Biodiversity in the Eastern Himalayas

Conservation through Dialogue

Editor
Chen Guangwei

ICIMOD
International Centre for
Integrated Mountain Development

about ICIMOD

The International Centre for Integrated Mountain Development (ICIMOD) is an international organisation devoted to development of the Hindu Kush-Himalayan region covering all or parts of eight sovereign states: Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan. The Centre is located in Kathmandu, Nepal. 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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Summary Reports of Workshops on Biodiversity Conservation in the Hindu Kush-Himalayan Ecoregion

Chen Guangwei

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Foreword

Nature blooms, sings, crawls and prances in abundance in the Hindu Kush-Himalayas (HKH). Successions of forests adorn its valleys and flanks – from the tropical hardwoods to an astounding array of rhododendrons in alpine splendour. Tigers prowl at lower reaches while snow leopards mark their territories across high elevations. Giant pandas and small red pandas live on the rich variety of bamboo species. The world's greatest variation in altitudes combined with meteorological and geological convergences have created some of the world's richest and most beautiful biological diversity in the Eastern Himalayan region.

This wealth of biodiversity has helped support a rich diversity of human cultures and spurred the development of vast storehouses of indigenous knowledge on the use and care of nature's products. This has led to the identification, modification and cultivation of a variety of plants and animals, which help feed and keep healthy populations around the world. Himalayan biodiversity also provides ecosystem services within and below the mountains in the regulation of climate and water regimes, the safeguarding of present and future genetic assets, and the glorification of mountain, rivers, lakes, and caves held sacred.

Unfortunately, mutually beneficial and benign human interactions with mountain biological diversity are only part of the complex story of peoples and nature in the HKH. Throughout most of this fragile mountain region, biodiversity is being lost through over-exploitation of land, conversion to agriculture, pasture and settlements and resource degradation.

Governments have responded to this tragic threat by enacting new laws and policies for biodiversity protection, setting aside large areas of land as protected areas, and designating or strengthening government organs for policy implementation. International and national NGOs have played a key role in supporting, and sometimes leading, these conservation efforts.

Given the increased economic and political pressures to destructive short-term use of these mountain natural resources, these actions are remarkable achievements.

However, this has clearly not been enough to remove the threats. It is now overwhelmingly evident that effective conservation and long-term sustainable use of biodiversity in the HKH requires site specific approaches centered around the active leadership and willing participation of local mountain populations. Appropriate and strong local institutions — such as those set up for community forestry, buffer zone management, and eco-development – are critical to long-term access to these commonly used resources. Programme and policy approaches such as sharing proceeds from ecotourism, economic incentives for conservation, and strict enforcement of violations – especially those emanating from outside – are necessary. Building the scientific and people skills among forest and park department staff for applying new tools in geographic information systems, remote sensing, stakeholder analysis, and the facilitation of local action play a central role in enabling these new approaches to work – and seeing if in fact they do work.

Painstakingly prepared by Professor Chen Guangwei, Head of the Mountain Natural Resources Division of ICIMOD, this publication addresses these and related issues in the conservation of biodiversity in the HKH. It is a major output of the workshops and programmes carried out by the International Centre for Integrated Mountain Development (ICIMOD) to increase regional

understanding and cooperation, build capacity, improve policy, and enhance implementation of conservation in the HKH. These include: 'Sub-Regional Consultation on Conservation of Hkakaborazi Mountain Ecosystems in the Eastern Himalayas'; 'Preparing a Model Management Plan for Pidaung Wildlife Sanctuary'; 'Report of Collaboration on and Integrated Management of Mountain Ecosystems in Hongqiang, Chuxiong, Yunnan Province of China; 'Nepal/Tibet Autonomous Regional Transboundary Cooperation for Conservation'; and 'Biodiversity Assessment and Conservation Planning for Eastern Arunachal Pradesh'.

As an independent, regionally focused mountain learning and knowledge centre, Professor Chen and ICIMOD colleagues have worked closely with its many partners in the HKH to develop this publication. These include government line agencies, research and educational institutes and non-government organisations. Among the most active partners are the Forest Department of the Ministry of Forests, Country Programme Coordinator of the Wildlife Conservation Society (WCS), and University of Yangon in Myanmar. In Nepal the International Union for Conservation of Nature (IUCN), King Mahendra Trust for Nature Conservation (KMTNC), the Mountain Institute (TMI), and the Worldwide Fund for Nature Conservation (WWF), Department of National Parks and Wildlife Conservation, Ministry of Forest and Soil Conservation as well as many at the grass roots' level have been key partners. In China the Kunming Institute of Botany, Chinese Academy of Sciences made key contributions.

We are grateful to Prof. Chen Guangwei, not only for all the hard work that went into this publication, but also for his dedication and commitment in working with his colleagues and partners in promoting sustainable natural resource management in the HKH. We are also grateful to the editorial staff for their strong contribution.

J. Gabriel Campbell
Director General

Editorial Preface

Recording families and species across different countries and language groups will inevitably lead to variations in spelling, particularly of scientific names. We have tried our best to identify the flora and fauna recorded here. Thanks to the help and advice of Dr. Tirtha Bahadur Shrestha, most of the flora and fauna have been identified and affirmed according to their scientific names. Those that have been resistant to scrutiny and research have been kept in the text and marked with an asterisk. In all probability over the years the Latin spelling has been subject to differentiation from the intended original, but obviously, within the areas in which the flora and fauna are located, they are known by these names to local scholars. It is our intention not to lose valuable records by simply omitting what we cannot verify.

In relation to references, the reader will note the number of documents in other languages, and documents that were written over 50 years ago. In such cases references may not be complete: publishers and place of publication may not have been available in our archives or through research.

We have kept all titles given by authors, even when they have not been cited in the text. This area of Asia has received such limited coverage globally that the editors believe themselves justified in doing so.

The Editors

Acknowledgements

First I would like to express my appreciation to the John D. and Catherine T. MacArthur Foundation for providing financial support to ICIMOD so that biodiversity conservation projects in the eastern Himalayas could be undertaken.

I also extend my thanks to the following people: Ms Camille Richard fulfilled the role of Project Coordinator in 1999; Mr Ajay Rastogi, invited as a consultant, conducted research work in India and helped prepare the workshop in Myanmar in 1999; Professor Li Bosheng, of the Botany Institute, Chinese Academy of Sciences, gave a valuable presentation in Putao; Professor Long Chunlin, of the Kunming Institute of Botany, Chinese Academy of Sciences, led the activities in Yunnan, China; Mr U. Shwe Kyaw, Deputy Director of the Forest Department, Ministry of Forests, Myanmar, played an important role in organising workshops in north Myanmar; Mr U. Saw Tun Khaing, the Wildlife Conservation Society Country Coordinator for Myanmar, presented his very valuable reports in the two workshops in north Myanmar; Mr U. Htun Nyo, Deputy Director of the Nature and Wildlife Division, Department of Forests, Myanmar, jointly conducted the workshop for Pidaung Wildlife Sanctuary.

