**

Land type	Ilam	Panchthar
	Area (sq.km)	Area (sq.km)
Cultivated area	448 (26.1%)	412 (33.1%)
Non-cultivated area	228 (13.3%)	190 (15.3%)
Forest area	959 (55.9%)	577 (46.3%)
Grazing land	34 (2.0%)	53 (4.2%)
Other	49 (2.8%)	13 (1.1%)
Total geographical area	**1717**	**1246**

Table 2: **Total cultivated area by land type classification**

District	VDC	Total cultivated area in sq.km		
		Khet	Bari	Total
Ilam	Maipokhari	0.5	9.5	10.0
	Maimajhuwa	0.0	3.2	3.3
	Mabu	1.8	10.6	12.4
	Jamuna	0.2	16.5	16.7
	Gorkhe	1.0	4.3	5.3
	Jogmai	1.7	6.0	7.7
	Pashupatinagar	0.3	13.8	14.1
	Jirmale	0.6	9.9	10.5
	Sriantu	0.4	3.6	4.0
	Samalbung	0.9	11.6	12.6
	Swoyang	5.6	8.3	13.9
Panchthar	Chyangthapu	6.0	11.5	17.5
	Phalaicha	0.0	0.0	0.0
	Memeng	3.0	11.0	14.0
	Prangbung	1.9	6.0	7.9
	Sidin	1.9	6.1	8.0
Total		**25.8**	**131.9**	**157.6**

Source: Various VDC profiles and key informants

Cropping Practices and Household Income

Both districts have diverse, integrated subsistence cropping practices. The principal cereal crops in the area are maize, rice, wheat, and millet, with maize being cultivated by more than 80% of households (Anonymous 2002). The main vegetable crops are potatoes, radishes, peas, cabbages, cauliflowers, chillies (the akbari variety, a local landrace), leafy vegetables (mustard in particular), and beans. Potatoes are the main vegetable crop cultivated commercially.

Most of the vegetables and cereals are seasonal and produced for subsistence. Other crops include high-value cash crops such as large cardamom, tea, broom grass, and ginger. Mixed cropping patterns are predominant in the hilly terrain. Most of the vegetables, usually legumes, are grown alongside maize and rice. On irrigated 'khet', the main crops are rice and wheat, whereas on 'bari', maize and potatoes are more popular. One major drawback according to vegetable traders, with regard to current cropping patterns and cultivation practices, is lack of diversity in the production and sale of vegetables.

Farm incomes accounted for a lion's share of family income in the sampled households. On an average the farm sector accounted for 78% of the total household income, and the off-farm sector only 22%. In Samalbung, the contribution of farm income to total household income was highest (89%) and in Maimajhuwa it was lowest (58%) (Table 3). Among the various components of farm income, income from cash crops was the most important component. Income from cash crops accounted on average for about 40% of the total farm income. Likewise vegetables, including potatoes, accounted for about 35%. This high contribution to farm income from vegetables was because of the inclusion of potatoes in the vegetable group. Most of the households cultivated potatoes on their land as a traditional staple food crop. The income from vegetables excluding potatoes, however, accounted for only 13.5%.

Table 3: **Average household income of the sample population by VDC**

VDCs	Household income (%)	
	Farm	Off-farm
Mockery	81	19
Maimajhuwa	58	42
Mabu	69	31
Jamuna	68	32
Gorkhe	72	28
Jogmai	77	23
Pashupatinagar	86	14
Jirmale	87	13
Samalbung	89	11
Sriantu	88	12
Swoyang	70	30
Average	78	22

Market Linkages and Challenges

In Ilam, local residents used 'haat bazaars' (local markets), town markets (markets around the major towns and cities), and border markets to sell their products. The main outlets for exporting vegetables to India (Siliguri, Sikkim, and Darjeeling) and other countries are Birtamod in Jhapa district and Manebhanjyang and Pashupatinagar in Ilam district. In Panchthar district, sale is restricted to the 'haat bazaar' and, to some extent, to local traders because there is no road access even to the district headquarters; as a result there are few vegetable traders in Panchthar district. From many VDCs, such as Siding, Memeng, and Prangbung, local farmers use porters to carry products to the nearest traders. Porters and horses are the major mode of transportation in Panchthar, whereas in Ilam people do use jeeps, trucks, and buses. Horses carry a minimum of 100 kg and cost the least. Using porters is the most costly and perhaps the only means in some remote areas of Panchthar districts. The main problems associated with vegetable marketing are unreliable and inadequate transportation, lack of storage facilities, and lack of

a price information system. Taxation and levies imposed at several levels on vegetable marketing in cross-border markets reduce farmers' incomes even more. Competing with other countries in the international market is difficult for Nepalese traders due to an extensive taxation system and complicated certifying mechanism. For instance, there is great demand for tomatoes in Bangladesh and Pakistan, but Bhutan's export tax is half the cost of Nepal's and hence the price of tomatoes from Nepal is not favourable in these markets.

In Ilam, despite these difficulties, the vegetable trade increased over the year, in terms of both the number of traders and quantity of produce handled. The growth in vegetable trade is attributed to increased awareness about nutritional values, changes in eating habits, rising population, better profits from vegetables than from cereals, and rapid expansion in road networks. Some traders, however, mostly in Panchthar, believe that vegetable trade has decreased over the years because of inadequate supplies, fierce competition, migration, poverty, lack of organised markets, and a rise in exports leading to lack of availability in the domestic market.

There are various problems associated with the large-scale cultivation and production of vegetable crops. The major problems identified by the villagers are as follow:

- Limited support from government and non-government organisations in terms of providing technical knowledge about farming
- Natural calamities such as fog and hailstorms
- Limited organisational development; for example, there are only a few producers' groups (like Kishan Jagaran and Taja Tarkari Rara Samuha in Pashupatinagar and Segera Vegetable Growers' Group in Swoyang) established in the area although most of the landholdings are still small and scattered.
- Lack of irrigation, quality seeds, and other inputs such as storage and organised markets
- Limited road access

Technical assistance and training for farmers on adaptable and suitable modern farming and marketing methods with provision for storage facilities would increase the potential of vegetable production as a sustainable livelihood enterprise.

Potentials for Crop Diversification

Both Ilam and Panchthar have comparative advantages for growing vegetables because of their climate, location, and topography. Both districts have climatic conditions and soil types suitable for vegetable cultivation in the monsoon season. Altitudes ranging from 1,500 to 2,500m are suitable for producing rainy-season vegetables. Vegetables such as cauliflower, cabbage, peas, carrots, radishes, and beans grown here during the monsoon become off-season vegetables for the nearby terai belt as well as for Indian States like Bihar, West Bengal, and Uttar Pradesh. Due to the proximity of the districts to these areas, transportation costs are quite low and the percentage of loss in produce is also quite small. Places similar to Ilam and Panchthar in terms of climate and location, such as Dhankuta, have benefited from the comparative advantage that their locations have for vegetable cultivation. The average

household income from vegetables increased from NRs 2,480 to NRs19,150 within a period of three years because of vegetable cultivation during the monsoon. With increased road access, Ilam and Panchthar too can improve their income levels by taking up off-season vegetable cultivation, as off-season vegetables fetch much higher prices than seasonal vegetable crops.

Crop diversification is limited and farmers have been growing the same crops for generations, more so in Panchthar. The situation is changing slowly in Ilam due to its proximity to Darjeeling in India and farmers in Ilam are trying many new crops similar to those grown in Darjeeling.

Challenges and Recommendations

There is a climatic and economic potential for production of a wide variety of vegetables in Ilam and Panchthar districts of eastern Nepal. Farmers are quite slow in reaping the benefits and this is due to reasons ranging from lack of awareness to weak technical infrastructure. Farmers lack knowledge about off-season vegetable cultivation and are unaware of improved technologies for producing new vegetables and about how to combat pests and disease. Agricultural loans and inputs are not readily available in local markets and are restricted to the district headquarters in some districts. Some of the dry areas in Panchthar districts have no irrigation systems for the dry season.

Marketing channels are vital but least developed, and middlemen make most of the profit, leaving a meagre amount of the earnings for the farmers. Transportation is poor, unreliable, and costly because of the inappropriate and inadequate transport infrastructure. There are neither collection centres for vegetables nor information systems about market prices, this leads to high storage losses and biased pricing by traders. The study recommends the following actions to address these issues:

- Farmers should be given training on recent technology about different aspects of vegetable production, growth, and harvesting.
- The concept of cooperative marketing should be promoted among farmers in the two districts.
- There should be in-house investments in quality seeds and credit facilities in the villages of the two districts.
- Marketing channels and road networks should be developed.
- Collection centres at the production sites and market sheds at market entry points should be constructed.
- Local taxes should be levied.
- The potential for organic vegetable production should be explored.
- Micro-irrigation schemes should be facilitated in the drier areas of Panchthar district.

Conclusion

Most vegetable cultivation in Ilam and Panchthar districts is at the subsistence level, apart from vegetables such as potatoes, cabbage, peas, and chayote which are grown on a commercial scale. Most of the vegetables are highly productive due to intensive cultivation, however none of the farmers is involved in vegetable seed production on a commercial scale except for seed potatoes. Lack of availability of quality seed or an organised market in the two districts, inefficient storage facilities, and lack of knowledge about scientific methods for dealing with plant diseases are major problems hindering vegetable-based enterprise development.

Being a comparatively drier area, Panchthar is more suitable for extensive seed production and could easily provide sufficient vegetable seeds for production in Ilam.

Developing collection centres and proper outlets to collect vegetable produce and export it to nearby districts and across the border would benefit local farmers immensely and also help develop vegetable production as an income-generating enterprise for the area. The non-functional Jaubari Potato Development Centre could be developed into a Resource Centre for producing and testing vegetable seed samples and training farmers and technical staff.

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Non-Timber Forest Products as Alternative Livelihood Options in the Transborder Villages of Eastern Nepal

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Technology transfer for efficient harvesting of non-timber forest products (NTFP) and development of marketing channels are avenues to sustainable livelihoods.

Introduction

Biodiversity conservation is a top priority among all nations and this has led to the establishment of many protected areas (PA) and nature reserves (Brooks et al. 2004). Despite efforts to conserve endangered or threatened ecosystems, the sustainability of both human livelihoods and wildlife conservation is still a problem (Borrini-Feyerabend et al. 2004). In order to both address the people's need for sustained livelihoods and protect the natural environment, the right approach to conservation and development is essential. The transboundary biodiversity management initiatives of ICIMOD are engaged in developing transboundary conservation landscapes linking protected areas in the Kangchenjunga complex covering parts of Bhutan, India, and Nepal (Sharma and Chettri 2005). The approach works well for safeguarding PAs

and the buffer areas around them if local communities are taken into account. The initiative is also exploring ways of strengthening conservation linked livelihood options for people in the complex to improve their living standards while ensuring sustainable use of resources available across national borders.

This study looks into the livelihood options and potentials of non-timber forest products (NTFPs) in 12 village development committee areas (VDCs) bordering India in eastern Nepal: Memeng, Siding, Prangbung, Chyangthapu, and Falaincha in Panchthar district, and Maipokhari, Maimajuwa, Maabu, Jamuna, Jogmai, Gorkhe, and Pashupatinagar in Ilam district. A total of 146 households (ranging from seven to 16 houses depending on the size of each VDC) was surveyed to examine natural resource use patterns.

The economy of the area is land based. Average landholdings per household are about one hectare in Panchthar district, and about two hectares in Ilam. About 80% of the landholdings are individually owned and 20% are 'adhiya' (land given to other people for cropping for half the crops produced). Most of the land is rainfed ('bari'), about 61% in Ilam. Irrigated land ('khet') accounts for 23% of the total land cultivated in Panchthar but only four per cent in Ilam (Figure 1). Cardamom plantations are found on nearly 18% of the total land in both districts. In many VDCs, land is left fallow for livestock grazing.

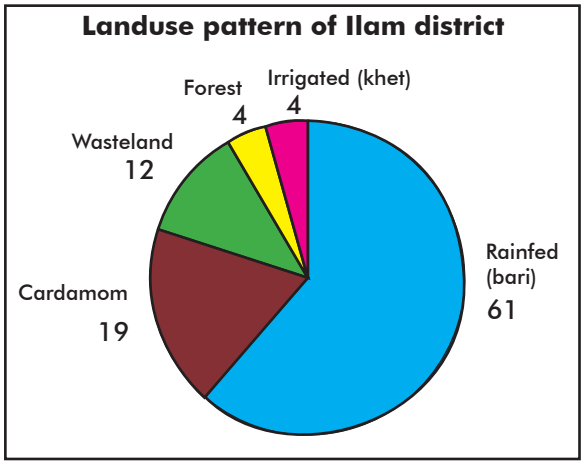

Figure 1: Different land-use types reported from the two districts of eastern Nepal

Livestock rearing is one of the major activities in these districts: livestock are mostly stall fed in Ilam, but in Panchthar they are mostly grazed with partial stall feeding. Animal husbandry is an important occupation in all areas. Milk and milk products are important market commodities. Successful agroforestry practices have led to the maintenance of greenery, ecosystem stabilisation, and a relatively stable economy. Planting broom grass on steep terraces is common practice.

Cardamom cultivation with moisture-loving shade trees and tea cultivation are characteristic of the landscape in these eastern Nepal districts. Edible crops grown in agroforestry systems, such as maize, ginger, paddy, millet, wheat, and vegetables (cash crops), are evident in Ilam. Such cultivation is slowly being adopted in Panchthar. A total of 41 plant species are used as fodder in Panchthar with 20 species coming from the forest and the remainder from agroforestry systems or from trees maintained on farmlands. Common fodder species include 'dudhilo' (*Ficus nemoralis*), 'nebaro' (*Ficus roxburghii* and *Ficus hookerii*) and 'gogun' (*Saurauria nepaulensis*). In Ilam, about 30 plant species are used; the majority of them coming from

agroforestry plots. Popular timber species include 'falant' (*Quercus glauca*), 'chilaune' (*Schima wallichii*), 'uttis' (*Alnus nepalensis*), and 'chanp' (*Magnolia* spp). Average timber use per household is 30-50 cubic metre, with a yearly demand of 300-500 cubic metres. Firewood is the principal source of energy and is used for cooking, preparing animal feed, heating water, heating in winter, curing cardamom, preparing alcohol, and making 'chhurpi' (dried cheese).

Non-timber Forest Products (NTFPs)

Gathering forest species for food, medicine, shelter, and other uses dates back to early human civilisation. Some of these traditions continue to this day and are an important part of the heritage and culture in the two districts. NTFPs make a significant contribution to the local economy.

Use of NTFPs at the household level

NTFPs commonly collected for medicinal purposes include 'bikhma' (*Aconitum palmatum*), 'kutki' (*Neopicrorhiza scrophulariiflora*), 'khanappa' (*Evodia fraxinifolia*), 'pakhanbed' (*Bergenia ciliata*), 'chinfing' (*Heracleum nepalense*), and 'panchaunle' (*Dactylorhiza hatagirea*). Cultivation of 'chiraito' (*Swertia chirayita*) also began a few years ago. Among the aromatic plants, 'dhupi' (*Juniperus* sp) and 'sukpa' (*Juniperus indica*) are collected more frequently than 'seto chandan' (*Matricaria chamomilla*), 'bhimsenpati' (*Buddleja asiatica*), and 'sughandawal' (*Valeriana jatamansii*). Fibre-yielding plants are more prevalent in distant villages near the Indian border, 'argeli' (*Edgeworthia gardneri*), 'allo' (*Giardiana diversifolia*), and 'lokta' (*Daphne bholua*) are planted on the sides of field terraces in Falaincha, Chyangthapu, Memeng, and Prangbung VDCs. The former three VDCs have established cottage paper industries. Other VDCs in the area export semi-processed products such as bark or pulp to these cottage paper industries.

Wild edibles collected by villagers are mostly food supplements. Major wild edible species include 'katus' (*Castanopsis indica*), 'tarul' (*Dioscorea species*), 'ainselu' (*Rubus ellipticus*), and 'siltimbur' (*Lindera neesiana*). Besides the use of NTFPs as medicine, fibre, and wild edibles, the bark of 'majito' (*Rubia manjith*), 'gobre sallo' (*Pinus wallichiana*), and 'uttis' (*Alnus nepalensis*) are used to produce dye. Many ornamental species along with beverages like tea (*Thea sinensis*) and spices such as 'tejpat' (*Cinnamomum tamalla*) are also cultivated as NTFPs.

Potential NTFPs for domestication and commercialisation

The local people are well aware of collecting seasons, methods, and frequency of collection of specific products (Box 1). Many medicinal plants are closely associated with the culture and traditions of the local communities.

Box 1: Local belief associated with the use of medicinal plants

Medicinal plants such as 'chimphing' (*Heracleum nepalense*) and 'khanappa' (*Evodia fraxinifolia*) is plucked on the first Tuesday after the Teej festival. This practice is known as 'Harlo'. The people believe that the medicinal plants plucked that day are extremely effective and potent.