I would like to give special thanks to Ms Daw Kala Ya Lu of Myitkyina University who prepared papers for the workshops in both Putao and Myitkyina. The participants at the workshops in Myanmar made a great effort to make them a success and I would like to express my heartfelt thanks to them. I thank Dr Binayak Bhadra, the Director of Programmes of the International Centre for Integrated Mountain Development (ICIMOD), for providing advice to the projects and the Secretariat of Mountain Natural Resources, ICIMOD – Reeta Rana, Sarita Joshi, and Govinda Shrestha – who assisted in the documentation and daily management of the projects.

Chen Guangwei

Abstract

This publication presents information about ICIMOD's activities and findings in biodiversity conservation during the period leading up to the new millennium.

Part One provides some general background information on biodiversity conservation in the Hindu Kush-Himalayan Ecoregion and introduces the Regional Collaborative Programme for the Tibet Autonomous Region (RCP-II), the people involved in biodiversity conservation, the features of the biogeographical region of the Qinghai-Tibetan Plateau, the evolutionary trends of flora and fauna, and advances in biodiversity research and networking. Part Two provides fundamental data for the Hkakaborazi Mountain Ecosystem in Myanmar, including its physical conditions, flora, fauna, and socioeconomic environment. The socioeconomic and cultural surveys contribute first-hand information about the local communities; the status and threats to the survival of large mammals in north Myanmar; and rare data about markets and prices in the trade in animals. Part Three focuses on management of Pidaung Wildlife Sanctuary in Myanmar, its changing history since 1913, and its possible future. Part Four reports on the integrated management of mountain ecosystems in Hongqiang, Chuxiong, in China, with emphasis on community-based conservation and development.

Executive Summary

Biodiversity conservation is an important ecological issue and a key indicator of sustainable development. The Hindu Kush-Himalayan (HKH) region is extremely diverse biologically and successful conservation in this area has both local and global implications.

In recent years the efforts of the International Centre for Integrated Mountain Development (ICIMOD) towards biological conservation have been focused mainly on two projects in practical operation. This publication is concerned with one of these: 'Regional Collaboration for Biodiversity Management in the Eastern Himalayas and Models for Integrated Management of Himalayan Ecosystems'. The project (comprising of four sub-projects) has had support from the MacArthur Foundation and the United Nations Environment Programme (UNEP) and has been carried out in three countries, China, Myanmar, and Nepal.

Using research papers and workshop reports, this publication presents the key activities and findings of ICIMOD in the field of biodiversity conservation during the period from 1999-2001, together with discussion and analysis. After providing an overview of biodiversity conservation in the region (Part 1) the book focuses on three of the sub-projects. Part 2 is concerned with the sub-project 'Regional Collaboration in the Conservation of Hkakaborazi Mountain Ecosystem'. It presents and discusses information and data on Hkakaborazi National Park (in Myanmar) within the context of conserving its unique ecosystem and biodiversity. Most of the papers were presented at a workshop and the workshop report is also provided. Part 3 of the book is devoted to the sub-project 'Preparing A Model Management Plan for Pidaung Wildlife Sanctuary'. It examines biodiversity conservation in Pidaung Wildlife Sanctuary (in Myanmar) and focuses on the preparation of a management plan for the sanctuary, which can also be used as a model for other similar areas. The papers in this part were also presented at a workshop and the workshop report is included. Part 4 comprises a detailed report of the sub-project 'Biodiversity Collaboration and Integrated Management of Mountain Ecosystems in Hongqiang, Chuxiong, Yunnan' (China). The report was prepared as a post assessment of the project; it is based on two short-term field surveys and previous project progress reports.

This book provides a synthesis of information on the current status and future prospects for biodiversity and its conservation in the HKH region. The case studies serve as useful examples and provide an opportunity to share valuable experiences to help ensure that the management of ecosystems and their biodiversity in other areas is successful. Conserving this rich biodiversity will help local communities build up their capacity for integrated, sustainable development. It will also contribute towards the urgent global task of biodiversity conservation, which must be undertaken because ecosystems and the genetic material of the species they accommodate have direct and indirect potential value for all human beings both now and in the future.

Acronyms and Abbreviations

ACA	Annapurna Conservation Area (Nepal)
APEC	Asia Pacific Economic Cooperation
ATREE	Ashoka Trust for Research in Ecology and Environment
BGR	bio-geographic region (Note from ed: not a standard acronym)
CAMC	conservation area management committee (CAMC)
CBD	Convention on Biological Diversity
CF	community forestry
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CNY	Chinese currency
DNA	Deoxyribonucleic Acid
DFO	District Forest Office
DFO	district forest officer
DNPWC	Department of National Parks and Wildlife Conservation (Nepal)
FAO	Food and Agriculture Organization
FPC	forest protection committee
FUG	forest user group
GEF	Global Environmental Fund
GIS	geographic information systems
GLORIA	Global Observation Research Institute for Alpine Environment
GO	government organisation
HCABC	Hongqiang Community Association for Biodiversity Conservation (China)
HKH	Hindu Kush-Himalayas
HMGN	His Majesty's Government of Nepal
ICF	International Crane Foundation
ICIMOD	International Centre for Integrated Mountain Development
INBAR	International Network for Bamboo and Rattan
INGO	international non-government organisation
IPGRI	International Plant Genetic Research Institute
IUCN	International Union for Conservation of Nature and Natural Resources
JFM	joint forest management
KIB-CAS	Kunming Institute of Botany, Chinese Academy of Sciences
KMTNC	King Mahendra Trust for Nature Conservation (Nepal)

LEAD	Leadership for Environment and Development
MNR	Mountain Natural Resources
MoU	memorandum of understanding
NCEA	National Committee for Environmental Affairs
NGO	non-government organisation
NPWC	National Park and Wildlife Conservation
NTFP	non-timber forest product
NWCD	Nature and Wildlife Conservation Division
OP	operational plan
PAS	protected area system
PPP	Parks and People Project
PRA	participatory rural appraisal
QNP	Qomolongma Nature Preserve
RCP-II	Regional Collaborative Programme 2
RMC	regional member country
RS	remote sensing
SFM	sustainable forest management
SSC	Status Survey and Conservation Action Plan
TAR	Tibet Autonomous Region
TMI	The Mountain Institute
TPA	totally protected area
UNCBD	United Nations Convention on Biological Diversity
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WCS	The Wildlife Conservation Society
WHS	World Heritage Site
WII	Wildlife Institute of India
WWF	Worldwide Fund for Nature
ZNR	Zixishan Nature Reserve