Large cardamom cultivation has been popular for a long time in these areas. Earnings from cardamom provide important income for local farmers. Similarly other NTFPs, such as 'chiraito' (*Swertia* spp), 'bonjo' (*Acorus calamus*), 'dhupi' (*Juniperus species*), 'argeli' (*Edgeworthia gardeneri*), lily (*Lilium* spp, a wild flower locally known as 'jaighantam'), and 'titepati' (*Artemisia vulgaris*) are slowly being brought into a successful domestication process for income generation.

Commercialisation of NTFPs ranges from their consumption at the local level to the export of unprocessed NTFP materials to districts nearby and even across the borders. Local traders or middlemen are mostly involved in dealing with NTFP trade and export. In fact, they even run collection centres in major towns in the VDCs. Market limitations for farmers have benefited local traders who procure products from farmers at nominal costs and later trade them at higher prices.

Local Institutions

Community forest user groups (CFUGs) and the District Forest Office (DFO) in Ilam have the capacity to build nurseries and are cultivating many of the NTFPs, especially medicinal and aromatic plants (MAPs). Technical knowhow in processing raw materials into marketable products is limited. One non-government organisation, Uccha Pahadi Jadibuti Kendra, has some expertise in technical processing of medicinal plants and is taking the initiative in cultivating and marketing them (Box 2).

Box 2: Uccha Pahadi Jaributi Kendra

Uccha Pahadi Jadibuti Kendra was established in 2003 in Maipokhari, Ilam, with the goal of producing and marketing medicinal, aromatic, and ornamental plant products, and of conserving these plants. About 66 types of medicinal, aromatic, and ornamental plants have been planted.

Illegal Harvesting and Trade in NTFPs

Medicinal plants, cardamom, tea, broom, and other non-timber cash crops are all exported unprocessed in large quantities across the border in India. The DFO in Ilam recorded an increased trend in NTFP exports in 2001-2002 compared to previous years. Exports of 'chiraito' and 'lokta', however, have decreased in recent years mainly due to restrictions by Indian officials in the border areas. Illegal harvesting and trade of NTFPs are not reported directly; however, evidence was given during informal discussions with local farmers. Collection of species such as 'bhikhma' (*Acsponitum palmatum*), 'kutki' (*Neopicrorhiza scrophulariiflora*), 'jaikhantham' (*Lilium* spp), 'panchaunle' (*Dactylorhiza hatagirea*), 'dhupi' (*Juniperus* spp), 'sukpa' (*Juniperus indica*), 'sunpati' (*Rhododendron anthopogon*) and 'lauth salla' (*Taxus baccata*) is increasing every day. Only a small quantity of NTFPs is consumed locally, they are exported unprocessed through major routes from Ilam and Panchthar to Siliguri in West Bengal, India.

The estimated quantities of NTFPs exported to neighbouring countries are given in Table 1. It seems that Ilam and Panchthar are producing large quantities of NTFPs and exporting them to the neighbouring towns of Siliguri with chiraito predominant.

Table 1: **Major NTFPs and estimated quantity exported from the two districts (tons/ year)**

NTFP species	Ilam	Panchthar
Chiraito (*Swertia chirayita*)	21.14	15.35
Bikhma (*Aconitum palmatum*)	2.22	1.63
Kutki (*Neopicrorhiza scrophulariiflora*)	1.67	2.94
Bodookhati (*Astilbe rivularis*)	2.22	0.65
Pakhanbed (*Bergenia ciliate*)	1.67	0.65
Chimphing (*Heracleum nepalense*)	4.45	4.25
Panch aunlee (*Dactylorhiza hatagirea*)	0.56	0.33
Khokhim (*Bergenia purpurascens*)	0.56	0.65
Timur (*Xanthoxylem armatum*)	13.35	9.80

Conservation Initiatives

Local farmers have a lot of knowledge about the use of NTFPs and their conservation. Conservation initiatives, such as villager clean up campaigns and restoration and management of forests and water resources can be seen in most of the VDCs. Some VDCs also carry out community forestry to restore the forests while some establish plantations on farmland. Landslide prevention methods are used in Jamuna VDC; in Jogmai VDC, river diversions and pipeline extensions for drinking water are also built alongside road construction and maintenance. Transfer of technology and skills (along with cultural exchange) is prevalent among the residents of these two districts and the people from the state of Sikkim and Darjeeling in India.

Conclusion

The rural mountain population in the study area is closely linked to their natural resources. Their economy is largely dependent on agriculture and rearing livestock. Rainfed agriculture is supported and improved by organic manure from the forests and livestock. Diversified animal products, such as milk, soft and hard cheese, butter, meat, and fur have always been good sources of earning for the villagers in Ilam and Panchthar districts.

Interest in NTFPs is increasing rapidly. Agroforestry innovations in the form of large cardamom and broom-grass cultivation have supplemented the incomes of rural people. Cultivation of medicinal and aromatic plants and their use as cash crops are recent. Villagers are well aware of collecting seasons and the use of specific products of many medicinal and aromatic plants. Cultural exchange is closely associated with indigenous technologies and farming practices. Indigenous knowledge should be tapped and documented. Intensive training on cultivation, conservation, and processing techniques for NTFPs, needs to be carried out on a large scale. Training needs are felt more in the mountain villages of Panchthar district. Strengthening of local institutions so that they can provide training is highly recommended, as they are more accessible to the local community.

Active management of NTFP collection and cultivation can help maintain ecosystem complexity and also play an important role in restoring biodiversity. Extraction of a broader range of natural resources than timber products can lead to economic diversification and stability for rural forest and mountain communities. Setting up national, regional, and global marketing channels for the products will open up avenues for improved access and bring increased benefits to local people. Managing forests by focusing on NTFPs will also help increase the long-term value of forest resources, and such initiatives could contribute to biodiversity conservation and sustainable forest management of this important biodiversity-rich landscape.

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Socioeconomic Analysis of the Toorsa Strict Nature Reserve and Jigme Dorji National Park Conservation Corridor in Bhutan

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The conservation of cultural and natural heritage is inherently linked to human well-being, the effective management of conservation areas, and developing conservation corridors

Introduction

Bhutan has identified nine per cent of its total geographical area as biological corridors (NCD 2003). The westernmost corridor, which connects Toorsa Strict Nature Reserve (TSNR) with Jigme Dorji National Park, forms an important land-use unit in the proposed Kangchenjunga landscape, since it connects to the Bhutan conservation complex. This is one of the six corridors identified by ICIMOD for re-establishing natural connectivity among the protected areas in the Kangchenjunga landscape (Sharma and Chettri 2005). The corridor covers an area of 149 sq.km with a north-south length of 30 km. It passes through Bji 'geog' (local subunit) in Haa 'dzongkhag' (district) and Tsento geog in Paro dzongkhag and connects to protected areas in the southern part of the Kangchenjunga landscape.

As per the recommendations of the stakeholders during a national consultation in 2003, a socioeconomic survey was carried out in the proposed corridor. The major objectives were to generate information on household and settlement patterns, livelihood options, resource use, grazing patterns, and human-wildlife conflict issues and to develop an action plan with the local communities addressing the conservation and development issues.

Topographic Overview

The survey was carried out in Bji and Tsento geogs, the largest geogs in Haa and Paro, respectively. Bji geog, with an area of 802.2 sq.km, has seven villages with 260 households. The climate is characterised by cool summers and extremely cold winters with heavy snowfall in the northern part. Tsento geog occupies 575 sq.km and is divided into 14 'chiwogs' (villages) with 330 households. Almost 80% of this area falls inside the corridor. This geog has a cool to extreme temperate climate with mean temperatures of 17°C during the warmest month and 4°C in winter.

Socioeconomic Profile

Demographic structure and land-use patterns

The total population of Bji geog is 2,038 with the highest number (666 people) in Hatey village. In Tsento 'geog', the total population is 2,190. Within the villages, houses are mostly scattered but sometimes grouped into one or more clusters. In Bji, the land-use pattern consists of dry lands, kitchen gardens, orchards, 'sokshings' (leaf-litter collection areas), native pastures and improved pastures. Of the total arable land of 657 ha, native pasture dominates with 54 ha (AEO 2004). The high percentage of pastureland clearly indicates the importance of livestock rearing in these two 'geogs'.

About 85% of the total land area is under forest cover which is mainly dominated by blue pine and other conifers. A similar land-use pattern is evident in Tsento where native pasture occupies the biggest area of 16 ha. The agricultural land here is mostly dry with only 3% of the total area under wetland cultivation.

Livelihood Strategies

In both 'geogs', people are mostly subsistence farmers who depend on agriculture and livestock for their livelihoods (NCD 2000). Almost all households have some land for cultivation; the size of landholdings varies according to the social status of the villagers. Since the landholding of most villagers is small (<1 ha), people are often engaged in other livelihood activities such as daily labour, trade, pottery, and carpentry. In Bji, farmers have easy access to markets for their products because of excellent road networks that connect to major market towns such as Haa, Thimphu, Paro, and Phuntsholing, whereas Tsento is comparatively remote.

The farming system

The farming system is characterised by two inseparable components of agriculture and livestock. People depend on agriculture for cereals (red rice, wheat, and barley) and vegetables (potatoes,

radishes, and turnips) whereas livestock provide dairy products, draught power, and farmyard manure. Farmyard manure combined with leaf litter from the forest forms an excellent fertiliser for organic farming.

As reported by the locals in Bji, the yields of wheat, barley, and potato have decreased drastically over recent years due to crop damage by wildlife, decreasing fertility of the soil, and unpredictable climatic conditions. Paro is generally the most fertile 'dzongkhag' in Bhutan. Important agricultural crops in Tsento include rice, wheat, barley, buckwheat, oil seeds, potatoes, and other vegetables. Apples are also an important horticultural cash crop. The livestock population in Bji and Tsento is given in Figure 1.

The important livestock products marketed by villagers are milk, butter, and cheese from yaks and cattle. Eggs and pork are also common. Horses and mules are used as pack animals and provide additional income to some farmers (LEO 2004). The yaks are reared at Soeyaksa village which is located within the proposed Toorsa Strict Nature Reserve-Jigme Dorji National Park corridor.

Regarding livestock migration, the migration of yaks is locally referred to as 'ri nor' meaning high-altitude livestock migrating to the northern areas bordering Tibet, China. The migration of local cattle is called 'tha nor' or low-altitude cattle migrating to the southern areas in Bhutan such as Samtse and Dorokha. Migration involves a mutual ownership system which is a traditional practice. In addition, people rear cattle in the homestead that are not involved in migration, mainly jersey cross-breds.

With support from the livestock centre, the fodder species cultivated by the locals to overcome the fodder shortage are Italian rye grass, tall fescue, cocksfoot, white clover, rubinia, willow, and oat.

The registered pastures in these 'geogs' belong to communities, monasteries, and outsiders. All villagers have their own specific communal 'tsamdrog' (grazing area) for grazing which is strictly inaccessible to other villagers outside the specific community. Internal agreements can be made in cases in which the community does not have its own pastures. As indicated by the locals, the community pastures are better managed than natural pastures which have open access.

Forestry

Both Bji and Tsento have good forest cover with 70-80% of the total land under forest. People depend on the forest for timber, fuelwood, leaf litter, fodder, and incense and also collect wild mushrooms and ferns. Blue pine (*Pinus wallichiana*) is the most favoured timber species while fir (*Abies densa*) and hemlock (*Tsuga dumosa*) are used for roofing shingles. Local people are positive that forest cover has now increased in comparison to the past as a result of strict enforcement of forestry rules and regulations.

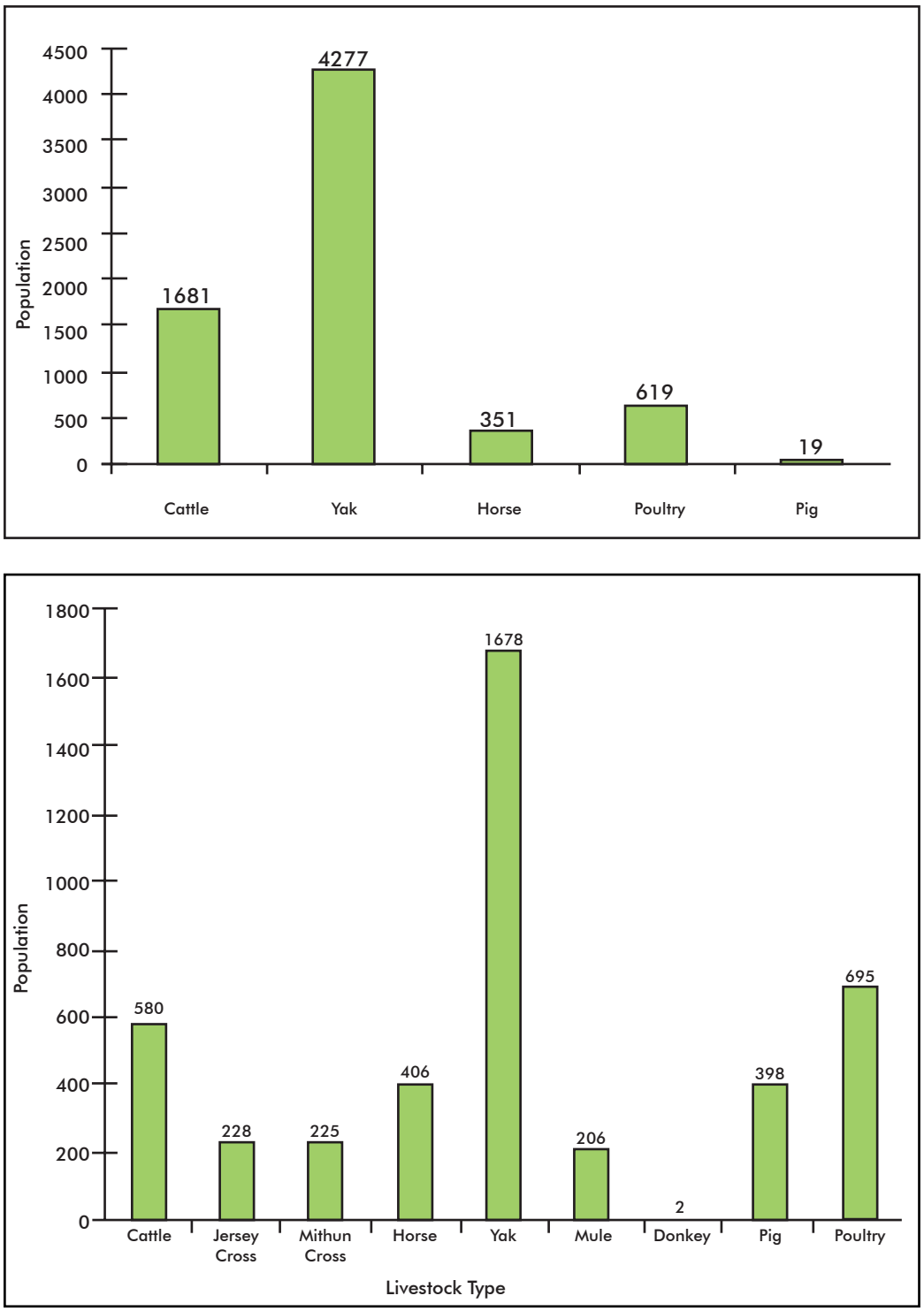

Figure 1: Livestock population of Bji (top) and Tsento (bottom) (source: Livestock Extension Centre, Bji and Tsento geog, 2004)

People are entitled to two standing trees per year for firewood. The permit is issued by the Forest Range Office, but dry firewood can be collected without a permit. During winter, firewood doesn't seem to be enough, therefore there is increasing difficulty in finding dry firewood. People also use kerosene, electricity, and liquid petroleum gas (LPG) to meet their energy needs.

Community Activities and Belief

Community activities mostly revolve around Buddhist religious beliefs and festivals. Religious ceremonies such as 'Mang Rimdo', 'Nungney', 'Bumday' and 'Kanjur' recitations are performed and local deities associated with lakes, forests, and mountains are also worshipped. One of the most popular festivals in Tsento is the annual 'Paro Tshechu' often known and enjoyed by tourists. People also celebrate annual festivals like 'Lochey' and 'Lomba'. The local people have traditional beliefs that prevent them from polluting and destroying sacred sites. Festivals and other social and cultural gatherings bring the communities together and strengthen their cooperation and goodwill.

Conservation and Development Issues

Tsento is very remote compared to Bji and many villages do not have access to good roads. The national highway goes as far as Drugyel, after which feeder roads connect a few villages, and the remainder of the villages are connected only by trails. The forests in these 'geogs' host considerable numbers of wild animals such as sambar, barking deer, serow, wild pigs, wild dogs, leopards, musk deer, goral, and monkeys. The farmers in Bji often report human-wildlife conflicts, mainly related to crop damage and livestock predation by wild animals. People take protective measures, such as fencing, guarding the crops and livestock, and scarecrows, which they think are laborious and not too effective.

The conservation and development issues for the two geogs lying within the corridor include the following:

- Crop damage by wildlife and how to address this issue: by compensation or change in cropping patterns?
- Community forestry programmes are needed to handle both institutional and natural resource management issues.
- Livestock depredation: compensation mechanisms should be embedded within local institutions or come from the local government.
- Improved breeds should be introduced as a strategy to reduce animal populations and increase yields, thus contributing to conservation by reducing pressure on grazing lands.
- Access to markets for agricultural and livestock products needs to be improved to ensure better returns than at present.
- Sanitation improvements are essential to ensure good health, especially of women and children.

The 'Ninth Five Year Plan(2002-2007) for Bji Geog (RGOB 2002 a) and Tsento Geog' (RGOB 2002 b) includes improvement of livestock breeds, establishment of backyard farms, animal health services, crop improvement, income generation schemes, and institutional and capacity development programmes. This strategy should be linked to the programmes of the Ninth and Tenth Five Year Plans (2008-2012) with conservation links from additional projects.

Recommendations

Based on the issues discussed, the following action plan was prepared by the local communities.

- Develop a strategy, such as compensation or technology, to reduce crop damage
- Develop the infrastructure for easy access to and marketing of local goods
- Find alternatives to timber
- Develop a strategy and the technology to control landslides in villages like Jamtey Gonpa
- Streamline the compensation scheme for livestock damage
- Encourage introduction of improved breeds to reduce unproductive livestock
- Develop pastures by means of innovative technologies and options

Conclusion

The report provides an overview of the socioeconomic conditions of the local people residing within the Toorsa Strict Nature Reserve-Jigme Dorji National Park conservation corridor. It presents the conservation and development issues identified by the local communities and gives a priority action plan based on the participatory village planning meetings held for villagers in Bji and Tsento 'geogs'. The recommendations given above should be developed and integrated into the National Plan of the Royal Government of Bhutan. For the present, operationalisation of the three remaining protected areas in Bhutan (including Toorsa Strict Nature Reserve) should be given top priority, simultaneously considering implementation of the management plan of the Toorsa Strict Nature Reserve-Jigme Dorji National Park biological corridors.

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Conservation and Income Generation Opportunities from High-Value Species: Cordyceps Policy in Bhutan and its Implications for the Himalayan Region

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Farmers are allowed to harvest and sell Cordyceps on condition that they do it on a sustainable basis: long-term sustainability should be the focus.

Introduction

Cordyceps sinensis (Berk.) Sacc. is currently a hot topic in the Hindu Kush-Himalayas. Its value as a medicinal plant par excellence makes it expensive, hence the name of the plant carries with it an air of high mountain mysticism and the lure of a gold mine. The mountain communities in Bhutan say it is their 'gift from the sky': God rewarding them finally for their long toil in beautiful but forbidding high mountain conditions.

People's optimism about income from the sale of *Cordyceps* is unrealised. *Cordyceps sinensis* is a protected species in Bhutan. Following field research and policy review, however, the Royal Government of Bhutan lifted the total protection status in 2004 and allowed local communities to collect it for trade. Nevertheless, the government remains highly concerned about sustainability issues, and the probable extinction of *Cordyceps* due to intense commercialisation.

Species' conservation and rural income opportunities present themselves as two conflicting objectives in managing plant resources. Do conservation and development mean a parting of the ways or could they converge? Taking the case of *Cordyceps* in Bhutan and by means of a general literature review, the research attempts to answer two central questions.

1. How justified is the optimism of high mountain communities about their 'gift from the sky'?
2. How justified is the state's concern about species' conservation and sustainability issues?

Taxonomy: ecology and distribution

The first time *Cordyceps* came to be known in the West was in 1736 when Du Halde wrote about it, but it was not until 1842 that the first *Cordyceps* specimens arrived in England. Berkeley, in 1843, formally described and illustrated the fungus as a member of the Pyrenomycetes family, under the name *Sphaeria sinensis* n.s. Later, in 1878, Saccardo transferred it to the genus *Cordyceps* (Fr.) Link, as *Cordyceps sinensis* (Pegler et al. 1994). Zang and Kinjo (1998) reported 33 species of *Cordyceps* from the alpine areas of China and Nepal, of which, *C. nepalensis, C. kangdingensis,* and *C. multiaxialis* are described as new species. Globally, over 300 species of *Cordyceps* have been recognised. Modern taxonomic listing of *Cordyceps* is still incomplete (Jones 2002). *Cordyceps* is found in cold, grassy, alpine pasturelands of mountain ranges over 3,800 masl; the distribution range in the Hindu Kush-Himalayas includes Bhutan, Nepal, the Indian Himalayas, Tibetan Plateau, and mountain ranges in interior China. In Bhutan, it is found between 4,070m and 4,800m[1] in the high alpine mountain valleys in the northern part of the country

Cordyceps belongs to the entomogenous fungi, the group that attacks the egg, larvae, or adult stages of insects. The spores from the fungus infect the insect and the mycelium spreads rapidly to fill the whole insect body. The fungus can remain dormant inside the insect for long periods, particularly when conditions are dry. When the conditions are moist and temperature favourable, hyphae emerge throughout the body (Cooke 1977). The *Cordyceps* spores are widely dispersed by wind and water in autumn. Some of the spores fall, germinate, and penetrate into the caterpillar larvae of *Hepialis* species of the Lepidoptera order of insects (moths and butterflies). The infected caterpillars are killed by spring. The uninfected caterpillars pupate into relatively large, primitive moths and take two years to complete the life cycle. The caterpillars live in vertical tunnels in the soil and emerge at night to feed on roots and aerial parts of plants. Some species are reported to be serious pests in pastures. The fluctuations in *Cordyceps* populations are related to weather conditions (Luk 1998; Zhu et al. 1998; Pegler et al. 1994; Jones 2002).

[1] The lowest altitude recorded for *Cordyceps* for western Bhutan was 4,070m, behind Lingshi Dzong, and the highest 4,800m.

Status of *Cordyceps* in Bhutan

The common perception of *Cordyceps* is that it is rare and endangered, thus requiring protection. In Bhutan, it is accorded total protection status under the provisions of the Forest and Nature Conservation Act 1995. Total protection is accorded to a species when its population has fallen to a precipitously low level and when its survival is unlikely if the causal factors continue operating (IUCN 2001). Namgyel and Tshitila (2003) argue that no scientific evaluation was undertaken to justify its position as a totally protected species. In the absence of scientific information, we learn from the local people.

Living for generations in the area with regular visits to *Cordyceps* habitats, while herding yaks, the local people have practical experience of the *Cordyceps'* ecology. Across the region they believe that *Cordyceps* follows a cycle of good and bad crop years. Some sites follow a cycle of three years, and others alternate years. Some sites bear *Cordyceps* on a regular basis year in and year out, albeit in small quantities. Some previous sites bearing *Cordyceps* will not bear it in the following year, while some sites with no previous *Cordyceps* will bear it. There is no definite growing pattern. Local people also do not think collection will lead to extinction or cause a decline in *Cordyceps*. They say they have observed for many years hundreds of Tibetans across the border picking *Cordyceps*, and it is still available. Its production is more influenced by weather conditions than collection.

Commercialisation of *Cordyceps'* collection

Cordyceps is extraordinary in that it is a mushroom growing out of the head of a caterpillar. Locally people believe that it takes the form of a 'plant' during summer and an 'animal' during winter. The Bhutanese and Tibetans call it 'Yartsa Guenboob'[2], and the Chinese call it 'dong chong xia cao'. Both the terms refer to *Cordyceps* as 'summer grass winter worm'. The Nepalese call it 'kira gans'- the insect grass. It is a herbal medicine with a long history of use in China. It is said that the First Emperor Shih Huang Ti (B.C. 219), the architect of the Great Wall of China, talked about a magical mushroom – the 'herb of deathlessness' – which ,when eaten, gave one long life or immortality. In Tibet, pastoralists have observed for generations that yaks which grazed on *Cordyceps* rangelands showed increased strength and renewed energy (http://216.55.141.125/*Cordyceps*.htm). As *Cordyceps* grows in remote high mountain valleys and is perhaps not widely known amongst the common people, it was considered rare and was available or known only to the emperors and their courts.

Du Halde, in his historical account of China in 1736, gave the following account of *Cordyceps* (cited in Pegler et al. 1994):

> "You must take five grams of this root entire to the very end, stuff the belly of a tame duck with it, and boil it over a gentle fire; when it is boiled take it out of the duck again, the virtue of which will have entered entirely into the flesh of the duck; eat of this morning and night for eight or ten days together. I accordingly made the experiment when I immediately found my appetite return, and my strength restored; the Emperor's physicians gave me the same account but told me that they only prescribed at Court because of the difficulty they had to procure it."

[2] In Nepali literature, it is commonly known as 'Yarsa gumba'. The 'gumba' is perhaps the Nepalese equivalent of the Bhutanese/Tibetan word 'guenboob', meaning winter insect.

With the growing affluence of China in the last 50 years, and development of the market economy, items once beyond reach became available to the masses. Thus use of *Cordyceps* in China as a health tonic became more widespread over the years. It has only been in recent years, however, that *Cordyceps* has drawn scientific interest and gained international prominence (Jones et al. 2002; Pegler et al. 1994; Zhu et al. 1998).

The introduction of *Cordyceps* to the West and the promotion of its medicinal potency created an international market demand for it overnight. This also dovetailed with the global trend of more and more people turning to 'alternative' or 'traditional medicines'. Demand has been reinforced by the mostly positive research results showing *Cordyceps* as an all-round medicine for treating circulatory, respiratory, immune, and sexual dysfunction, and for improving energy, stamina, appetite, endurance, and sleeplessness (Zhu et al. 1998; Holliday et al. 2004). With the street value of a kilogramme of *Cordyceps* ranging from US$ 2,000 to 10,000 (Jones et al. 2002), the farm-gate prices have also become attractive. Locally, traders in Bhutan pay US$ 800 to 1,300/ kg to collectors, and they sell it across the border in Tibet (China) for US$ 1,000 to 2,000. Similar prices are reported from the Nepal and Indian Himalayas (ANSAB 2003a; Jayshi 2003; Negi 2003; Garbyal et al. 2004).

Policy dimensions of *Cordyceps* trade

The commercialisation of *Cordyceps* is a new phenomenon in the Himalayan region. Only in recent years has it begun to appear, albeit in a romanticised form, in the popular press[3], and as a discussion topic on the electronic forums[4]. Socioeconomic and ecological research on *Cordyceps* is limited at the moment. Internet searches indicate that clinical research trials relating to the culture, hybridisation, isolation, and testing of active compounds have mushroomed. The results of a study commissioned by ICIMOD on policy approaches in the region are summarised in the box.

Policy makers and resource managers in Bhutan, Nepal, and India are for the most part ignorant of commercialisation of *Cordyceps* and have yet to grasp its scale and scope. Given the limited literature available on the socioeconomic status of *Cordyceps* even in China, it may also be a new subject there.

In China, *Cordyceps* was classified as a Class 2 protected species in 2001 and requires a provincial permit for trade. The provincial governments are not strict, but, nevertheless, more and more counties now require people to obtain licenses to gather *Cordyceps*. This requirement is mainly targeted at outsiders, and it enables local administrations to earn more money through the issue of permits to outsiders. In some cases, however, the result has been that outsiders outnumber the locals, and this is a source of conflict in the context of revenue sharing and use of the resource base (Daniel Winkler, personal communication 2004).

[3] 'Local 'Viagra' destroying Tibetan way of life.' *Indo-Asian News Service*, March 19, 2004; 'Old Chinese mushrooms pep up the middle-aged.' *The Independent*.
[4] Mountain Forum-Asia, an electronic discussion group for mountain topics

Policy research on Cordyceps

Cordyceps sinensis, known in Bhutan as 'yartsa guenboob', is an important high-value product in the HKH region. ICIMOD commissioned a study on the *Cordyceps* species to look into traditional conservation practices, national and international market demand, linkages, and potentials for commercialisation. In the international market *Cordyceps* brought about US$800 to 1500/kg. Local people have no control over the collection of *Cordyceps*. Due to its high monetary value, *Cordyceps* is extracted illegally and the Government of Bhutan loses US$ 4 million every year to illegal poachers. Law enforcement capacity is stretched to the limit because of the difficult and rugged terrain, thus there is illicit trading on a large scale by outsiders. As a result, *Cordyceps* is in the hands of outsiders who take the monetary benefits and earn substantial incomes. Now, as a result of the research, Bhutan has legalised the harvesting of *Cordyceps* following a royal command issued by His Majesty the King on June 17, 2004 so that local people can benefit. Farmers are allowed to harvest and sell the *Cordyceps* on condition that they do it on a sustainable basis. Long-term sustainability should be the focus. Bhutan has introduced a community-based natural resource management (CBNRM) model for *Cordyceps*. This change in approach is important in remote rural areas of developing countries where biodiversity is concentrated, where poverty tends to be pervasive, and where the reach of development programmes is often limited. This will lead to renewed emphasis on finding ways of deriving new economic opportunities from biological resources which do not lead to further losses of biodiversity.

In Nepal, the government lifted the restriction on *Cordyceps* trade in 2001, but two conditions were introduced. The first is the royalty of Nepali rupees 20,000/kg of *Cordyceps*, and the second is the ban on export of *Cordyceps* in a raw form. These conditions are difficult to implement. Firstly, the royalty is exorbitant and beyond the means of poor mountain peasants and pastoralists. Nepal exports annually an estimated amount of over 2,000 kg of *Cordyceps*, but royalty collections for one year only amounted to Rs 60,000. Secondly, *Cordyceps* is traded in raw form, and even if entrepreneurs want to add value, the necessary infrastructure, such as packaging, processing, and high-end marketing is not available in the country. Cordyceps can become an important source of revenue for some groups (ANSAB 2003b; Jayshi 2003).

Although *Cordyceps* is currently receiving the attention of natural resource managers and policymakers in India, it is not listed in any schedule of protected species in the country. At this time, India appears unworried about the trade in *Cordyceps* because it is not listed in CITES (WTI 2003). In Bhutan the government lifted the policy ban on *Cordyceps* collection in 2004 (Box). This policy change is largely due to the results of research studies that suggested that the policy ban was ineffective, and it was merely a source of conflict between the government and local communities. The result of the high price of *Cordyceps* for Bhutan is a serious transboundary problem because thousands of Tibetan collectors pour into the country and local communities will not cooperate with the government to stop foreign collectors as they find themselves unable to resist the temptation of cash from *Cordyceps* collection. Furthermore, there is no scientific justification as yet for total protection of *Cordyceps* (Namgyel 2003; Namgyel and Tshitila 2003; Jones 2002).

Conclusion

The high price of *Cordyceps* is creating a 'gold rush' phenomenon in the Himalayan-Chinese region: people from poor mountain areas travel in great numbers to the high alpine valleys in the hope of earning substantial incomes from it. From the numerous press reports, particularly in Nepal and India, one can surmise that it is presumed that the *Cordyceps* resource base is already threatened by intensive collection. This researcher feels it is too early to tell and that only long-term research can provide the correct information.

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Ecotourism Development in the Kangchenjunga Landscape: Potentials and Challenges

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Ecotourism is widely assumed to be inherently sustainable because it incorporates objectives of environmental and cultural conservation and emphasises economic benefits for local communities.

Introduction

The Kangchenjunga landscape located in the lap of Mount Kangchenjunga, the third highest mountain in the world, has always been a prime destination for tourists. The magnificent, diverse landscapes and rich cultural heritage within this landscape have attracted tourists, pilgrims, naturalists, explorers, trekkers, mountaineers, and adventure travellers over the last couple of decades. In view of the limited industrial growth in this remote landscape, tourism is becoming a source of employment generation for local people. Since 1990, there has been a tremendous increase in tourist numbers (Rai and Sundriyal 1997; Maharana et al. 2000a). The landscape has been visited by renowned naturalists and explorers, making it a priority area on the itinerary of many nature lovers. Darjeeling has been promoted as the 'Queen of the Hills'

and the state of Sikkim is evolving as an ideal destination for ecotourists (Sharma et al. 2002). The recently developed Kangchenjunga Conservation Area (KCA) and Jumolari in western Bhutan have been progressive in promoting tourism (Anonymous 2002; Gurung 2006). Most of these initiatives are city centred, however (Gangtok, Darjeeling, Kalimpong, and so on) and very few are in the wilderness (Yuksam-Dzongri, Sandakphu, and others).

The recent advocacy and facilitating role played by ICIMOD in developing transboundary conservation landscapes and corridors, discussed in previous chapters, have brought about enormous insights into the potential of ecotourism development in the landscape. In addition, the initiatives taken by SNV and ICIMOD with regards to developing a Great Himalayan Trail, for instance the South Asian Sub-regional Economic Cooperation's (SASEC) tourism working group have brought attention to the potentials of regional tourism and its potential for benefiting countries in the region (SNV and ICIMOD 2006). These initiatives have opened up new avenues for tapping the potentials of transboundary ecotourism in the landscape.