Contents

part one

conservation of hindu kush-himalayan mountain ecosystems and sustainable development — 1

part two

a study on hkakaborazi national park of north myanmar — 45

part three

management model plan for pidaung wildlife sanctuary, myitkyina of myanmar—175

part four

report of collaboration on and integrated management of mountain ecosystems in hongqiang, chuxiong, yunnan province of china—219

part one
conservation of hkh mountain ecosystems and sustainable development

Introduction to Part 1

Conservation of Hindu Kush-Himalayan Mountain Ecosystems and Sustainable Development

The Hindu Kush-Himalayan (HKH) Ecoregion is highly diverse biologically, in terms of ecosystems, species, and genetic resources, due to extreme altitude differences and associated changes in climate and soil conditions, which create a vertical zonation in natural vegetation. There are many rare and endemic species to be found there. The eastern Himalayan region, influenced by a tropical monsoon climate, has the richest biodiversity of all the Himalayas and has been recognised as one of the 10 most biologically diverse areas in the world. This biodiversity is a substantial resource for the human population in this region, providing the basis for their survival through agriculture, animal husbandry, forestry, and industry; hence long-term, sustainable use of these biological resources is vital.

This part of the book examines several important aspects of biodiversity conservation in the region and provides a useful general background for the more specific parts of the book that follow. The first part gives a detailed overview of the HKH Ecoregion and its biodiversity; it addresses the reasons for conserving this biodiversity as well as the factors causing its decline. It also describes the important role of the International Centre for Integrated Mountain Development (ICIMOD) in this conservation. The second part focuses on the HKH member countries and local people as the main stakeholders of and important contributors to biodiversity conservation in the region, using examples to illustrate this. Pidaung Wildlife Sanctuary is introduced as a case study to illustrate how management can be improved to protect and conserve biodiversity and the importance of local people's participation in the successful management of the sanctuary. The third part discusses the unique biodiversity of the Grand Canyon of the Yarlung Zangbo River, located in the Qinghai-Tibetan Plateau in the eastern Himalayas. The diversified climates of the plateau and the moisture passage created by the grand canyon of the Yarlung Zangbo River splitting the south-eastern Qinghai-Tibetan Plateau (through which warm, wet air flows from the Indian Ocean and reaches the inner part of the plateau) give rise to a rich ecosystem and species' diversity, which are detailed in this part. The final part focuses on advances in bidioversity research and networking in the HKH Ecoregion. The concept of the Qinghai-Tibetan Plateau as a

'new animal geographical area' is discussed and the evolution of flora and fauna to adapt to the harsh environmental conditions of the region is considered, with examples. Also addressed is the future of research into biodiversity in the region, which is hampered currently by a lack of funds, facilities, and personnel. Using the example of China, the benefits of research networks, which integrate national parks and reserves with research stations, is examined.

Participatory Biodiversity Conservation in the Hindu Kush-Himalayan Ecoregion
– Towards Participatory Conservation and Development

An Urgent Task

This project focuses on the eastern Himalayan eco-region, one of the high-priority regions of the 200 global ecoregions as defined by the Worldwide Fund for Nature (WWF). The eastern Himalayas cover the border region of south-west China, the east of India, and northern Myanmar, specifically south-eastern Tibet and north-western Yunnan (China), eastern Assam (India), and northern Myitkyina (Myanmar). This area is situated in the tropical and subtropical mountain zones with altitudes ranging from a few hundred metres above sea level to snow-glacial peaks towering above eight thousand metres. Accessibility in this region is generally difficult. With a lack of infrastructural facilities and difficulties with communication, most local people maintain subsistence livelihoods, relying on slash-burn agriculture, herding, and hunting.

The region is rich in biodiversity in terms of both flora and fauna. Many rare and endemic species inhabit this region, including relic species from the glacial period. However, with the invasion of commercialisation and globalisation, along with increased population pressure, its biodiversity is at risk. Therefore, an urgent need exists to draw international attention to and increase local awareness of the protection of the flora and fauna in order to maintain the structure and function of the ecosystem.

The region is also characterised by diverse mountain cultures. A number of minority groups lives here, for example Tibetans, Menbas, Lobans, Lisus, Drowns, and Kechins.

The global context of sustainable development of the Hindu Kush-Himalayan (HKH) Ecoregion must also be considered. There are increasing flows and exchanges of economy, culture, people, and information between the HKH and the outside world. The great wealth of biodiversity in the Himalayas is due to the wide variety displayed by its mountain environment, which has an extreme biodiversity in ecosystems, species, and genetics. The species' diversity in the Himalayas represents different floristic elements from paleoarctic and Mediterranean to Indo-Malaysian and east Asian flora. The wide diversity of fauna in the region is as rich as that of the plants. For instance, the giant panda, golden monkey, sika deer, takin, red panda, lynx, musk deer, and gibbon are endemic to the region. New research has suggested areas of interest in the Qinghai-Tibetan Plateau. New research has led to the consideration of a large part of the plateau in the region as a Trans Himalayan zone and an area unique in many respects.

In the instruments adopted at the Rio Summit, mountains are defined in Chapter 13 of Agenda 21, as 'important resources of biological diversity', and 'storehouses of biological diversity and endangered species'. Mountain biodiversity has multiple dimensions and is fragile. Global recognition of the alarming loss of biodiversity and recognition of the value of biodiversity resulted in the 'Convention on Biological Diversity', signed at the 1992 Earth Summit in Rio de

"one of the high-priority regions of the 200 global ecoregions"

Janeiro, Brazil. The convention places immense importance on biological diversity and the need to preserve it for future generations. Conservation of biodiversity in the HKH is a very important component of the worldwide effort. The International Centre for Integrated Mountain Development (ICIMOD) plays an important role in biodiversity conservation through promoting the conservation of nature reserves, the study of indigenous knowledge and ethnobotany, encouraging the participation of local people in natural resource management, and transboundary cooperation in conservation. ICIMOD's activities are now focused at grass-roots' level and incorporate regional collaboration for conservation, poverty alleviation, and development through training workshops and technology transfer; this project was designed to address these issues.