In the global conservation scenario, alternative forms of tourism have occurred simultaneously with increased recognition of the need to implement the concept of sustainable development and effective conservation (Secretariat of the CBD 2004). In some instances, ecotourism is assumed to be inherently sustainable and conservation oriented, although few attempts have been made to verify such assumptions (Maharana et al. 2000a, 2000b; Nyaupane and Thapa 2004; Bajracharya et al. 2005). Therefore, in principle, ecotourism incorporates the objectives of environmental and cultural conservation and emphasises economic benefits for local communities. Ecotourism could be a vehicle for sustainable development and act as a vehicle for realising tangible benefits for local communities as well as for conservation. It also has the potential to be more environmentally damaging than mass tourism since it occurs usually in fragile environments and opens up previously undiscovered destinations to the mass market (Wall 1997). The challenge before us is to balance the twin objectives of conservation and sustainable and pro poor development.

The tragedy of mass tourist spots digging their own graves and the emerging global market for ethnic and unique experiences has given rise to enterprises operating under the banner of ecotourism in various parts of the world. Its increasing importance as a business opportunity and its phenomenal growth within the larger tourism industry has made the concept of ecotourism quite popular in developing countries. Notwithstanding, although economic benefits from ecotourism include foreign exchange revenue, employment opportunities, improved awareness of conservation objectives, and stimulation of economic activities, there are still many challenges to overcome to achieve conservation of wilderness areas (Chettri et al. 2002; 2005a; Kruk and Banskota [in press]). There is still a big gap in the marketing sector as well and private enterprises and other stakeholders need to play an increasing role. In this chapter, we will discuss some of the opportunities and challenges discovered in the Kangchenjunga landscape during a participatory planning process for developing a transboundary landscape and corridors connecting the existing protected areas in order to address the twin objectives.

The Evolving Scenario

Tourism is the world's largest growing industry, with 691 million international tourist arrivals worldwide, generating $US 523 billion per year (WTO 2004), and an expected annual growth rate of 4.1% over the next 20 years (Lama and Sattar 2002). It is estimated that mountains have approximately a 15-20% share of the global tourism market, generating between $US 70 and 90 billion per year (PAIA 2005). After coastal regions, mountains are thought to be second in global popularity as tourist destinations (Walder 2000). The need to address mountain concerns and the potential contribution that tourism can make to mountain communities are increasingly being recognised. Agenda 21 of the UN Conference on Environment and Development (UNCED) stated that the fate of the mountains may affect more than half of the world's population, and it acknowledged mountain tourism to be an important component of sustainable mountain development and conservation (UNESA 1992).

Research has shown that tourism does not necessarily lead to development and conservation unless deliberate efforts are made to link the industry with development concerns in the mountains – specifically poverty alleviation, environmental conservation and regeneration, and the empowerment of local communities (Banskota and Sharma 1998; Kruk and Banskota [in press]). Even in the highly successful model of the Annapurna Conservation Area Project (ACAP), the benefits of tourism development are said to go mainly to lodge and restaurant owners, with subsistence farmers and poorer or lower classes benefiting only to a limited extent (Gurung 1998; Nyaupane and Thapa 2004; Chettri et al. 2005b). The main reason why the poor seem to have been unable to benefit much from tourism is that the linkages between tourism and the local production system are weak, and supply side planning and management have been poor and in some cases even completely ignored (Banskota and Sharma 1998). In spite of all these, tourism in South Asia increased from 3.2 million international tourist arrivals in 1990 to 6.8 million in 2003 with an average growth rate of 7.7%. This figure is projected to more than double by 2010, reflecting the growing strength of China, India, and Bhutan (ADB 2004). The challenge is to balance resource and conservation factors to make mountain and tourism development sustainable, so that the positive impacts on mountain communities and environments are maximised and, at the same time, negative impacts are minimised as much as possible.

Ecotourism Initiatives in the Kangchenjunga Landscape

Over the last two decades many sustainable tourism models have been developed for the eastern Himalayas (Sharma et al. 2002; Bajracharya et al. 2005) and their impacts on conservation and socioeconomic development have been assessed (Banskota and Sharma 1998; Gurung 1998; Maharana et al. 2000a, b; Chettri 2002; Nyaupane and Thapa 2004). What these models have in common is the aim to limit adverse impacts on the environment and local culture, while helping to generate income and employment for local communities. The concept of ecotourism in the Kangchenjunga landscape is a comparatively recent phenomenon.

As a result of the pilot experience and the positive idea gained by Sikkim biodiversity and ecotourism initiatives (Sharma et al. 2002), the Government of Sikkim identified tourism as an important instrument for reduction of poverty, and it has been actively planning its tourism industry. The Sikkim Government, along with Tata Economic Consultancy Services, developed a fifteen-year Master Plan for Tourism Development for the State of Sikkim. The plan contains short, medium, and long-term phases (TECS 1998). The initial phase was perceived as a consolidation phase in which emphasis was given to providing new infrastructure and upgrading existing attractions and infrastructure. New legislative measures were taken to protect both the natural and man-made environment. Recently, to supplement the initiatives, rural cultural heritage sites with vast ethnic populations of Lepchas, Bhutias, and Nepalese were identified as potential factors in diversifying from existing tourism products (Kruk and Banskota [in preparation]).

Similarly, the Darjeeling district of West Bengal and Bhutan have also made impressive progress in promoting ecotourism as a vehicle for conservation and sustainable development (Anonymous 2002). The Darjeeling Gorkha Hill Council and Government of West Bengal are working rigorously to identify and promote natural and man-made tourism products both within and outside protected areas. Emphasis is being given to diversifying tourism in rural and protected areas and minimising concentration on the towns of Darjeeling and Kalimpong. These initiatives are instrumental in conceptualising ecotourism development in the region. In addition, many entrepreneurs and development organisations, such as Help Tourism-Siliguri; TURISTA-Kolkata; Darjeeling Ladenla Road Prerna (DLR Prerna), and Ashoka Trust for Research in Ecology and the Environment (ATREE) – Darjeeling, are coming to the forefront and helping the government promote ecotourism in the area.

Potential Ecotourism Products

Recent trends indicate a surge in the number of visitors to ecotourism destinations, mainly located in the mountains. Hiking, camping, rafting, mountaineering, rock climbing, mountain biking, wildlife viewing, and other forms of non-consumptive recreation are in growing demand (Nepal 2003). The potentials for tourism development in the Himalayas are substantial. The number of visits in the Himalayan region has grown in recent years (Figure 1), but the data on tourist inflows into the region are not properly recorded and maintained; although the contribution to the mountain economy appears to be quite significant (Sharma et al. 2002).

The Kangchenjunga landscape, comprising the Himalayas of Sikkim and Darjeeling together with the adjacent neighbouring areas of eastern Nepal and western Bhutan, has been an attractive destination for adventure tourists (trekkers, mountaineers, white water rafters, and bikers), naturalists, and academicians as well as for health conscious people over the last century (Dozey 1989). Visits are usually limited to a few and inadequately equipped destinations, however. Realising the potential for economic development through tourism, several new initiatives have been established to institutionalise tourism as an alternative livelihood option in the region (TECS 1998; ADB 2004; ATREE 2006; Kruk and Banskota [in preparation]).

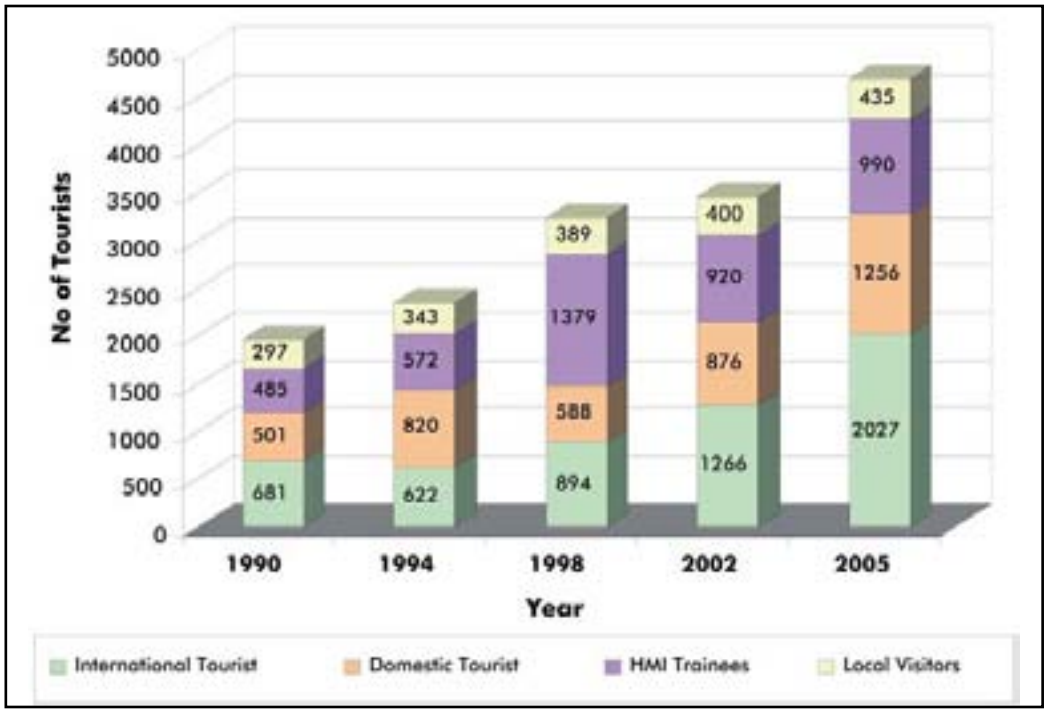

Figure 1: Trend of Tourist Arrivals in KNP

Adventure tourism in the form of trekking along routes such as the Manebhanjyang-Singalila-Falut trek in Darjeeling; Yuksam-Dzongri-Goecha La trek in Sikkim, and Jumolari trek in western Bhutan are Kangchenjunga landscape routes that have gained in popularity in recent years. Similarly, tremendous efforts have been made by the Governments of Nepal, India, and Bhutan as well as other stakeholders to develop new products and new trekking routes: Buddhists circuits, homestays in rural environments (Box 1), and wildlife tourism in protected areas (see TECS 1998; ADB 2004; SNV and ICIMOD 2006; Kruk and Banskota [in preparation]).

To add to these initiatives and to promote incentive-based conservation of the landscape, ICIMOD and its partners identified six conservation corridors and developed comprehensive participatory plans for eastern Nepal, Darjeeling, and western Bhutan. These plans also recommend various eco-friendly tourism products such as village tourism, homestays, and new trekking routes as alternative options for economic development and conservation. Some of the actions recommended are alternative treks to Sandakphu through Ilam, homestays in some of the village development committees (VDCs) in border areas; village tourism in and adjacent to protected areas and corridors, and wildlife tourism in Hangetham, Ilam (Table 1). Being a transboundary complex, the potential for developing trekking trails across the border along the Singalila ridge and the Sikkim, Darjeeling, and Bhutan triangle was recognised and facilitating tourist flow across the landscape with cooperative understanding between the Governments of Nepal, India, and Bhutan was recommended.

Box 1: Homestay as a tourism product

Homestay is a form of tourism that develops micro-enterprise and employment opportunities through household-owned and operated accommodation, as well as through related-guide services and interpretation that would enhance a visitor's experience of villages and their surroundings. With good numbers of tourists flowing into the area, there is a high potential for the people to provide accommodation and facilities, which is environmentally responsible and which promotes the local economy. For example, a homestay would include fuel-efficient cooking and heating, and indigenous composting toilets that are hygienic, as well as other resource-efficient and environmental friendly services.

The homestay practice also provides an opportunity to strengthen the local culture and tradition in terms of hospitality, use of decor, cuisine, and buildings, while encouraging cultural and environmental conservation. On the other hand, it is a good opportunity for visitors to learn about local mountain cultures through local guides and from the experience of staying with a family. In addition, through nature guide and interpretation services, the community would be able to focus on their natural wealth, such as the snow leopard and its role in the maintenance of natural heritage.

Such conservation-based entrepreneurship is gaining impetus in many villages of Sikkim and Darjeeling and also has great potential in the proposed corridor areas.

Prevailing Challenges

Traditionally, the chief occupations of the people of the Kangchenjunga landscape are agriculture, agroforestry, horticulture, and animal husbandry. Agricultural practices in these hills are mostly subsistence, characterised by low input, low risk, and low yields. The geometric progression of the human population exerts pressure on traditional practices and leads to the fragmentation of landholdings. Hence, there is an urgent need for diversified income-generating activities to limit the pressure on forest resources and protected areas used by wildlife as habitats.

In recent years, Darjeeling, Sikkim, and Bhutan have received increasing numbers of tourists. One of the reasons for this growth could be the political instability in neighbouring Nepal. This increased dependency on tourism for their livelihoods has forced the people of this region to play marginal roles as commission agents, menials, cooks, drivers, and porters. Moreover, most of the destinations located in wilderness areas are visited less than other places due to lack of information, lack of skilled professionals, and inadequate accommodation facilities. On the other hand, convenient (with comparatively better visitors) amenity destinations are overcrowded. All these factors have led to promotion of tourism in organised groups, which results in less spending by visitors at the sites visited.

Tourism development planning should be integrated with other community development and conservation plans in order to promote diversification of livelihood opportunities in mountain areas, rather than being overdependent upon tourism per se (Rai and Sundriyal 1997; Banskota and Sharma 1998; Lama and Sattar 2002). Keeping this as a principle, the Governments of Nepal, India, and Bhutan are rethinking strategies and developing attractive products for

Table 1: **New ecotourism products envisaged by the local people in different corridors of the Kangchenjunga landscape**		
Country	**Corridor**	**Product**
Nepal	1. Ilam-Panchthar-Taplejung corridor	Village tourism New trail to Sandakphu Bird watching Promotion of Nepali paper Skilled human resources
India	2. Singhalila National Park-Senchel Wildlife Sanctuary corridor	Village tourism Homestay Skilled human resources
	3. Senchel Wildlife Sanctuary-Mahananda Wildlife Sanctuary corridor	Village tourism Homestay Skilled human resources
	4. Mahananda Wildlife Sanctuary-Neora Valley National Park corridor	Homestay Skilled human resources
	5. Neora Valley National Park-Toorsa Strict Nature Reserve corridor	Wildlife tourism Bird watching Skilled human resources
Bhutan	6. Toorsa Strict Nature Reserve-Jigme Dorji National Park corridor	Promotion of monasteries Homestay Skilled human resources

tourists. Emphasis has been given to eco-friendly products linked to conservation targets. Most of the planning has taken place through a top-down approach without people's participation. The participatory plans developed by ICIMOD and partners for promoting conservation corridors revealed that there is great potential for diversifying tourism in the identified corridors. It also became clear that planning should be done with the communities using an innovative approach that addresses local people's aspirations for economic well-being. To achieve this, the entrepreneurs, governments, and developmental organisations concerned have to come forward and facilitate the engagement of communities living in these areas.

Although the Governments of Sikkim and Darjeeling, Nepal, and Bhutan are promoting the area with various trademarks, there is still a lack of initiative in terms of making products regional entitities and benefiting from the vast landscape. Government tourism planners should work with neighbouring jurisdictions so that appropriate plans can be made to promote transboundary tourism as a unique attraction and bring about benefits on a regional scale. Even though many community-based initiatives, such as 'homestays'and 'village tourism', are found in some areas, they are still lagging behind simply due to lack of political will. Hence, these initiatives have not received due credit.

The Kangchenjunga landscape has numerous tourism products to cater to the varied interests of tourists. It is rich in wildlife, culture, scenic beauty, and pilgrimage centres. These potentials have not been realised through appropriate marketing strategies and policy support from the governments concerned to attract the special interests of tourists. The countries sharing this landscape need to work together and promote ecotourism products in such a way that they cater to the various market segments. Market research on tourist arrivals needs to be carried out on a regional level. Currently most of the destinations and visitor activities are city centric

and many promising areas with ecotourism potential have been neglected. The various departments and agencies involved in tourism should create programmes and strategies to diversify tourism areas for the benefit of poorer sections of society. In this respect, it is important to establish a proper benefit-sharing mechanism to ensure that benefits not only accrue to outside tour operators and service providers, who tend to exploit marginalised mountain communities. Mechanisms should be put in place so that fair benefits are ploughed back to local communities and a portion reserved for conservation activities.

Conclusion

The Kangchenjunga landscape is an important trajectory area for tourists interested in visiting Nepal, India, and Bhutan. The landscape has diverse existing as well as potential products to cater to the ever-increasing tourism flow. Diversifying the products would definitely reduce the crowds and concentrated tourism flows in selected destinations and also give the rural populace living in the corridor area incentives for remaining in wilderness areas and conserving the rich biodiversity. Emphasis must be given, however, to developing quality products at village level by strengthening planning and management skills and linking products with demand and supply; and for this the active participation and facilitation of the private sector is essential. Apart from these, to tap the potential of ecotourism for rural people and to offer them direct benefits from wilderness areas, the various community-based and non-government organisations and government authorities have to come forward and facilitate communities who are offering to diversify such products, especially in areas such as human resource development, development of low capital businesses such as homestays, and village tourism and link them to the mainstream tourism market. More importantly, a mechanism is needed to take advantage of geographic and ecological contiguity across the landscape and facilitate cross-border tourism with policy support and cooperation from the countries sharing the common landscape.

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Potential Micro-Enterprises and Income Generating Activities in the Kangchenjunga Landscape

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Enhancing livelihood options for rural communities living on the fringes of protected areas is vital for the conservation and effective management of biodiversity.

Introduction

Increasing populations and dependency of communities on forest resources for their livelihoods; issues related to rights and tenure; human wildlife conflicts; alienation of communities; and pressures from market forces are increasing threats to biodiversity (Kothari et al. 2000). Biodiversity management in and near protected areas is not possible without the participation of local communities, and they need to be given adequate alternatives in order to meet their needs for secure livelihoods (Sharma and Chettri 2003). Most forest-dependent communities are poor and isolated from major development interventions. Their poverty is exacerbated by limited information, opportunities, capacities, and external support.

The Transboundary Biodiversity Management initiative implemented by ICIMOD focuses on developing conservation corridors between protected areas of Bhutan, India, and Nepal and on addressing conservation at the landscape level through regional cooperation (Sharma and Chettri 2005). It aims to address the twin challenges of improvement in living standards and biodiversity conservation (Chettri and Sharma 2005). The way to reduce pressures on biodiversity and improve natural habitats is to introduce alternative livelihood and income-generating options for forest-dependent communities and, in turn, involve them in the conservation process (Jodha 2004).

A short field research project was carried out in 2004 in an attempt to assess possibilities for micro-enterprise development and other income-generating potentials opportunities among communities in the proposed Kangchenjunga landscape. The purpose of the study was to understand the conservation and development issues and the potentials and constraints.

Methodology

Participatory research was carried out among three distinct categories of stakeholders, development professionals, and experts; non-government organisations (NGOs); and community members, including the key resource persons. Interviews and focus group discussions were used to gather information. Field visits were also made to the corridor sites to understand the current development interventions. In addition, discussions were held with private entrepreneurs, marketing agents, and representatives of civil society from Bhutan, India, and Nepal.

Conservation and Development Practices and Issues

Views of experts and NGOs

The major issues presented are related to agriculture, horticulture, floriculture, forest products, cash crops, and potential income-generating technologies. In agriculture, the priority concern is the problem of disease and decreasing productivity of high-value cash crops. The production of organic fruit and vegetables and floriculture – including production of bulbs, flowers, seeds and saplings, and cultivation of orchids, dye, and medicinal and aromatic plants – are considered areas with potential benefits for communities. Ginger is an important cash crop that provides income to farmers during the festive season (October), but the negative effects of its cultivation on soil fertility cause concern. The cultivation of broom grass is emphasised (Box 1) because it is not so labour intensive and provides fodder as well as income from the sale of brooms.

Livestock is another important sector highlighted by different stakeholders, but there are differences of opinion between the choice of improved and local breeds. Some people express serious concern about the depletion of local breeds, such as the 'siri', and the introduction of European breeds. HIMUL, a semi-government milk marketing and processing corporation is playing an active role in purchasing milk and in providing animal health-care facilities in the project areas in Darjeeling.

Box 1: Plantation and use of 'Amliso'

'Amliso', a broom-grass (Thysanolaena maxima), has been domesticated in Darjeeling district for the last three decades. 'Amliso' promotes sustainable use of fragile and degraded land, provides fuelwood and fodder during lean periods, and generates income from its infructescence. It is commonly-used for making brooms. 'Amliso' plantation has a cycle of about six years in which five annual harvests are taken. This cycle generates a net revenue of US$ 3,374 per ha against a total investment of US$ 1,995 per ha, a return of nearly 1.7 times the cost of investment. If the cultivator is self employed, then the return goes up to 4.4 times the initial investment (Uma et al. 2001).

The degree of threat to medicinal and aromatic plants, mainly due to indiscriminate harvesting and falling productivity in natural areas, is another concern. A significant breakthrough includes the cultivation of *Swertia chirayita* ('chiraito') by communities in many areas within the proposed landscape. The intervention of the 'Panchavati Greentech Research Society (PGRS)', a local NGO based in Darjeeling, helps communities cultivate and sell seedlings of chiraito locally.

Cinchona cultivation, promoted by the Government of West Bengal, is facing problems due to declining markets and inadequate management skills. The government is sceptical, therefore, about trying other herbal species; hence the non-timber forest product (NTFPs) sector has remained largely untapped in the region, despite the presence of vast academic information. The SERVE project of WWF-India is contributing to economic development activities, conservation of indigenous tree species, and protecting watersheds.

A new concept of tea tourism has also been initiated by the SERVE project in Teenchule village which has been promoted as a model village for ecotourism in Darjeeling. Communities manage the entire process and it is claimed to be successful.

Views of communities

Communities lack adequate sources of income for leading a proper life. They had issues of deteriorating conditions of soil on their farms, lack of stable income from farming due to fluctuating market rates, and an increasing incidence of diseases in their main crops such as cardamom and ginger. The shortage of fodder is acute and natural water sources are drying fast. Communities have to depend on non-farm work (daily wages and labour) to meet their subsistence needs for a considerable portion of the year. People have very limited access to credit and loans from the government to invest in alternative activities. Illegal felling of trees from the forests is a serious concern for local communities. Rights over forests are restricted and coordination between the forest department and village-level organisations needs to be strengthened.

Constraints

The various constraints to developing micro-enterprises and alternative income- generating activities, according to the stakeholders and from personal observations, include the following.

- Lack of capacities and skills
- Lack of information and awareness
- Poor state of development interventions in the project areas
- Lack of community mobilisation
- Lack of credit facilities
- Poor integration with government development schemes
- Lack of stable markets
- Lack of proper demonstration sites
- Unsupportive policies
- Lack of a scientific approach to NTFP development.
- Low levels of disposable income and risk-taking abilities.

Discussion

In protected area management practices, the needs of people were always sidelined and their relocation has been thought to be the most practical solution to achieving conservation objectives. But relocation is an extremely difficult process and invites conflict. Therefore, many recent conservation policies have highlighted involving communities in the conservation process (Box 2).

Box 2: Eco-development

Eco-development was launched as a centrally-sponsored scheme in the 1990s to reduce the dependence of people living within PAs and the areas surrounding PAs. The scheme began as a site-specific village-level programme advocating the sustainable use of village resources, providing alternatives to fuel, fodder, and timber and also creating job opportunities for individuals and families, ensuring the active participation of people in conservation (Campbell 1992).

To ensure community participation in forest and biodiversity conservation, joint forest management (JFM) in India, community forestry in Nepal, and community-based natural resource management (CBNRM) in Bhutan were introduced to involve people in the protection and conservation process. Participatory approaches of this sort to forest and PA management are limited in the proposed landscape; and the approach of targeting community forest institutions for conservation and improvement of livelihoods provides limited scope. The potential intervention group for large-scale dissemination and impact appears to be interventions in micro-enterprise development at the village level.

Since most of the villages in the proposed project areas are remote, community mobilisation around options to introduce conservation and livelihood improvement programmes is crucial. Despite the availability of schemes and policy guidelines on community participation, there are several lacunae in their operation and implementation, and, as such, the success and impacts on people's livelihoods, and people's participation in biodiversity conservation, remain questionable: not least because most of these areas have very limited development support from the government and other development agencies.

Recommendations for Potential Areas of Intervention

An integrated approach

With increasing population and falling productivity of farmlands, generating alternative sources of income is essential. It is important to promote activities that balance the need for conserving biodiversity and meet the requirements of local communities, on the one hand, and promote technologies and skills that can provide additional income on the other. A single intervention cannot raise the living standards of communities and will require an integrated approach for holistic development.

Community managed micro-enterprises; introduction and production of high-value niche products and services; capacity and awareness raising; and access to resources, technologies, and markets could be strategies to mainstream economic activities.

Improving the productivity of current farming systems

This is the most vital issue faced by the communities in the proposed landscape. Interventions for improving the productivity of the subsistence systems are much needed. Regarding high-value cash crop farming, the incidence of disease in cardamom, the most valuable cash crop in the region, may cause problems in pursuing traditional agroforestry based on *Alnus* and cardamom. Cardamom plantations are being replaced by broom grass, a much less valuable plant for local communities. The possibility of introducing other off-season cash crops and improving soil fertility should be explored. Compost making can be integrated into this approach to improve soil fertility.

Strengthening and promoting development initiatives

Involvement of development organisations in the project locations should be promoted. This can be achieved by educating local NGOs to take an interest in conservation and community development initiatives and by providing them with appropriate tools and options to initiate relevant programmes. A network of village development organisations such as the forest protection committees (FPCs), eco-development committees (EDCs), and community forest user groups (CFUGs) can facilitate information sharing and local action.

Existing local institutions like the panchayats, FPCs, and EDCs in India, and CFUGs in Nepal should be strengthened. They should be made aware of different development schemes, policies, financial markets, technologies, and methodologies. Training and capacity-building programmes that enable them to plan and initiate development activities should be carried out.

Linking to micro-credit and micro-finance institutions

Communities should be organised and self-help groups could be formed to inculcate the habit of saving and enhance financial security. There is a huge potential for securing micro-credit from local and national governments, financial institutions, and cooperative banks. Micro-credit is a very important input for developing appropriate livelihoods and enterprise strategies

as middlemen play a vital role in providing credit to farmers. Micro-credit should be taken as an important component in the entire enterprise and in income-generating activities. The concept of village banks and consumer cooperatives should also be explored.

Development of market linkages

Apart from the existing markets, local retail markets should also be developed. Establishing retail networks for rural farm products could be another option. The role of marketing organisations in selling farm products should be analysed. Organising the urban-educated unemployed and local NGOs to form marketing associations on a profit basis could help to link producers to markets. Such organisations can develop market linkages and pass on the necessary information to producers and purchase in bulk from them. The potential to develop linkages with the government, army institutions, tea estates, hotels, and restaurants – and not just markets in the plains – should be explored.

Community ownership in such organisations can also be developed through issue of equity shares. Strengthening existing institutions such as 'Teesta Tours and Agro Trade', a private company based in Siliguri, could be a starting point for introducing the process in Darjeeling.

Promotion of appropriate technologies

Other income-generating activities, which have minimum negative effects on the environment, such as beekeeping, have a lot of potential in the project areas. In areas where bee flora are abundant, beekeeping could provide a good source of income. The ICIMOD beekeeping project can contribute a lot in terms of providing training and technologies to communities and NGOs; but caution should be taken in and near tea estates where the use of pesticides is very high. Other technologies, such as low cost renewable energy systems, which could provide alternatives to firewood, or that use use water efficiently, should also be explored. The current dairy development situation should be studied and appropriate recommendations and strategies for the development of the sector promoted. Successful angora rabbit farming enterprises should also be studied.

Agroforestry promotion

Agroforestry provides the best opportunity for creating green belts and providing corridors for the movement of animals. There are already good practices in cardamom-based agroforestry in the areas and it should be strengthened. Indigenous, fast-growing tree species, which have a potential demand in the private sector (Box 3), should be researched and integrated into agroforestry plantations, village forest, and wood-lot activities.

Box 3: Towards community benefit

The private sector has played an enormous role in promoting agroforestry in the Punjab, Haryana, and western Uttar Pradesh in India after the Supreme Court of India imposed a ban on green felling. The majority of plywood industries from North East India shifted to these places and new industries were established. The process initiated by WIMCO Limited, known for manufacturing matches, is a good example of integrating forestry and the private sector to increase community gains (personal observation).

Cooperation

Collaboration with the government will enable leverage from existing schemes and programmes and communities will gain if programme activities are included in the plans of local development authorities. The NGO network in Darjeeling could provide a platform for promoting project goals, objectives, and activities among different stakeholders and generating a common understanding. This can be linked to enhancing development activities in the project locations by developing expertise in different sectors.

Organic certification, as in the case of tea in Darjeeling, is successful due to participation of the private sector and strategies to certify other indigenous products, e.g., ginger, cardamom, and so on, through collaborating with NGOs and the private sector have potential.

Capacity building

Improving the capacities and skills of the different stakeholders involved in activities will be essential to bring about a positive impact on conservation and livelihoods. Training on different aspects of conservation, resource planning, micro-credit, development of micro-plans, technologies, enterprise development, marketing, and business management will be vital for success.

Ecotourism promotion

Ecotourism has immense potential in the area and it is being introduced in some places, although on a small scale. The tourism sector has the potential to boost rural enterprises and different allied activities without creating too much dependency on outside forces. If properly planned and executed, ecotourism can provide equitable benefits to different sections of society by minimising leakages and providing a market for local products.

Promotion of NTFPs for income generation

NTFPs are another option for improving livelihoods and enhancing conservation in the project areas. The fibre-yielding species, *Daphne* and *Edgeworthia*, growing in the project area could provide scope for local-level cultivation, processing, and value addition for hand-made paper. Similarly, other medicinal plants, such as *Swertia chirayita*, *Gloriosa superba*, *Piper longum*, and *Aloe vera*, can be cultivated and marketed. Manufacturing of vegetable dyes using 'manjith' is another possibility. Strategies to incorporate cultivated herbs as ingredients in herbal tea can be developed.

Conclusion

The Kangchenjunga landscape is an area with great potential for developing micro-enterprises. The past history of Darjeeling in tea, timber, and tourism has made it an area of immense potential for entrepreneurs. Demands for broom grass and cardamom have made the landscape a very productive area. There are other potentials, however, such as NTFPs, dairy products, apiaries, and organic farming. Facilitation by ICIMOD and other development organisations, interventions by the private sector, and commitment from local entrepreneurs and governments

in the field of poverty alleviation through micro-enterprise development, would definitely bring about a positive attitude towards conservation.

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Section 4

The Policy Perspective

Bandana Shakya

Policy Issues of Land-Use and Land-Tenure Systems and Natural Resource Management in the Proposed Conservation Corridors in Darjeeling

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The effort of conserving biodiversity by establishing conservation corridors should be in consonance with the policies pursued at various levels.

Introduction

Darjeeling is an important district in the state of West Bengal, India. It has a rich biodiversity blended with a diverse culture. Covering an area of 3,255 sq.km, the district is located between 26°31′ and 27°13′ N and 87°59′ 30″ and 88°53′ E. It is divided into three subdivisions; Kalimpong being the largest (1,057 sq.km), followed by Darjeeling (936 sq.km) and Kurseong (425 sq.km). It shares boundaries with Nepal to the west, Sikkim to the north, and Bhutan to the east. There are five important conservation areas in the form of wildlife sanctuaries and national parks covering above 10% of the total land area (CEPF 2005). These protected areas are scattered as 'islands' of conservation without the connectivity needed to ensure the long-term survival of species. In 2003, the International Centre for Integrated Mountain Development

(ICIMOD) introduced a landscape approach to conservation focusing on developing connectivity and transboundary cooperation (Sharma and Chettri 2005). Through consultations with experts, conservation authorities, and civil society and through research, it was found that there is an urgent need to establish forested paths or conservation corridors between different protected areas in this biodiversity-rich pocket of the eastern Himalayas (Pradhan and Bhujel 2000). Following a consultation held in Darjeeling in 2003, research on different aspects of biodiversity conservation measures was commissioned from different experts and institutions. This paper is part of this research endeavour.

The report is generated from a comprehensive study carried out on policy and land-tenure aspects in three of the potential corridors: Singhalila National Park (SNP) with Senchel Wildlife Sanctuary (SWS); Senchel Wildlife Sanctuary with Mahananda Wildlife Sanctuary (MWS), and Mahananda Wildlife Sanctuary with Neora Valley National Park (NVNP).

The major objectives of the study were to

- Review policies on natural resource management and land-use and tenure systems for each of the identified corridors emphasising the gaps;
- Analyse social, economic, and environmental issues for each corridor; and
- Develop a framework of joint action between institutions in order to develop conservation corridors, taking community participation as the key element.

The basic criteria for selection of corridors were based on consultations, assessment of natural migration routes of wildlife, the existing forest cover, the number and width of the gaps, and the presence of large settlements. Since major sections of the corridors pass through government reserve forests, a detailed study was carried out to examine gaps or bottleneck areas.

Results

The research revealed that there are three potential corridors in Darjeeling that were once naturally connected to the three key protected areas. The detailed findings from the corridors in terms of land-use pattern and land-tenure systems, and their relationships to national and regional policies, are given below.

Land-use patterns and gaps

Corridor I: Singhalila National Park- Senchel Wildlife Sanctuary

This corridor passes through a continuous belt of montane, wet temperate broad-leaved forest with occasional patches of *Cryptomeria japonica* and *Alnus nepalensis* plantations mixed with other broad-leaved forests containing species such as *Symingtonia, Machilus, Castanopsis,* and *Magnolia*. The altitude varies from about 2,000 to 2,500m. The forests are mostly reserve forests except in the gaps identified below.

The first gap is the linkage between Little Rangit River and Manebhanjang block. In terms of tenure rights, there are two categories of forest: government-owned forest and private forest. The government-owned forests are mostly temperate broad-leaved forests dominated by

Cryptomeria with occasional stunted bushes. There are small patches of 'khasmahal' forest (a category of forest that is allocated for public use). Private forests are dominated by plantation of species such as *Alnus, Castanopsis, Eurya, Symplocos, Ficus, Saurauia nepaulensis,* and *Ficus nemoralis*. About 25% of the area is under agriculture.