Background and Importance of Biodiversity in the Hindu Kush-Himalayan Ecoregion

General

The HKH Ecoregion covers the HKH mountain system and the Qinghai-Tibetan Plateau. This region is one of the largest mountain systems in the world, and the Qinghai-Tibetan Plateau is recognised as the third polar region of the world. Geographically, the HKH covers all or part of the following countries: Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan (see Table 1). The mission of ICIMOD is to help promote the development of an economically and environmentally sound mountain ecosystem and to improve the living standards of mountain populations in the HKH. The mountains are a vast storehouse of hydropower, timber, fuelwood, medicinal plants, minerals, and water. The most important fact is that they are rich in terms of their ethnic

"the Qinghai-Tibetan Plateau is recognised as the third polar region of the world"

Table 1: Areas and Populations of the Hindu Kush-Himalayan Region

Country	Inclusions	Area (sq.km)*	Population in 1997 (apprx. millions)	Density per km²
Afghanistan	25 out of 30 provinces	390,475	15.54	40
Bangladesh	Chittagong Hill tracts	13,295	1.14	86
Bhutan	Entire territory	46,500	0.71	15
China	All of Tibet and Qinghai and parts of Yunnan and Sichuan	2,420,266	30.45	13
India	All of 8 and parts of 3 northern states	461,139	41.16	89
Myanmar	All districts in the 4 states of Kachin, Chin, Shan, and Rakhine	317,629	10.10	32
Nepal	Entire territory	147,181	21.66	147
Pakistan	North West Frontier Province, federally administered tribal areas, northern areas, Azad Jammu and Kashmir, and 12 districts of Balochistan	489,988	31.13	63
	ICIMOD Ecoregion	Total 4,286,473	Total 151.89	61

*As an ecoregion, the area does not imply any judgement on the legal status of any territory or endorsement or acceptance of such boundaries.

diversity — there are over 1,000 tribes in the region, each with their own unique cultural heritage, language, and indigenous knowledge.

Extending over 3,500 km, the HKH Ecoregion is host to the world's highest ecosystems and a variety of environments. These mountain environments are extremely rich in biodiversity because of the varied altitude, climatic conditions, geological-biophysical conditions, and soil formations. Historically, human interactions with the mountain environments have further enriched their biodiversity, in particular with respect to the distribution patterns of plants, animals, and genetic diversity. For example, many medicinal materials can be found in the higher mountains, and these provide actual and potential benefits. The provinces of Sichuan and Yunnan in China have long been known as production bases for medicinal plants and Tibetan medicine has been developed based on the these special plant and animal resources. The botanical wealth of the Indian Himalayas and Nepal consists of more than 8,000 species belonging to 200 families and about 30% of the Himalayan flora are endemic. Nine thousand plant species have been reported in the virgin forests of the eastern Himalayas, of which nearly 3,500 or 39% are endemic to the region. The total number of species of plants in the HKH Ecoregion is estimated to be as high as 25,000 or 10% of the world's flora. Table 2 from Pei Shengji (1996) illustrates plant species' diversity in the region.

Table 2: Plant Diversity in the Hindu Kush-Himalayan Region

Country	Geographical areas (km²)	Number of species of flowering plants and ferns
Afghanistan	652,090	4,500
Bangladesh	144,000	7,400
Bhutan	46,500	5,000
China	9,596,960	29,700
India	2,387,590	17,000
Myanmar	676,577	7,766
Nepal	147,181	5,568
Pakistan	796,095	6,000

Source: Pei Shengji (ed.) (1996) *Banking on Biodiversity*, report of the Regional Consultation on Biodiversity Assessment in the HKH. Kathmandu: ICIMOD.

The Global Convention on Biodiversity (1992) called on participating nations to cooperate and undertake measures to promote the conservation of biodiversity in order to ensure the sustainable use of its components and a fair and equitable distribution of the benefits occurring from the use of its resources. Biodiversity conservation is given high priority by the HKH regional member countries. Many areas have been demarcated as protected areas, and innovative participatory approaches to development and conservation are being implemented. However, the challenges are immense; conserving the natural and cultural heritage and, at the same time, improving livelihoods require continued commitment and increased efforts as well as regional collaboration.

Biodiversity – Sustainable Development Indicators

As explained previously, the HKH Region represents one of the world's richest ecosystems. The flora and fauna of the countries in the region have been greatly influenced by the presence of the Himalayas. The eastern Himalayan range has been relatively stable physically and climatically since the Quaternary epoch and many primitive and relict species have been found in the region. Mountain wildlands, in general, are considered a great refuge for endemic and endangered species and communities (Mountain Agenda 1992).

The HKH Region contains a wide variety of landscape vegetation types and microclimates. Within these, species have evolved and different gene types have been created. Human protection, selection, and domestication of both native and exotic plants and animals have also resulted in an enormous genetic diversity. It is believed that rice strains in this region originated

"biological diversity is the most important natural resource base for the human population in this region"

from several wild species of *Oryza* in the Eastern Himalayas. Many of the wild relatives of crop plants in this region are now threatened or endangered. Animal species, such as honeybees, silkworms, shell-lac insects, wild yak, wild donkey, and antelope are also threatened due to changes in habitat and environment.

Biodiversity: the Substantial Resources of Mountain People

Biological diversity is the most important natural resource base for the human population in this region. It is the basis of their survival. Thousands of species of plants and animals supported the development of early societies, providing the basis for the evolution from hunting and gathering to agriculture, animal husbandry, forestry, and industry. These early societies concentrated on the development of both wet and dry rice cultivation; tea plantation; domestication of barley, buckwheat, yak and many other species in the region; and the use of thousands of wild species to meet their basic needs. Because 90% of the region's population are engaged in agriculture, animal husbandry, and forest-related activities, continuing use and maintenance of biological diversity and providing a foundation for long-term sustainable development are particularly important to the people of the HKH Region. Development of the mountain economy in these regions will depend on sustainable use of biological resources, maintaining a rich diversity of mountain crops in farming systems, management of pastures, fodder trees in diverse mountain ecosystems, and development of medicinal plants and animals, edible mushrooms, ornamental plants, and beekeeping.

Biological resources also have important ecosystem functions such as watershed protection, reduction of natural disasters, climate regulation, photosynthesis, and crop pollination. Such resources also provide genetic capital for new varieties of medicines and industrial innovations. The potential of biodiversity and genetic resources in the HKH Region are extensive. The diverse mountain ecosystems provide broad opportunities for people to develop their unique landscape-ecosystems for agriculture, forestry, animal husbandry, rural industry, and ecotourism.

Loss of Biodiversity

Generally speaking, the whole environment and its biological resources in the HKH Region are undergoing drastic impoverishment as a result of human action. Deforestation and habitat alteration cause highly diverse natural ecosystems to become far less diverse, often monocultural agroecosystems have resulted in the extensive reduction of biological species in the region. Overexploitation of biological resources, stimulated by inappropriate economic policies and faulty institutions, insufficiently protected areas, poaching, poor law enforcement, local encroachment, and illegal trade are the main problems for the natural conservation of biodiversity. Special attention should be given to the eastern Himalayan region as it was recognised as one of the 10 richest areas for biodiversity listed in the world's threatened Biotas, 'Hot Spots' (Myers 1988).

"deforestation and habitat alteration cause highly diverse natural ecosystems to become far less diverse"

The Role of the International Centre for Integrated Mountain Development: Regional Collaboration in Conservation of Mountain Ecosystems

Biodiversity Conservation of the Regional Collaborative Programme for the Tibet Autonomous Region-II

The mandate of ICIMOD, as stated, includes the following statement: "to help promote the development of economically and environmentally sound mountain ecosystems ... " Environmentally sound mountain ecosystems can mean many things, ranging from the state of mountain resources, flora, and fauna to different biophysical and socioeconomic processes taking place in mountain areas. In view of the fact that most mountain households directly depend on renewable natural resources for their day-to-day survival and that these are fast deteriorating, ways and means to improve the conditions of these natural resources are an important priority for most mountain communities. There are two high-priority areas: one focuses on people and resource dynamics in mountain watersheds and the other on the governance and management of common property resources. Public participation, including community-based management and gender issues, is emphasised. The goal of the project is to review and assess the state of biodiversity, identify appropriate biodiversity management techniques, promote participatory action-research programmes, and undertake capacity building of local institutions — including training and the development of a framework for assessing and monitoring change.

Objectives

The long-term goal of the current programme is to ensure conservation of biological diversity in the mountain ecosystems of the HKH and to enable the governments of the participating countries to develop policies on and programmes for the conservation of biodiversity in the HKH. For this purpose, policy-makers and decision-makers will be provided with options for biodiversity conservation in these mountains; and these will include those in which local people will be recognised as the custodians and managers of biodiversity.

Outputs

The outputs will be

- a comprehensive database for each bio-geographic region (BGR),
- options for sustainable management of biodiversity for each BGR,
- protected area system plans for each BGR,
- policy recommendations to be communicated to government decision-makers and non-government organisations (NGOs),
- increased awareness of different stakeholders through information exchange and networking among participating countries, and
- increased regional cooperation.

Components

- Review of the status of biodiversity in the HKH by major BGRs and farming systems
- Review and assessment of the present system, the location of protected areas in the region, and the extent to which the major BGRs are represented in these protected areas
- Identification of different management options (local and central) for biodiversity conservation within and outside protected areas and preparation of biodiversity conservation and management guidelines for each of the major BGRs

"recognised as one of the 10 richest areas for biodiversity listed in the world's threatened Biotas, 'Hot Spots'"

- Development of mechanisms for regional collaboration in biodiversity conservation in the HKH

Activities Carried Out

Workshops

A workshop on the 'Promotion [of] and Regional Collaboration on Biodiversity Conservation and Management in the Eastern Himalayas' was organised from 12-15 March 1998, in Kunming, China. Country project team members from China, Myanmar, and Nepal participated in reviewing project implementation and progress made from 1995-1997 and plans for the new phase (1998-2000). An international workshop on 'Subregional Consultation on Conservation of Hkakaborazi Mountain Ecosystems in [the] Eastern Himalayas' was held in Putao, North Myanmar, from 25-29 October 1999.

Training

A training course-cum-workshop on bamboo was organised jointly by the International Plant Genetic Resource Institute (IPGRI), ICIMOD, and the International Network for Bamboo and Rattan (INBAR) in collaboration with the Kunming Institute of Botany of the Chinese Academy of Sciences and Southwest Forest College in Yunnan, China from 10-17 May 1998. There were 25 participants from 13 countries in Asia; five of which were Himalayan countries. Training workshops on transboundary biodiversity conservation and ecotourism, both held in 1998 and 1999, were organised jointly by ICIMOD, The Mountain Institute (TMI) , the Department of National Parks and Wildlife Conservation, Nepal (DNPWC), and the Qomolangma Nature Reserve (QNS), Tibet, China. The workshops were held in Kathmandu and a field trip to Langtang National Park in Nepal took place. A training workshop on 'Preparing [a] Model Management Plan for Pidaung Wildelife Sanctuary' jointly sponsored by the Forest Department, Ministry of Forestry, Myanmar, and ICIMOD was held in Myitkyina, Kachin State, Myanmar from 12-14 December 2000.

"mechanisms for regional collaboration in biodiversity conservation in the HKH"

Case studies

A case study reveals that, like other villages in the conservation area area, the Natkanle villagers are still relying on traditional medicine for health care. Secondly, more than 40 medicinal plants from mountain forests are being used in the local herbal medicine systems. Thirdly, village monasteries are regarded as sanctuaries and all plants and wildlife species are protected, including medicinal plants; they are all highly valued. This case study was carried out from October 1997 to March 1998. A final report on the case study was received in May 1998. A project supported by World Wildelife Fund (WWF) entitled 'Biodiversity Assessment and Conservation Planning for Eastern Arunachal Pradesh, India' was completed in 1999, in which geographic information systems (GIS) and remote sensing (RS) were applied for land-use and land-cover mapping and gap analysis of nature reserves. A project on 'Biodiversity Collaboration and Integrated Management of Mountain Ecosystems in

"relying on traditional medicine for health care"

Hongqiang, Chuxiong, Yunnan Province of China' was completed in December 2000. 'Transboundary Cooperation for Conservation between Nepal and the Tibet Autonomous Region' is an on-going activity in which ICIMOD's expertise in the form of consulting services, seminars, and lectures is an important resource.

The Role and Future Activities of the International Centre for Integrated Mountain Development in Biodiversity Conservation

The International Centre for Integrated Mountain Development is known to the region and will play the important role of regional coordinator, having the ability to call all member countries to work together. Institutions and universities of donor countries will be invited. Partner institutions, local governments, and grass-root communities of member countries are the key members of the project.

A diverse set of APPROACHES AND TOOLS for participatory conservation will be applied, including

- community-based activity for participatory conservation of biodiversity;
- buffer-zone establishment and land-use planning;
- technology transfer to reduce human pressure on natural resources, including agroforestry, soil conservation, rural energy, biogas, and drinking water programmes, water harvesting, and the introduction of new crops and forage materials;
- equity and gender issues and empowerment of grass roots' women and organisational development;
- poverty reduction and the introduction of cash crops, beekeeping, ecotourism, and rural industry;
- transboundary cooperation and measures for preventing illegal poaching and illegal transboundary trading in wildlife;
- grass-roots' NGOs; and
- GIS and RS application and establishing a database of nature reserves.

It is emphasised that biodiversity must be integrated into regional development planning, vis-à-vis biodiversity conservation, and must consider the needs of regional development which are closely linked to poverty alleviation and income generation.

Conservation of Mountain Ecosystems: A People and Management Model Plan for Nature Reserves

–A Case Study of Pidaung Wildlife Sanctuary

Professor Chen Guangwei
Head, Mountain Natural Resources Division, ICIMOD

People and Biodiversity Conservation in the Hindu Kush-Himalayan Ecoregion

Establishing nature reserves is one of the important measures for protecting natural resources and many countries have already established conservation systems. In 1977 there were 30,350 nature reserves in the world. Now there are many more areas demarcated for conservation. This is an important practice for protecting good forest cover as well as environments that have been severely degraded. Inappropriate human activity is one of the key driving forces causing losses in biodiversity and environmental degradation and in return it threatens its own survival. Sustainable development is a new vision; people have learned from their development history.