The second gap is the link area between Ghoom Bhanjang and Dhooteria block of Wildlife Division I. In this gap, the reserve forests are comprised mostly of temperate broad-leaved forests and plantations separating 'khasmahal', vested forests, and tea gardens. The private lands and vested forests of approximately 0.1 sq.km fall under Darjeeling Gorkha Hill Council and are covered with mixed plantations of *Alnus, Acer, Castanopsis,* and *Michelia* as dominant species followed by *Eurya* and *Symplocos*. There are patches of plantations of *Ficus roxburghi, Saurauia nepaulensis,* and *Ficus nemoralis*. Tea estates account for approximately 0.02 sq.km of land, whereas settlements cover 0.01 sq.km with a few houses. The vested forest linking the two forest blocks of Ghoom Bhanjang of Darjeeling Forest Division and Dhooteria Block of Wildlife Division I, still contains young forests in good condition. This patch of forest now occupied by the villagers could be converted into a community-conserved area with proper motivation and incentives. A narrow belt of forest in the upper reaches of Kusumbing Tea Garden (locally known as Bhalukhop) could be used to link the Ghoom Bhanjang block of Darjeeling Forest Division in the east which, if maintained, would make it a viable corridor.

Corridor II: Senchel to Mahananda Wildlife Sanctuary

This corridor is comprised of more or less continuous montane temperate forests to subtropical wet hill forests. The fringe villages ('khasmal busties') include Middle Mamring, Toryok, Mana Khas, Tham Khas, Ghaletar, Selpo Khas, and Latpanchar Cinchona Plantation, whereas forest villages such as Sixth Mile Busty and Larmat Forest Village are covered by forest protection committees (FPC). Eco-development committees (EDC) cover Jholi, Siltong, and six acres of Cinchona villages.

Along this corridor, there are a number of key seasonal ponds such as Namthang Pokhari, which are important natural habitats for the Himalayan newt (*Tylototriton verrucosus*). The significant feature of this corridor is that it runs along one ridge and both sides of the ridge support good vegetation and connect directly to Mahananda Wildlife Sanctuary without a major bottleneck. Interaction with the fringe villagers revealed that barking deer (*Muntiacus muntjak*), clouded leopard (*Neofelis nebulosa*), jungle fowl, (*Gallus gallus*), and other small animals use this area as their extended habitat. In order to make the corridor secure and also to improve the vegetative cover , supplemental planting in an agroforestry system is required. This is also necessary to provide some economic benefits not only to forest villagers but also to the people living on the fringes of the proposed corridor. It will motivate them to provide shelter for the straying wildlife, and would ensure its safe passage through village areas.

Corridor III: Mahananda Wildlife Sanctuary to Neora Valley National Park

The corridor runs along the three subtropical reserve forest ranges, Chel, Noam, and Neora. Most of these subtropical forests are contiguous and link to Neora Valley National Park. There are two fringe villages in each of the above three ranges which have been institutionalised as

FPCs for effective management of the natural resources. The forests are mostly covered by tropical and subtropical species but, in the upper reaches, some species in temperate forests, such as 'rani champ' (*Michelia doltsopa*) and 'kawla' (*Machilus edulis*) were also recorded. The tropical belt is dominated mainly by sal (*Shorea robusta*), teak (*Tectona grandis*), and lampate (*Duabanga indica*).

There are a number of tea gardens on the fringes of the corridors: Ellenbari, Washabari, Bagrakot, Manabari, and Pathar Jhora. The first two tea gardens have the corridor passing along the boundary of the garden, but in the case of Bagrakot and Pathar Jhora, the corridor passes through the gardens. In the Pathar Jhora abandoned tea garden there is a corridor path where villagers earlier used to grow paddy. There are some wasteland and rock outcrops on the elevated river bed.

Land-tenure system

There are a number of land-tenure systems along the corridors. Reserve forests, which are dominant in all three corridors, are under the control of the Forest Department and under a strict management regime. 'Khasmahal' forests, though owned by the state government, are meant for public use. Most of the private lands are 'raiyati' lands (Box 1). They are classified according to their use, such as 'ghareri' (home), jungle (forest), 'sukha khet' (dry agricultural land), 'jhori' (bushes), 'alaichi' (cardamom) cultivation, orchards, 'nali' (drain), 'bato' (road), and tea garden. Such lands are tenanted and the raiyats have absolute hold and are given 'patta' defining the area, classification, and so on. To change the classification and use, it is necessary to have the additional district magistrate's (ADM) permission and sanction with a no objection certificate from the management (in the case of tea estates). For 'khasbasti' users, rights are as per land classification. Land given on lease to tea estates is governed by the standard lease document.

Socioeconomic and Environmental Implications

The Singhalila National Park-Senchel Wildlife Sanctuary corridor area, being at high altitude, is agriculturally not as productive as other areas, so can be converted into a community-conserved area with the introduction of an agroforestry system. The agro-forestry scheme will bring about change in the monoculture currently being practised, thereby enhancing environmental values with positive economic benefits accruing to the community. The initial

Box 1: Raiyats

Defined by the West Bengal Land Reform Act 1955 and subsequently amended in 1981, 'raiyat' means a person or institution holding land for any purpose whatsoever. 'Raiyats' are not entitled to sub-soil rights and there are certain restrictions to the rights of 'raiyats' in Sadar, Kalimpong, and Kurseong sub-divisions of Darjeeling District. The collector, from time to time, gives directions regarding the form of cultivation to be adopted by a 'raiyat' or prohibits cutting more than one tree with respect to his plot. 'Raiyats' require special permission in writing from the collector or another authorised officer of the state government for any extra benefits from their lands.

cost of re-establishment may have to be provided by development projects, however, with all benefits accruing to the villagers.

In the Senchel to Mahananda Wildlife Sanctuary corridor, re-establishment of a forest belt for corridor purposes will benefit the tea gardens by reducing soil erosion and by conserving and regulating water flow. Some of the potential products that can be exploited to provide income-generating activities are broom grass, oranges, ginger, cardamom, floriculture, and small tea cultivation. A market information system and the requisite infrastructural support are required for marketing the produce. Further, there is a significant number of primary and high schools where environmental awareness programmes can be held to promote conservation of biodiversity among children.

West Bengal Forest Development Corporation (WBFDC) has created an ecotourism resort in the Mahananda Wildlife Sanctuary to Neora Valley National Park corridor on the east bank of the Teesta near Mongpong Forest Reserve. The elephants coming from Mahananda Wildlife Sanctuary on the west bank, cross the Teesta and railway track and take temporary shelter here before moving on further east. In the process, the elephants routinely damage the temporary structures put up by the WBFDC for the benefit of tourists. These structures have to be restored every year at considerable cost. Besides elephants, other animals such as barking deer, wild boar (*Sus scrofa*), jungle fowl, and leopards (*Panthera pardus*) are also common. This ecotourism spot is very popular with people coming all the way from south Bengal districts. Although not an easy proposition, this resort needs to be relocated to avoid the elephant track. Selection of an alternative site has to take many factors into account and will require a detailed survey and enquiry.

Another gap through which elephants move occurs near the army camp at Mongpong near Ellenbari Tea Estate just by the side of NH-31. This narrow gap has a small army playground. The next gap is near Bagrakot where the army settlement has about six small huts. Relocation of these huts would considerably ease elephant movement along this tract. Negotiations have to be carried out with the five households (toribari areas) affected by the corridor and an amicable settlement has to be made. A change in the cropping pattern may minimise man-animal conflicts. The communities should also be trained in biodiversity conservation and be acquainted with animal behaviour. The environmental implication is obvious because of various establishments like the railway, defence establishments, tourist centre, highway, tea garden, and settlements along the natural elephant migration route. Mitigation of such problems will be crucial for restoring the ecology and environment in this region.

Biodiversity Conservation, Tenure, and User Rights in the Light of Local, State, National, and International Policies

Under the Convention on Biological Diversity (CBD) (to which India is a signatory), India has agreed to make an inventory of its biological resources, establish a system of protected natural areas where appropriate, and encourage the landscape-level approach (Secretariat of the

CBD 2005). The Vth World Park Congress similarly recommends that governments, inter-government organisations, NGOs, local communities, and civil society promote participatory processes, communication, education, and public awareness for effective conservation and management of protected areas, and establish biological corridors to link protected areas and facilitate species' migration (IUCN 2005). The importance of adopting mechanisms that foster participation of all the stakeholders involved in protected area planning and management should also be stressed.

The Government of India, emphasising people's participation in the sustainable management of natural resources, adopted the 1988 National Forest Policy. Environmental stability, restoration of ecological balance, and preservation of biological diversity were the thrust areas. The 1988 Forestry Policy clearly indicates the importance of providing corridors to link protected areas in order to maintain genetic contiguity between artificially separated sub-sections of migrant wildlife. In June 1990, a circular was sent regarding the involvement of village communities and voluntary agencies in the regeneration of degraded forest lands and the involvement of committed voluntary agencies and NGOs to motivate and organise village communities to protect, afforest, and develop degraded forest land, especially in the vicinity of habitations.

Throughout the country, as many as 27 state governments have adopted JFM resolutions paving the way for forming joint forest management committees (JFMCs). In West Bengal forest protection committees (FPCs) and eco-development committees (EDCs) have been formed pioneering the movement. Darjeeling Gorkha Hill Council has also endorsed the government notification for the JFM falling under its jurisdiction. Therefore, there are enough policy-level institutional arrangements already in place. The Central Government, along with international bodies like the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP) have to play a proactive role in helping stakeholders develop the corridors.

Framework of Joint Action between Institutions for the Development of Corridors

Eco-development is a strategy to overcome unsustainable and incompatible resource use by dependent communities while enabling them to earn their livelihoods in and around protected areas. Stakeholders' participation is the key to success in eco-development. In the case of corridors, it is necessary to move towards planning for larger landscape levels, and integrating protected areas into regional development plans, basing the entire planning process on collaborative efforts amongst stakeholders. During the last three years, ICIMOD facilitated the development of a strategic document and action plans by the Government of West Bengal: these endeavours were for the purpose of establishing corridors through extensive participatory planning and consultation processes at local, national, and regional levels. Potential conservation corridors linking four protected areas were revisited using GIS technology and land-use mapping for each corridor. On the policy front, local conservation initiatives were adopted with policy implications addressed to national and regional levels and the global

initiatives of the Council on Biological Diversity (CBD). The initiative opened up an avenue for experts and government representatives to visualise and discuss conservation and development concerns within the ambit of national priorities that have regional and global implications.

Conclusion

Making the corridors viable would involve planning for a larger landscape than originally envisaged in the context of an individual corridor. Most of the critical watersheds of the rivers in north Bengal are situated in these hills. Despite the ecological importance of the landscape, it has been subjected to great stress and continues to face multiple threats. Connecting the protected areas with corridors has an important role to play in terms of both vertical and horizontal coverage for conservation of this important landscape. Similarly, establishment of the corridors in an effective manner will have social implications. Wise and sustainable use of biodiversity for economic development could be a promising incentive for local communities. One important area in which economic intervention is necessary is developing livelihood strategies based on options for off-farm income generation. Due attention should be given to indigenous knowledge and an additional focus on building upon existing traditional systems would be useful. So far, livelihood strategies have focused to a great extent on alternatives to forest-based resource use rather than attempting to establish participatory management of resources based on well-defined regulations and principles of sustainability. Livelihood strategies should also reinforce positive interaction of protected areas and people. To alleviate pressure from protected areas, productivity of land and water resources (forests, private land, and government-owned land) needs to increase. Mutually beneficial linkages between economic and ecological concerns need to be built into strategies: however, decisions should be taken on a case-to-case basis and include identification of zones from which regulated use could be allowed without undermining wildlife habitats. In the case of non-consumptive benefits, ecotourism has the best potential but needs to be backed up by supportive policies allowing benefits to accrue to local communities. Successful implementation of the corridor concept will not only help conservation of biodiversity but also motivate forest users to use natural resources sustainably. This, in turn, will help restore natural cover on the degraded and unstable hill slopes of Darjeeling. The watersheds will also receive some protection through reduction in surface runoff, soil erosion, landslides, and floods: this should also lead to an overall improvement in the moisture regime in the hills.

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Traditional Practices and Customary Laws of the Kirat People of Eastern Nepal and Comparison with Nepal's Statutory Laws

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Legal procedures have to be compatible with the customary laws and traditional practices that are the legacy of local communities.

Introduction

This research focused on the dominant settlements of Kirat communities in eastern Nepal. These communities follow ancient and nature-based customary laws and traditional practices closely linked to biodiversity conservation, agricultural productivity, and sustainability of human health and nutrition (Shrestha 1997). The objectives of the study were to highlight the customs, traditions, and rituals of this dominant indigenous people from Ilam and Panchthar districts and to study a possible framework for facilitation of customary laws and traditional practices. An attempt is also made to identify the gaps in the statutory laws of Nepal in terms of indigenous customs and traditional practices and possibilities of amendment, especially in relation to biodiversity conservation.

The study covered most of the VDCs in Ilam district but, in the case of Panchtar, only the northeastern part could be covered because of the prevailing security conditions. Both districts are important in terms of the prevailing transborder sociocultural and environmental issues and are well known for their scenery and their many traditional conservation sites.

Customary Laws and Traditional Practices

The Kirat community is composed of four ethnic tribes: Limbu, Rai, Lepcha, and Dhimal. Among these, the Limbu is the dominant indigenous tribe and one of the oldest communities in the Panchthar and Ilam districts of eastern Nepal. Their social, cultural, and economic systems are governed by community norms that integrate well with nature, and there is a rich legacy of indigenous knowledge (Box 1). Traditional practices such as 'shapokchomen' rites (womb worship), 'yangdang phongma' (naming ceremony), 'maggena' (rituals for giving a new life spirit), 'udhauli' and 'ubhauli' (celebrating the changing of seasons), and 'tongsing' (ancestor worship) are closely associated with livestock, agriculture, farming, and forest products.

Box 1: Culture and biodiversity

The 'ahal' or water dyke is established in a open areas nearby to be used for grazing and bathing buffalos. Pastureland species, many aquatic animals, and micro-organisms would gather around these areas, maintaining local biodiversity. Similarly, pigs and fowl are an integral part of ceremonies like marriages, births, local festivals, and worship. The indigenous people know how to manage these culturally valuable resources.

Among these customary laws, the conservation of 'ranivana' (community forests) that supply fodder, foliage, fuelwood, and medicinal plants to local communities is significant. In such forests, the responsibility for conservation is given to the head of the local community who, with the cooperation of the people, issues orders concerning use and allocation of forest resources. The shamans and priests established the policy of ranivana conservation which are now being conserved as community forests.

'Kharka pratha' is another example of a customary land-use law through which the community would assign 'kharka' (pastures for grazing cattle). Similarly, 'mahavir' or bee cliffs were traditionally maintained by Limbus and Rais. There were also customary laws governing fishing in rivers and streams and taking care of water resources. With the implementation of the Land Reform Act 1964 and the Land Registration Act 1962, the rights of local heads were seized and transferred to the revenue office. This created conflicts and land ownership problems (Oli 1995).

Institutional Framework and Implementation Procedure

The institutional framework that provides support and implements traditional practices and customary laws was closely associated with the 'kipat' land system (Box 2) and the Limbu

community (Shrestha 1997). Two types of institutional framework were recognised: formal institutions such as the 'amal' (local court), 'amini' (appeal court in the transboundary zone), and 'adalat' (appeal court in the non-transboundary zone); and informal institutions such as traditional religious bodies, social organisations, and individual intermediaries.

Box 2: Traditional land-use system

The 'kipat' system is a particular land-tenure system associated with the Limbu community. It represents a communal form of land tenure inherited by the same communities from their ancestors as a source of livelihood. Traditionally, kipat rights were recognised not only for cultivated land but also for wasteland and forest. The kipat system went through a long history of political changes from 1774 to 1950. With the implementation of different acts, the kipat system ended in 1964.

The subba (head) of the amal was called 'amali' or 'pagari subba'. The subbas had the legal power to rule on community issues regarding forests, rivers, pastures, wetlands, and religious sites. They were the people responsible for making decisions about conservation and restoration issues: however, while making decisions, experienced elders were often consulted. The central government would then depute the military authority to collect revenue, 40% of which went to the subbas as 'khangi' or wages.

With great reverence and faith, common people accepted many of the religious sites and temples as symbols of their customary laws and traditions. Social bodies such as 'samaj', 'chumlumg', and 'manghim' played a significant role in shaping social institutions. In addition professionals, such as the 'shikari' (hunter), 'bijuwa', or 'phedangba' (healer or priest), and 'dhami' or 'jhakri' (protector), were greatly respected for carrying out social and cultural rites.

Sharing information and executing customary laws were mostly oral except in cases of conflict. The community heads passed the laws orally and individuals would abide by them. The legacy of harmonised command and control generated a sense of social pride in the community and faith in their traditional and customary laws. The old 'Muluki Ain' (Civil Code 1854 AD) was also in support of customary laws, and dispensed justice based on customs and traditions.