"inappropriate human activity is one of the key driving forces causing losses in biodiversity and environmental degradation and in return it threatens its own survival"

The Hindu Kush-Himalayas (HKH) is the working area of the International Centre for Integrated Mountain Development (ICIMOD) and encompasses a working area known as an ecoregion. This region includes the HKH of eight member countries: Afghanistan, Bangladesh (Chittagong District), Bhutan, China (Qinghai-Tibetan Plateau and Hengduan Mountains), India (northern mountainous area), Nepal, and the northern parts of Myanmar and Pakistan. This ecoregion, situated in the largest mountain system of our planet, forms a complex of special ecosystems. The Qinghai-Tibetan Plateau is also known as the third polar region of the Earth and has colourful landscapes, extremely differentiated ecosystems, and a rich biota with diversified genetics.

This young, dynamic ecoregion has experienced great change in the past 100 million years in terms of the evolution of its geology, geomorphology, climate, vegetation, and fauna. Today it is sensitive to global change. The ecoregion accommodates a diverse culture, which is supported strongly by its diverse ecosystems. The region is inhabited by many important species of animals and plants named in the list of endangered species: giant panda, tiger, elephant, red panda, and the Indian one-horned rhinoceros. Due to population growth and development, as well as poaching and illegal trading in wildlife, the environment is deteriorating. But many natural reserves and protected areas have been established, and many laws and regulations addressing biodiversity conservation have been made. Biodiversity conservation in this region is a tough, long-term task with the

participation of the local people being of paramount importance. The International Centre for Integrated Mountain Development has been working for more than 15 years in this region and will be required to make a major contribution towards regional collaboration.

The HKH member countries and local people are the main stakeholders of and important contributors to biodiversity conservation.

The contributions of member countries to biodiversity conservation in The Hindu Kush-Himalayan Ecoregion

The example of Nepal

Nepal, a country that can be considered as a large slope of the southern Himalayas ranging from tropical valleys to snow peaks, has been making great efforts for biodiversity conservation. Details of the protected areas and buffer zones are presented in Figure 1 and Tables 3 and 4. There are also a series of activities that have been carried out including the Parks and People Project (PPP).

Table 3: Protected Areas in Nepal (1999)

Descriptions	Area (km^2)	Year of establishment	Physiographic region
Royal Chitwan National Park (World Heritage Site (WHS) 1984)	932	1973	Terai-Siwalik
Sagarmatha National Park (WHS 1979)	1,148	1976	High mountains-High Himalayas
Royal Bardia National Park	968	1976/1998	Terai-Siwalik
Makalu Barun National Park	1,500	1991	High mountains-High Himalayas
Langtang National Park	1,710	1976	High mountains-High Himalayas
Shey Phoksundo National Park (WHS)	3,555	1984	High-Trans Himalayas
Rara National Park	106	1976	High mountains, wetland
Khaptad National Park	225	1984	Middle-High mountains
Koshi Tappu Wildlife Reserve (Ramsar Site 1987)	175	1976	Terai
Royal Sukla Phanta Wildlife Reserve	305	1976	Terai
Parsa Wildlife Reserve	499	1984	Terai-Siwalik
Kanchanjunga Conservation Area	2,035	1997	Middle mountains-High Himalayas
Annapurna Conservation Area	7,629	1992	Middle mountains-High Himalayas
Manaslu Conservation Area	1,663	1998	Middle mountains-High Himalayas
Shiva Puri Watershed and Wildlife Reserve	144	1984	Middle mountains
Dhorpatan Hunting Reserve	1,325	1987	Middle mountains-High Himalayas
Total	23,919		Terai-High Himalayas

Source: DNPWC (1999a)

A brief overview of the development of legislation for conservation in Nepal is given below.

- Before 1973 the Department of Forests was responsible for nature conservation.
- In 1973 the National Parks and Wildlife Conservation Act was made.

Table 4: Buffer zones established for protected areas of Nepal (1998/1999)

Buffer zone	Area (km^2)	Year
Royal Chitwan National Park	750	1997
Royal Bardia National Park	328	1997
Langtang National Park	420	1998
Shey Phoksundo National Park	449	1998
Makalu Barun National Park	830	1998
Total	2,777	

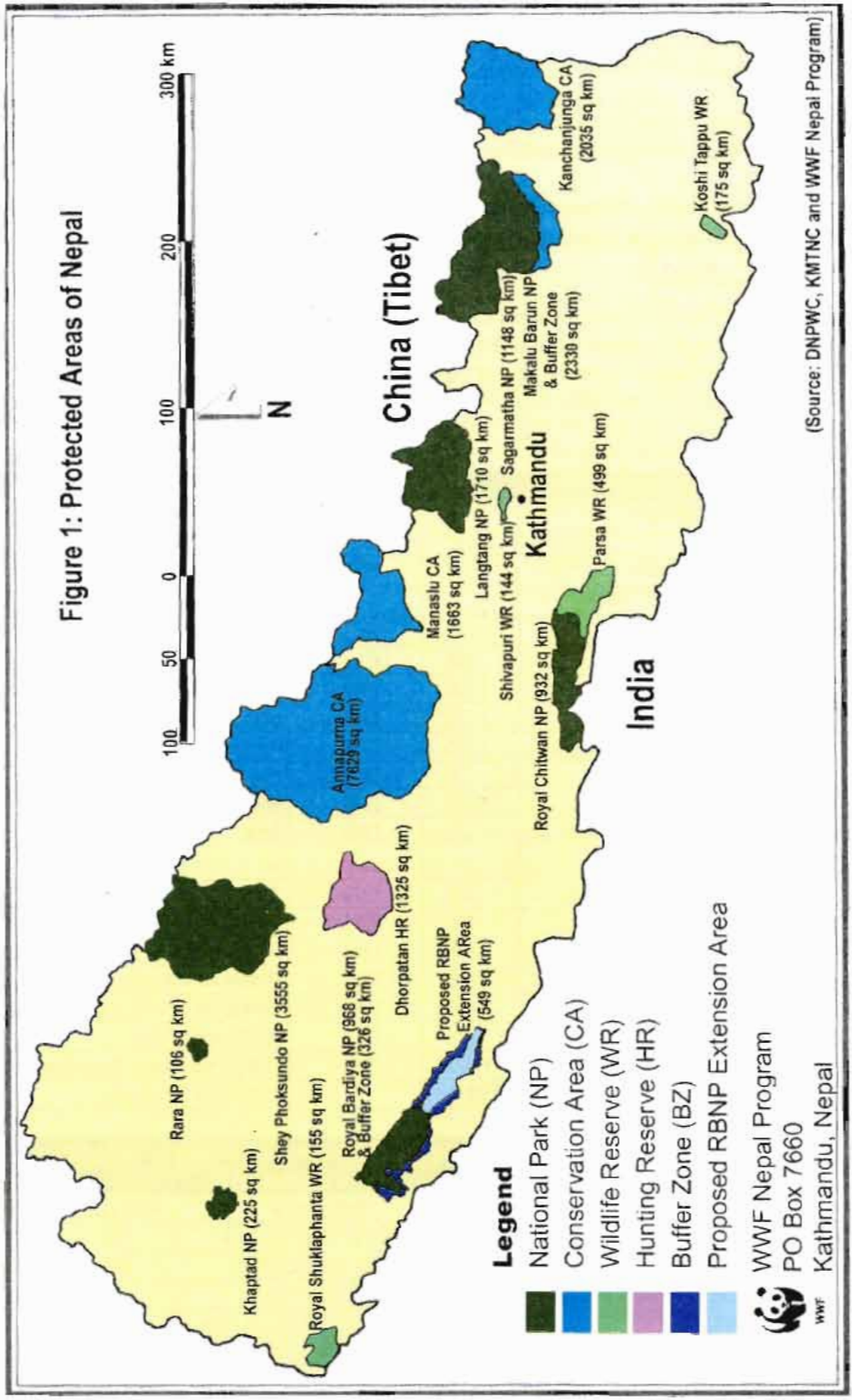


Figure 1: Protected Areas of Nepal
100
50
0
100
200
300 km
N
China (Tibet)
India
Kathmandu
Kanchanjunga CA (2035 sq km)
Koshi Tappu WR (175 sq km)
Makalu Barun NP & Buffer Zone (2330 sq km)
Sagarmatha NP (1148 sq km)
Langtang NP (1710 sq km)
Manaslu CA (1663 sq km)
Shivapuri WR (144 sq km)
Parsa WR (499 sq km)
Royal Chitwan NP (932 sq km)
Annapurna CA (7629 sq km)
Dhorpatan HR (1325 sq km)
Proposed RBNP Extension ARea (549 sq km)
Royal Bardiya NP (968 sq km) & Buffer Zone (326 sq km)
Shey Phoksundo NP (3555 sq km)
Rara NP (106 sq km)
Khaptad NP (225 sq km)
Royal Shuklaphanta WR (155 sq km)
Legend
National Park (NP)
Conservation Area (CA)
Wildlife Reserve (WR)
Hunting Reserve (HR)
Buffer Zone (BZ)
Proposed RBNP Extension Area
WWF Nepal Program
PO Box 7660
Kathmandu, Nepal
WWF
(Source: DNPWC, KMTNC and WWF Nepal Program)

The National Parks and Wildlife Conservation Division was created as a semi-autonomous branch of the Department of Forests.

- In 1982 the division was upgraded to a fully-fledged Department within the Ministry of Forests and Soil Conservation.
- Now there are 16 protected areas (8 national parks, 4 wildlife reserves, 3 conservation areas, and 1 hunting reserve) covering an area which is about 15% of the total area of the country.
- Initially, emphasis was on species' preservation but this has gradually shifted towards community-oriented conservation.
- In 1992 His Majesty's Government of Nepal (HMGN) introduced a policy of community development in buffer zones, legally mandating integrated conservation and development.
- In 1996, HMGN passed legislation to implement a policy under which 30-50% of park revenue will be spent on community development in the buffer zones.
- HMGN has implemented a policy of directing up to 40% of mountaineering fees to community development and environmental conservation in the alpine regions.
- Nepal has signed several international treaties concerning biodiversity and environment.
- Currently more than 100 non-government organisations are working within the context of nature conservation, but most of those are reliant on support from International non-government organisations.

Activities of other member countries of the Hindu Kush-Himalayan Ecoregion

The other member countries of the HKH have also established national parks and natural reserves to protect landscapes, ecosystems, and endangered species. Bhutan is an example and Figure 2 shows the large proportion of territory that has been allocated to the National Protected Areas' System (Sherpa 1996).

Many on-going activities for environmental protection and natural resource conservation include activities for biodiversity conservation. China provides an example. There has been a ban on cutting down native forests in China and a reforestation project has begun in the upper reaches of three important rivers: the Yangtze River, the Yellow River, and the Lanciang River. An area of 220,000 sq.km in the source region of these three large rivers will be demarcated as a protected area for nature restoration.

Local People Are Key Stakeholders in Biodiversity Conservation

Whilst local people enjoy the benefits of the rich biological resources, they also encounter difficulties including competition with wildlife for living space and resources. Examples of such conflicts are given below.

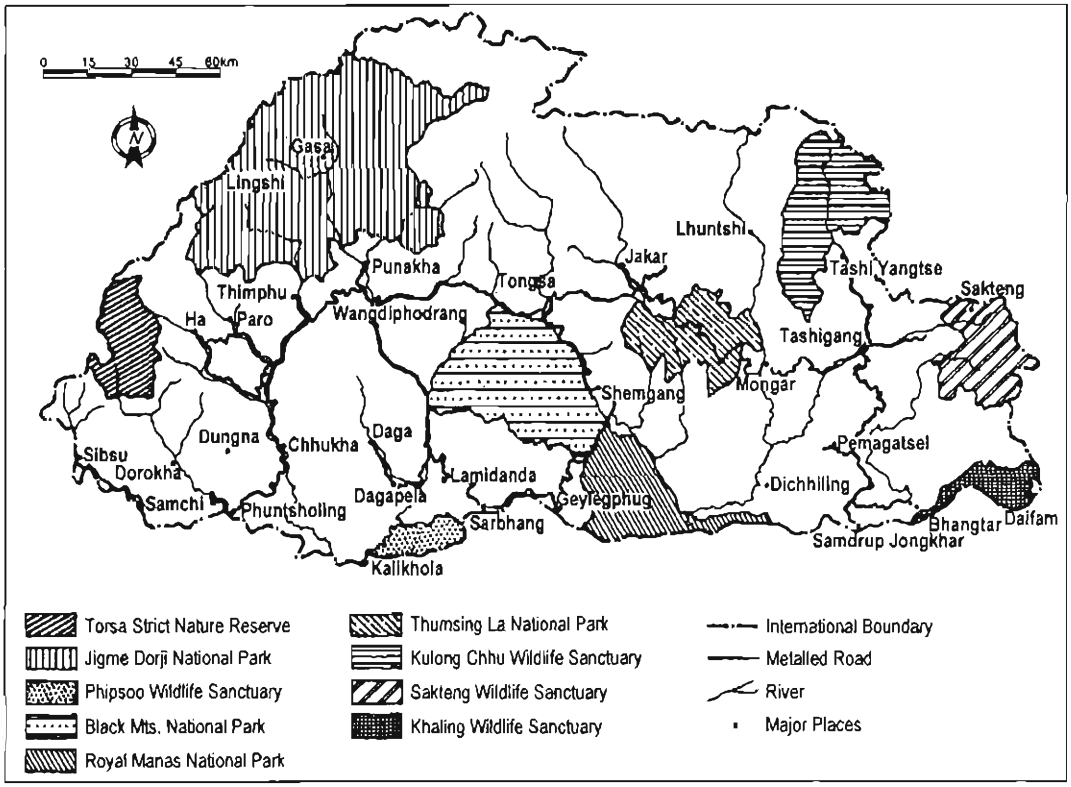
Human and animal deaths in protected areas of Nepal

Some humans are killed by animals. Data from Nepal serve as an example. Table 5 shows the number of local residents killed in accidents with wild animals in different national parks and wildlife reserves in the fiscal year 1998-1999. Table 6 shows wildlife casualties for the same period.