Implementation of traditions and customary laws was carried out through a bottom-up approach with social institutions as a mediating factor. There was a network of communities closely related to each other. Issues were presented orally before community members and witnesses, discussions, verification, facts, submissions, vows, and oaths were taken in making decisions. Conservation of biodiversity was deeply embedded in many cultural traditions; for example, cleaning heritage sites before big festivals, prohibition of hunting during breeding seasons, weeding of ranivan after the rainy season, and extracting timber before summer budding. Such actions were based entirely on natural processes and traditional knowledge. Transparency, morality, and a strong belief in the sociocultural fabric were the major features that made these systems participatory and successful.

Statutory Laws and Other Policies on Biodiversity Conservation

The review of the statutory laws and other legal policies concerning conservation in Nepal revealed the following.

Private Forest Nationalisation Act, 1956

This act inhibited individual control over vast areas of natural resources. Although it was a positive step towards managing the country's important resources, it gradually developed into a top-down approach of management and the community was ignored.

Panchayat political system

This was established as a public forum in which local people could elect their community heads as representatives in the local panchayat. The system, however, ignored the traditional practices and customary laws and shifted the use rights of the subbas and mukhias over their lands and resources to local revenue, chief district, and local forest officers. With the establishment of the Panchayat government many acts, such as the Forest Act 1961, Aquatic Animals' Protection Act 1961, Land (Survey and Measurement) Act 1962, Land Reform Act 1964, Plant Protection Act 1972, National Parks and Wildlife Conservation Act 1973, and Pasture Lands Nationalisation Act 1974, were passed into law.

Policies and strategies

The current policies and strategies for conservation of biodiversity include the National Conservation Strategy 1988, The Nepal Environment Policy and Action Plan 1993, Forest Act 1993, Environment Protection Act 1996, Nepal Biodiversity Strategy 2002, Sustainable Development Agenda for Nepal 2003, and the Tenth Plan (2002-2007).

With the establishment of a democratic political system in Nepal in 1990, Nepal promulgated the 'Constitution of the Kingdom of Nepal' through which the directives, principles, and policies of the state have provisions related to protection of the environment and conservation of biodiversity. Guided by this constitutional provision, Nepal gradually became involved in international treaties and conventions. This necessitated reform in the existing forest laws, leading to promulgation of the Forest Act 1993. The act takes all the values of the forest into account including social and environmental services. Section 23 of this act empowers the government to delineate any part of the national forest that has special environmental or cultural importance as a protected area. Article 26(4), being a principle of the state policy, proclaims that the state shall give priority to the protection of the environment and prevention of its further damage and that the state shall make special provision for protection of rare wildlife.

Community forestry, leasehold forestry, and statutory laws

Any part of a national forest handed over to a user group for the collective benefit of the community is regarded as a community forest. The history of community forestry in Nepal

began with the concept of a participatory approach to local resource management. His Majesty's Government of Nepal introduced the community forestry programme to improve the condition of the forests in the mid hills and high mountains, as well as to satisfy the basic needs of rural people for forest products.

Any part of a national forest leased to any institution, industry or community, under the current law, for production of forest products, agroforestry, tourism, or farming of insects and wildlife in a manner conducive to the conservation and development of the forest is regarded as a leasehold forest (LF). The major objective behind the establishment of leasehold forests was to alleviate poverty and to improve the ecological condition of degraded forest lands.

Community and leasehold forestry in Ilam and Panchthar

In Ilam there are 202 community forests among which 170 are already handed over to the community. The research carried out discovered that community forests in remote areas are more protected than those along the roadside or those which are easily accessible. In Panchthar, out of a total forest area of 38,500 hectares, 19,207 hectares still has potential to be developed into community forest.

Similarly, there is a large area of pastures and abandoned agricultural land in Nepal by the side of the Singhalila National Park. The pastures used to be leased to herders from India. These areas have a potential for leasehold forestry. The fact of an open and weak border in terms of policing, means that poaching and illegal trade in wildlife and forest species are rampant. Similarly, the upper part of Panchthar around Pauwa Bhanjyang, Silauti, and Ravi has suffered from illegal trade in medicinal herbs. These are serious transborder issues for which cooperation and collaboration are needed (Pant 2002).

Comparison of Traditional Practices, Customary Laws, and Statutory Laws

Although the Gorkha kingdom was guided by an Indo-Aryan philosophy, the Kirats followed Tibeto-Burman ideas. At the onset, the Kirats' traditions, values, beliefs, and customs were supported by the Gorkhas, and they provided them with user rights; however, with a change in social and political perspectives, clear changes were observed in resource management, conservation patterns, objectives, and the process of policy and decision-making.

The objectives of traditional practices and the customary laws were to protect natural resources, to use them for people's daily needs, to maintain the socioeconomic system, and to satisfy natural and supernatural deities by observing their rites. The statutory law, on the other hand, is subject oriented, heterogeneous with broader and wider objectives than customary laws, and with a complicated strategy and framework. This was necessary because statutory laws have to cover health, security, peace, education, and overall development of all sectors of society. The statutes emphasised individual interests for a culture of conservatism and a monetary economy: the concept promoted individualised distribution of natural resources and destroyed the will of the people to conserve resources collectively.

The natural resources that were managed by the community using indigenous approaches included water, forests, land, animals, aquatic life forms, and wild flora and fauna; genetic and species' level conservation was not precisely defined. The statutory laws, on the other hand, are in line with international laws on biodiversity conservation and include more than 50 sectoral articles taking into account the ecosystem, species, and genetic levels of diversity.

The conservation strategy in traditional practices was nature based and social norms and values were strongly executed. People observed these religious, cultural, and social norms strictly and were less oriented towards the commercial exploitation of natural resources. For example, a stone in the river was assumed to be the possession of the river god, so was not taken elsewhere. The statutory law, however, had to take into account the increasing heterogeneity in the social structure, physical development, resource use, and economy; and this had an impact on most of the traditional and customary laws.

Similarly, the decision-making process in customary law involved the active participation of family members in a community with focal guidance from mediators such as elders, priests, shamans, healers, and 'phedangbas'. Gender issues were of least concern. Statutory laws were developed around fundamental and basic human rights and gender issues were highly sensitised; the decision-making process was through a top-down approach using various policies and sectoral laws.

Despite provisions in statutory laws, time and sociopolitical change left community practices abandoned. Because there was little uncentive in the new legal system for the community to follow it, people became unresponsive to the conservation of natural resources (Basnet 1990). In Ilam and Panchthar, however, the effect of statutory laws has been positive in the context of management of community and leasehold forests. People's participation, transparency, good governance, morality, and sense of public welfare, which derived from traditional practices and customary laws, can still be solicited if some reforms can be made in the statutory laws.

Recommendations and Conclusions

An old Limbu saying, "ghar odar ho, vana vandhar ho" or "the house is a shelter whereas the forest is a treasure", indicates that the whole Kirat community has a culture and life-support system based entirely on forests.

Many of the acts and regulations of the 1990 constitution have overthrown customary laws and traditional practices leaving behind an indecisive and confused community as well as exponential resource exploitation. The indigenous community can be more effective in conserving local resources provided they are trained and guided towards sustainable economic practices through innovative programmes such as community and leasehold forestry.

The government should give priority to forest conservation and to developing forest-based industries, ecotourism, and cultural tourism in these two districts and should develop the infrastructure accordingly. An opportunity for income-generating activities based on customary

practices needs to be created. In addition, livelihood options should be addressed along with conservation measures. Biodiversity conservation should focus specifically on transboundary areas for conservation issues such as illegal trafficking, trade, land encroachment, poaching, hunting, and illegal grazing.

The indigenous knowledge of local institutions should be mobilised for conservation activities and communities should be consulted and informed when statutory laws are being formulated. In addition, communities can play an important role in creating awareness about statutory laws, policies, and projects among their people. Similarly, statutory laws related to conservation should be reviewed, amended, and reformed in order to incorporate selected customary laws and traditional practices. Active community participation in policy and decision-making processes should be solicited. Laws need to be implemented at the local level with the support and guidance of the district and national authorities and organisations. Policies should be appropriate, particularly with regard to the use of common property such as forests, pastures, watershed systems, and biological diversity.

The northeastern part of Ilam and Panchthar are close to India and there are many community forests that can be developed into conservation corridors for the proposed Kangchenjunga landscape. Therefore, an agroforestry programme should be introduced into boundary areas to provide livelihood incentives. Restoration of forest cover in the Churia foothills and along other pathways will not only facilitate the seasonal movement of wildlife species, it will also provide resting places for migratory birds. This would form a traditional corridor for cumbersome migratory wildlife such as elephants, tigers, and rhinocerus.

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A Landscape Approach to Biodiversity Conservation: an Evolving Scenario and Policy Perspective

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The Kangchenjunga landscape has been subject to progressive policy changes that have brought about a paradigm shift from people-exclusive to participatory conservation.

Introduction

Humans have co-existed with nature and shaped the earth's landscape for centuries (Bernbaum 1996; Colchester 1997 ; Ghimire and Pimbert 1997). The rise in consumptive use of natural resources, however, brought about an undesirable alteration in the state of nature and the earth's landscapes. However, conservation of resources also evolved at the same time and has a long history from as early as 2000 BC (Gurung 2006). In the early 19th century, the western world made a distinction between conservation and exploitative utilitarian management of natural resources. This contested the relationship between nature and human beings for the first time. Subsequently, an idealistic social construction of nature led to a movement to preserve

supposedly wild or pristine regions (Kollmair et al. 2005). The notion of preserving supposedly wild or pristine nature led to the setting up of the world's first national park in 1872, Yellowstone, in the United States of America. Following the 'Yellowstone model', which laid a foundation for protected area development, thousands of national parks and other forms of protected areas came into existence all over the world (Stevens 1997; Neumann 1998).

The Yellowstone model, perceived as a strict nature protection paradigm (Pimbert and Pretty 1997), emphasised preserving the pristine environment for reverence of nature, human recreation, and scientific investigation. Even though humans inhabited protected areas and had used their natural resources for centuries, the Yellowstone model considered consumptive use of natural resources to be incompatible with the preservation and maintenance of nature's inherent 'wilderness' and untouched state (Colchester 1997; Stevens 1997). Consequently, humans were excluded from protected areas. Natural areas were isolated from humans for conservation. Indigenous and local people were also evicted from their homelands in order to establish protected areas (Muller-Boker 1991; Colchester 1997; Stevens 1997; Straede and Helles 2000; McLean and Straede 2003). Their role in managing the natural resources in protected areas ceased, and nature conservation actually became a source of suffering for them (Alcorn 1993). As conservation began to lose its relevance for local people, establishment and management of protected areas proved to be impractical and difficult (Stevens 1997; Kollmair et al. 2005). Fragmentation of ecosystems, unprecedented biodiversity loss, unsustainable use of natural resources, and irreparable impairment in the quality of ecosystem services occurred.

The 1972 United Nations' Conference on the Human Environment declared that more prudent care for the environment was needed to avoid the consequences of environmental degradation. It also noted major undesirable disturbances in the ecological balance of the biosphere and irreparable destruction and depletion of resources caused by humans. In 1992, the United Nations' Conference on Environment and Development declared that environmental issues would be best handled with the participation of all citizens concerned. In addition, the Caracas Action Plan of 1992 drew up a global framework for expanding protected areas by involving local communities and other non-traditional interest groups. The Durban Action Plan, 2003, reinforced the importance of mainstreaming the participation of local communities and indigenous people in protected area management.

Loss of species in the isolated national parks in North America and Africa was observed. It confirmed that long-term conservation of the species in isolated, protected areas is not sustainable. The realisation grew that it was necessary to conserve species at landscape level, covering a wide range of areas extending beyond the political boundaries of countries. In the 1990s, policies emerged to maintain the integrity of environmental processes by integrating protected areas into more extensive and linked ecological networks. Since 2004, the Convention on Biological Diversity (CBD) has promoted an ecosystem approach as the best means to achieve the 2010 biodiversity target set by the Seventh Conference of the Parties (CoP 7) of the CBD. As a result, ecological networks – connecting core areas, corridors, and buffer zones – are now being set up to improve ecological coherence and conserve biodiversity at the

landscape level. Furthermore, the role of the ecosystem approach to biodiversity conservation is being promoted as an adaptive strategy to climate change (Secretariat of the CBD 2003). In recent years, biodiversity conservation in the eastern Himalayas has also begun to take on a broader perspective than heretofore by taking social, cultural, economic, and political concerns into account (Rastogi et al. 1997; Chettri and Sharma 2006). Protected areas are now being integrated into associated corridors and buffer zones in order to maintain and protect landscapes rather than protected areas only, and provide sustainable livelihoods to local inhabitants living outside the protected areas (Sherpa et al 2004; GoN/MFSC 2006; Wangchuck 2007; Chettri and Sharma 2006). In this chapter, we would like to present the evolving scenarios and policy perspectives developed over time in the Kangchenjunga landscape.

Kangchenjunga Landscape

The Kangchenjunga landscape is one of the five transboundary complexes identified by ICIMOD in the Hindu Kush-Himalayas (HKH) (Chettri and Sharma 2005). The southern part (without PR China) contains fourteen protected areas and six (proposed or impemented) conservation corridors. It has strict nature reserves (6.27%), national parks (43.50%), biosphere reserves (25.24%), conservation areas (19.60%), and wildlife and rhododendron sanctuaries (5.38%). Out of the total area, about 6032 sq.km is protected, areas established to protect species listed in the World Conservation Union's (IUCN) red list and the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) appendices (WWF and ICIMOD 2001). The proposed corridors cover an additional 1,722 sq.km.

Conventionally, conservation instruments in Bhutan, India and Nepal relied on the protectionist approach. Strict rules and regulations were put in place to address the conservation challenges. The policy provisions were inadequate for resolving park-people conflicts and land tenure. Communities residing in protected areas were seen as agents of environmental degradation and biodiversity loss. Lack of local participation in decision making related to conservation and development of protected areas was apparent. Generally, the conservation effort was ineffective.

Keeping abreast of change in the conservation paradigm, these countries embarked on the process of policy reforms: the governments of these countries recognised the need for integrated approaches to conservation. When planning for protected area systems, biosphere reserves, and conservation areas, human ecology is being included (Chettri et al. 2006). New areas have been added to the existing network of protected areas (additional buffer areas to Kangchenjunga National Park to form the Khangchendzonga Biosphere Reserve and a new protected area – 'Pangolakha Wildlife Sanctuary' in Sikkim and Toorsa Strict Nature Reserve in Bhutan). To include representative ecosystems in the protected area system, Bhutan has revised its old protected area system and adopted a new system by notifying a conservation complex and corridors in addition to the protected area system (NCD 2004). India increased the area under the then Kangchenjunga National Park and re-designated it as Kangchenjunga Biosphere Reserve. Nepal designated its part of Kangchenjunga as a conservation area. Across the landscape, community-oriented and biodiversity-based economic development models began

to evolve. Community-based enterprises for recreation became one of the most promising incentives for communities living in the protected areas. People-oriented buffer zone management is emerging. Mainstreaming social and economic inclusion into conservation programmes through community participation is also growing.

The three countries have adopted policies to enable management of protected areas and corridors. The Forest Policy of Bhutan (1974) requires that 60% of the country's land area should be maintained under forest cover. The Forest and Nature Conservation Act (1995), which superceded the Forest Act of 1969, requires the establishment of a national system of protected areas. The protected areas are to be linked by corridors of natural forest and surrounded by buffer zones. This Act also makes community-based management of natural resources a legal requirement. The Act states that forest resources should be managed and used sustainably according to a scientific plan. The National Biodiversity Act (2002) provides for community-based conservation of genetic resources. The Environmental Assessment Act (2000) provides legal measures to safeguard the environment and ecosystems from the negative impacts of development programmes.

In India, people's participation in sustainable management of natural resources has been emphasised in successive policy iterations. The National Forest Policy of 1988, which constitutes a major policy reversal, legitimises sustainable management of forest resources through people-oriented approaches. It recognises collaborative management of forests. The Department of Forests, community groups, and non-government organisations have distinct roles to play. Adoption of modalities to give usufruct benefits to village communities living close to forests to ensure their active participation in afforestation programmes is recognised. The policy dictates that forest management should integrate economic use and ecosystem services of the forests. It rules that forest corridors to link protected areas should be established in order to maintain genetic contiguity between artificially separated sub-sections of migrant wildlife species. Laws have been revised to regulate the implementation of the new policy. The Wildlife Protection Act (2002) and the Biological Diversity Act (2002) were enacted and a National Biodiversity Authority established. The Wildlife Protection Act recognises management of ecosystems at landscape level as a means of ensuring legal protection for wild animals, birds, and plants. In addition, eco-development (known as integrated conservation and development elsewhere) and joint forest management (JFM) modalities have been promoted to secure people-oriented conservation of protected areas and sustainable management of forest resources. Eco-development committees (EDCs) and forest protection committees (FPCs) have been established. Many self-help groups (SHGs) have been formed by women. Community funds have been set up to finance community development programmes out of the revenue generated by sale of forest products.

In Nepal, the Constitution of Nepal of 1990 recognises the importance of sustainable management of the country's natural resources. It provides for the establishment of a Natural Resources and Environment Committee in the House of Representatives. The committee is entrusted with the responsibility of evaluating the policies and programmes on natural resources. The Local Self-Governance Act of 1998 empowers the district development committees (DDCs)

to formulate and implement soil and biodiversity conservation plans. The National Parks and Wildlife Conservation Act of 1973, provides a legal basis for the management of protected areas. The Buffer Zone Management Regulations (1996) and the Buffer Zone Management Guidelines (1999) provide legislative support to address the needs of local communities and resolve conflicts between parks and people. The Aquatic Animal Protection Act (1961) provides legislative protection to the habitats of aquatic species. The Himalayan National Park Regulations (1979) have provisions for local communities to use natural resources for their daily requirements. The Forest Act (1993) recognises the need to manage forests for their ecosystem services and economic value. It also provides for community-based management of forest resources. Initial environmental examinations or environmental impact assessments are mandatory for development proposals involving forests. The 1990 constitution has been replaced by an interim constitution (in early 2008) while a new constitution is drafted. It is not yet known whether this will have any impact the above.

Challenges in the Kangchenjunga Landscape

Protected areas and ecosystems are now employed as a principal means of conserving nature – keeping diverse ecosystems and the well-being of different species, including humans, intact (IUCN/UNEP/WWF 1991; Chape et al 2005). The concept of managing protected areas has evolved from the protectionist paradigm to the people-oriented paradigm. The IUCN definition of protected areas and their classification, however, which is universally recognised, has not undergone revision since 1994. As a result, of the six IUCN categories, categories I and II are strictly against human consumptive use; categories III and IV also emphasise conservation, while category V envisages conservation along with recreational use. Category VI is the latest and recognises the aspirations and needs of local people and the importance of protected areas for the sustainable livelihoods of the local inhabitants and vice versa (Chape et al 2005; Scheri et al 2004). In essence, the scope for sustainable use of natural resources by local inhabitants beyond the subsistence level has not broadened (Gurung 2006). Category VI represents only about 23% of all protected areas (Chape et al 2003). The relevance of protected areas for providing ecosystem services and conserving biodiversity remains questionable unless protected areas are relevant to local development strategies and address the needs and aspirations of local inhabitants (Wilshusen et al 2002; Pimbert 2004; Scheri et al 2004).

Over the last three decades, efforts to conserve biodiversity in the Kangchenjunga landscape has gradually shifted from law enforcement and use restrictions towards participatory approaches emphasising equitable and sustainable use of natural resources (Chettri and Sharma 2006; Gurung 2006). The paradigm shift in conservation facilitated positive policy, institutional, and management initiatives in member countries. People 'exclusionary' to 'community-based' conservation evolved; however, there is still a long way to go before 'community-based' conservation becomes effective. For instance, at the moment, in the Kangchenjunga landscape, only about a quarter of the protected areas fall into the category in which people-oriented conservation can be practised.

The governments of the countries participating in landscape conservation have demonstrated their commitment to involve communities in the management of natural resources in protected

areas, buffer zones, and corridors. The policies of some countries, however, appear to give more importance to conservation than to the livelihood needs of local communities, whereas the policies of other countries seek to integrate conservation and livelihood needs. Equity or fairness in the management of common property resources needs the inclusion and representation in decision-making bodies of those who are poor and socially marginalised (Balasinorwala et al. 2004). Ensuring rights of access and benefits for the communities, particularly the poor and socially marginalised, is critical for governance of natural resources. Integrated conservation and development still lack demonstrable notable successes and convincing cases that show the effective reconciliation of people's development needs with protected area management (Wells et al 1999; Salafsky and Wollenberg 2000). Even policies seeking to integrate conservation and development suffer from gross inequity in resource distribution and decision making within community-based management regimes (Malla 2000; Bhattarai and Ojha 2001; Paudel and Ojha 2002).

A new scientific summary of the Intergovernmental Panel on Climate Change (IPCC) confirmed that global climate change would present practical challenges to local ecosystems (IPCC 2007). More extreme weather events, such as longer than usual droughts, higher than usual temperatures (milder winters), heat waves, and changes in local natural resources (such as biodiversity and water), will occur. Climate change will impact the natural landscape, human health, infrastructure, socioeconomic conditions of communities, and ecosystem services. Agriculture, forestry, water resources, human health, and natural ecosystems will need to adapt to a changing climate or face diminished functioning. Species inhabiting protected areas will face difficulties in changing behaviour or migrating in response to climate change (Thomas et al. 2004). While biological systems might accommodate minor (or slowly occurring) perturbations in a smooth, continuous fashion, even a minor change in climate may be disruptive for many ecosystems and individual species. Many of the landscape's species are currently under stress because of habitat fragmentation and high consumptive use of natural resources. This, coupled with a relatively rapid rate of anticipated climate change, is likely to challenge the resiliency of many species and their chances for successful adaptation. Tiding over such challenges will require improving the effectiveness of entire ecosystems and their components. Conservation corridors will need to have effective networks with diverse ecosystems. Connectivity of habitats for endangered and rare species of plants and animals is a necessity. Sustaining ecosystem services will need structural improvements in ecosystems; whereas in the Kangchenjunga landscape the connectivity concept is just evolving and the task is far from accomplished. The knowledge base also needs revision. Management interventions have to become relevant and effective. The capacities of professionals, local communities, and other stakeholders to plan, implement, monitor, and evaluate the relevance and effectiveness of protected areas and corridors need improvement. Institutions have to evolve to support community-based conservation.

The people living in the Kangchenjunga landscape are economically, physically, and socially vulnerable. Most depend on forest resources for their subsistence livelihoods as commercial resources remain beyond their reach due to difficulties in access, high prices, and limited supplies (Sharma et al 1992). Generally, the level of poverty among the populations residing

in protected areas is high. Very often, the livelihood options available are not lucrative. Economic returns from the use of natural resources are low and people have lower incomes than their compatriots outside protected areas. The most vulnerable are the ones who have no land. They resort to livelihood strategies that include temporary migration, collection of non-timber forest resources or medicinal plants, portering, wildlife hunting, and farm or forest-based and off-farm strategies. Their limited access to education, health care, and development opportunities creates an inexorable link between poverty and environmental degradation. Integrated conservation and development has yet to deliver workable solutions to the people-wildlife conflict. Wildlife poaching, overgrazing by livestock, illegal fuelwood collection and timber extraction, shortened fallow period for shifting cultivation, extensive non-timber forest product (NTFP) collection, and unregulated tourism are having a negative impact on protected areas. Haphazard land use continues to expose core areas and buffer zones to encroachment. Although rotational agroforestry (shifting cultivation) can be a valuable form of land use, distortion of the institutional mechanisms and functions that support it, and enforced shortening of the fallow period, can also result in negative impacts from this type of cultivation (Kerkhoff and Sharma 2006). Unregulated, and often excessive, use of resources brings the risk of habitat fragmentation. Unregulated collection of fuelwood, medicinal plants, and timber continues. Landslides, soil erosion, flooding, deforestation, poor agricultural practices, and forest fires aggravate habitat fragmentation.

Conservation corridors and some of the protected areas, (for instance the Toorsa Strict Nature Reserve) have yet to be placed under a knowledge-based management system. Management plans for several protected areas are in need of improvement. The infrastructure has to be improved. Conservation corridors are exposed to uncontrolled grazing, unsustainable harvesting of medicinal plants and other non-timber forest products, poaching of wildlife, slash and burn agriculture, forest fires, land degradation, indiscriminate felling of trees, and depredation of agriculture and livestock by wildlife.

Land uses in the proposed corridors include forestry, grazing, agriculture, tea gardens, and orchards. In some cases major development infrastructure, such as railways, runs through corridors. Demand on natural resources is relatively high putting pressure on forests and grazing resources. In some cases the migration routes of mega fauna of significance for conservation run through settlement areas and tourism infrastructure. The vegetative cover of some corridors requires improvement to improve environmental intactness. The review of information on corridors also reveals that alpine and subalpine pasturelands and common property resources for grazing by transhumance and settled communities are overgrazed. The warm temperate rangelands are used extensively for transhumance as well as by stall feeders, not giving enough time for rangelands to regenerate. Subtropical rangelands are grazed extensively in winter by transhumance herders as well as sedentary farming communities. At lower elevations, converting open pastures to community forests conflicts with traditional pasture management practices. In some areas, community forest user groups (CFUGs) prohibit the use of traditional migratory routes by animal herders. With the abolition of some communal land tenure and customary arrangements, ownership of the traditional community pastures inherited pasture resources has weakened leading to haphazard grazing and

mismanagement.

The success of conservation at the landscape level depends on the commitment at regional level for cooperation, sharing of information, and giving access to genetic resources and access to technology transfer (Sharma et al 2007). Research has revealed the prevalence of persistent poverty among the communities which are interdependent and located along or close to the international boundaries because of limited development. The increasing economic and environmental interdependence between countries offers opportunities for cooperation (Chettri and Sharma 2006).

International boundaries also play an important role because of their multifaceted functions as filter zones for illicit activities, gateways for people and goods, and zones of socioeconomic, cultural, and environmental integration (Chettri and Sharma 2006). A host of transboundary challenges exists: illegal trading of products of protected species, poaching of animals, transboundary grazing, and use of other natural resources are prevalent. There is a lack of strategies for intervention and no formal framework within which to address transboundary challenges. Legal and policy aspects, varying across countries, affect resource use and conservation mechanisms (including community rights on the use and tenure of resources) differently in countries within the landscape. Physical and financial constraints also prevent networking and regular exchange of information and best practices among countries within the landscape.

The Way Forward

Innovation and investment have to continue to (i) make the protected areas effective in delivering their goals; (ii) set up conservation corridors to make the ecosystem approach more effective; and (iii) resolve transboundary management problems. The areas of innovation and investment would include the following.

Remoulding policy

The existing policies of individual countries differ. The policy of Nepal supports sustainable use of resources in protected areas designated as conservation areas. Local communities are empowered to plan and manage the protected area. In the case of India, given that the majority of protected areas fall either in national parks or sanctuaries, the policy appears to favour protection. The scope of people-oriented conservation and development is limited to biosphere reserves. Although participation of local communities is recognised, their participation seems rather restrictive as the ownership of the resources is with the state and local communities are only partially empowered. Similarly, in the case of Bhutan, the protected areas are national parks and strict nature reserves, and this appears to favour protection. The scope for people-oriented conservation seems to be restrictive as the policy to promote community participation is perhaps not well articulated in the management plans of protected areas and corridors.

Protected area management is evolving to integrate conservation and development. Both existing and new challenges will have to be overcome through remoulding policy. Essentially,

policy should enable individual protected areas and corridors to become effective in delivering conservation and development goals. Across the landscape, a uniform policy may reinforce the conservation and development efforts of individual countries. Policy has to be remoulded to recognise participatory management, stakeholder partnerships, an ecosystem approach, securing access to and ownership of natural resources, equitable sharing of benefits, sustainability, transboundary cooperation, sharing of good practices, and improvement of policies through learning. As circumstances change, and if policies lose validity, policies should be revised and made adaptable to deal with the changes. Genuine promotion of people-oriented conservation requires policies that strike a balance between conservation and development. Policy advocacy on transboundary conservation issues has to continue along with national-level advocacy. A clear policy discouraging development projects that are likely to have negative impacts on the fragile ecosystem is essential.

Improved Knowledge

Research, technical, and scientific data determine the quality of biodiversity conservation programmes. Efforts have to continue to generate new information and knowledge. The relevance of biodiversity conservation programmes needs improvement in the quality of biological, physical, social, and economic information. Enrichment of the quality of research, technical, and scientific data is a continuing process to improve the quality of conservation and development interventions. Analysis of the information and knowledge gap should be spearheaded by individual countries and the quality of research enhanced. In addition good practices and indigenous or traditional technologies should be researched and recorded. Improvement in documentation should facilitate the application and use of information and knowledge; and use of information technology will improve the quality of documentation.

Improved Management

Management of protected areas and corridors has to be more effective. Improvement of management planning and implementation of plans are essential in this respect. The relevance of management plans, giving due recognition to cultural and traditional practices, needs to be updated by integrating conservation and development. Frameworks for monitoring, evaluating, and reporting at national and transboundary levels need to be designed and adopted. Participation of stakeholders, community organisations, self-help groups, religious institutions, local governments, state government, non-government organisations, ministries and departments, media, and education institutions should be strengthened.

Systems linking protected areas to conservation corridors have to be operationalised. Within the corridors, rehabilitation and restoration of habitats and degraded ecosystems should be undertaken. Socioeconomic development programmes need strengthening and sustainable livelihoods need promoting. Sustainable agricultural practices, improved livestock farming, productive pastoralism, ecotourism, processing, value addition, and marketing of agricultural products have to be developed. Sustainable use and management of forests, non-timber forest products, grazing lands, and water resources should be supported, and cultural and traditional practices supporting sustainable use of natural resources should be preserved and promoted.

Governance mechanisms for protected areas and corridors need improvements based on the involvement of community-based organisations. Enforcement of laws, rules, and regulations has to become effective. Use of natural resources in both protected areas and corridors has to become sustainable: livelihood practices should be made sustainable by reducing incompatible land uses and promoting productive use of resources based on comparative advantages. Processing and value-addition of high-value non-timber and medicinal plants and promotion of community-based ecotourism should be pursued as alternative economic opportunities. At the local level, platforms for stakeholder consultation need to be created to enable participation of stakeholders. Cooperation and collaboration among stakeholders require strengthening.

Institutional Innovation

Remoulding policy will call for institutional changes and the rules and regulations governing management of protected areas and corridors will need to be improved. Institutions to support people-oriented and collaborative governance of protected areas and corridors require innovation. Mechanisms to facilitate the coordination of transboundary issues as well as issues affecting individual corridors and protected areas have to be devised and applied. Common platforms to facilitate research, information exchange, and sharing of good practices among the countries in the landscape will need to be created. Guidelines and soft legal instruments, essential for addressing transboundary issues within the framework of existing laws of the countries, should be adopted.

Capacity Building

Efforts to improve professional capacities in research, collecting information, and writing management plans should be carried out. Similarly, the capability of communities to develop and implement management plans has to be improved. Improving the capacities of different target groups, including women, to become engaged in conservation and development will be necessary. Increased public education, participation, and awareness about biodiversity conservation and sustainable resource use will have to be promoted.

Transboundary Problems

Conservation interventions include from species' preservation to landscape conservation. Effective conservation of biodiversity involves an integrated conservation and sustainable development approach. Partnerships will need to be established between communities and government agencies within the landscape. Creation of platforms to facilitate information exchange, sharing of experiences, and fostering cooperation is envisaged.

At the landscape level, efforts to resolve transboundary conservation issues should be organised. Strengthening of policy dialogues for implementation of international conventions (e.g., CITES or the Convention on Migratory Species of Birds [CMS]) within the three countries is important. Mutual support to tackle transboundary issues will require formalisation; for instance, mechanisms and strategies have to be devised and employed to manage unauthorised cross-

border resource extraction, illegal trade of species and their derivatives, spread of forest fires, and spread of disease. Uniform strategies and approaches can be promoted for conservation of endemic species in the landscape.

Infrastructure and logistics have to be developed to facilitate management of transboundary conservation problems. Uniform strategies for and approaches to conservation of endemic species at the landscape level should be institutionalised.

Consultative meetings held in the past among the regional partners have noted a lack of cooperation and collaboration among partners in the context of sharing information and experience. Networking, creating consultative platforms, application of technology in information sharing, and exchange visits would improve this aspect.

In consulting with partners, the need to adopt a standardised long-term approach to research has been raised as an important issue. Adopting strategies and undertaking action to improve scientific and technical cooperation would enhance sustainable conservation and development. Technical cooperation to facilitate the sharing of expertise and enhance the competence of professionals and capacity building of communities would be useful.

Appropriate exchange and sharing of information can lead to development of common approaches that address common issues. Moreover, information exchange also fosters regional teamwork. As a result, standardised approaches to transboundary conservation of biodiversity can be developed and informed policy decisions can be made at the landscape level.

Joint research can be undertaken to improve capacities through sharing expertise. Creation of working groups among the partners would avoid duplication of research. It can optimise application of research results by protected area managers, policy-makers, and local stakeholders. Mechanisms for collaborative research and scientific programmes of mutual interest to the three countries can be promoted. Regularising exchange and sharing research outcomes and recommendations through annual regional seminars and workshops can make exchange of information dynamic. Cooperation for collaboration, data-sharing, intelligence gathering, and information exchange among the countries can be improved. Exchange of research, scientific, and technical data, as well as good practices and indigenous and traditional technologies relating to sustainable development and sustainable use of natural resources can be augmented.

Conclusion

Transboundary protected area management of the Kangchenjunga landscape is an important initiative taking conservation beyond protected areas and across the political boundaries of three countries. It still has a long way to go before the landscape becomes a fully functioning landscape and ecological network. National efforts, regional collaboration, and support from donors are needed if the landscape is to achieve its objectives. More investment has to come in to operationalise the landscape as a truly functioning transboundary conservation landscape.

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