Protection of the Tibetan Antelope

To protect the endangered Tibetan antelope from the threats of poaching and illegal international trade, a court order in India has banned the manufacturing of soft wool derived

Figure 2: **National protected areas' system of Bhutan**



"chinese people have even lost their lives protecting the Tibetan antelope from poachers"

Table 5: Human casualties in protected areas of Nepal in the fiscal year 1998-1999

Protected area	Number of people	Cause of death
Royal Chitwan National Park	4	Killed by tiger
Royal Chitwan National Park	8	Killed by rhinoceros
Royal Suklaphanta Wildlife Reserve	2	Killed by wild elephant
Royal Suklaphanta Wildlife Reserve	1	Killed by rhinoceros
Royal Bardia National Park	2	Killed by tiger
Parsa Wildlife Reserve	2	Killed by wild elephant

Source: DNPWC (1999a)

from this animal. At the time of writing a newspaper reported that this had left 20,000 workers jobless in Kashmir. Some Chinese people have even lost their lives protecting the Tibetan antelope from poachers (Guangwei 2000).

Protection of the wild ass

A recent survey in Maduo County of Qinghai (the upper reaches of the Yangtze River and Yellow River), China, shows that the wild ass population has reached 20,000. This has led to competition for forage between these animals and livestock (Guangwei 2000).

Extraction of resources from Chitwan National Park, Nepal

Due to the pressure of population growth there is an increasing demand for firewood and fodder. In the area around Chitwan, there are firewood and fodder deficits of about 47,947 tonnes and 26,913 tonnes respectively (King Mahendra Trust for Nature Conservation 1996). Each season, about 60,000 people enter Chitwan National Park to cut grass. Each entry permit costs NRs 5 (US $0.12). This has resulted in high pressure on grassland, livestock depreciation, and crop raids by wild animals. This illustrates a conflict between conservation and development. Its resolution may lie with the management of participation by local people in biodiversity conservation.

Table 6: Recorded wildlife casualties in protected areas of Nepal in the fiscal year 1998-1999

Wildlife species	No. of animals	Cause of death
Rhinoceros	31	Natural death (10), fighting between rhinoceroses (6), poaching (4), killed by tiger (1), trapped in swamp (6), other (5)
Tiger	7	Natural death (2), shot by park staff (2), poisoning (1), not known (2)
Baby elephant	1	Natural death
Leopard	4	Natural death (2), not known (2)
Bear	2	Not known
Musk deer	2	Killed by wildlife
Swamp deer	1	Not known
Spotted deer	10	Different incidents
Barking deer	3	Not known
Sambar deer	2	Not known
Blue bull	1	Not known
Palmin civet or toddy cat	1	Not known

Source: DNPWC (1999a)

Biosphere Reserves: A New Concept

A new concept in nature reserve management and reconstruction suggests that biodiversity conservation and habitat protection must be integrated into human social and economic activity (Figure 3) and regional development planning under the guidance of sustainable development. The concept of 'nature reserves of the biosphere', proposed by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Framework of Management and Reconstruction of Nature Reserves of the Biosphere (Sylvia), represents recent progress in this area. At the time of writing, there were 368 nature reserves of the biosphere identified in 91 countries. The key points of the framework are given below.

- It is linked with Agenda 21 and the Rio Convention of Biodiversity Conservation.
- Humans are considered as components of nature reserves.
- The framework should be integrated into regional development planning and policy.

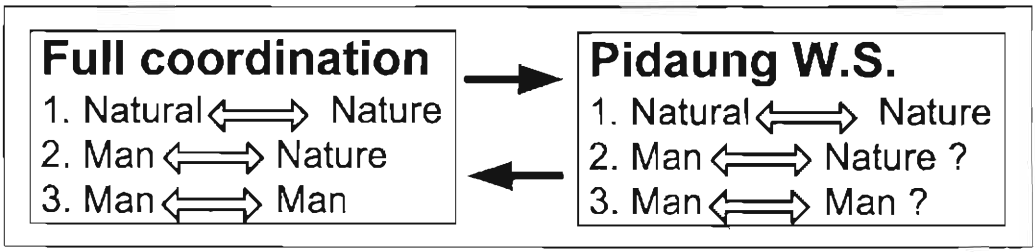


Figure 3: **Comparing the coordination function**

"all stakeholders should be invited to participate in management"

- Nature reserves should be established in regions where there is conflict between humans and the environment.
- The role of buffer zones should be emphasised and efforts made to enlarge buffer zones for the integrated management of the ecosystem as a whole.
- All stakeholders should be invited to participate in management and a partnership of management should be established.
- Public awareness should be promoted through information dissemination and environmental education.
- Open, participatory, and acceptable management should be practised.
- Related organisations, mechanisms, and policies necessary for nature reserves of biosphere need to be established (Nianyong 2000).

"public awareness should be promoted"

All these principles can be integrated with our experiences for improved management of nature reserves and national parks.

The example of China

In China there were 2,600 nature reserves in 1999, comprising 172.8 million ha which is 18% of the total area of China. This network of nature reserves covers a wide variety of environments and has advanced facilities and an effective management system. Of these nature reserves, 15 have been identified to be included in the World Biosphere Conservation Network of UNESCO. A Biosphere Conservation Network of China has been established which has already incorporates 83 protected areas in China (Nianyong 2000).

"this network of nature reserves covers a wide variety of environments"

The Integrated Management of Pidaung Wildlife Sanctuary

Pidaung Wildlife Sanctuary was initiated as a reserved forest of moist and dry deciduous forest in 1913 with an area of 724.42 sq.km and then became a game sanctuary in 1918. It was notified by the Ministry of Forestry under the Director of Nature and Wildlife Conservation, Forest Department in June 1996. It was formerly well known for large mammals such as rhinoceros, deer, bison, and wild elephant occurring in abundance. But Pidaung Wildlife Sanctuary has been suffering from all kinds of human destruction. Reassessment of its status has only recently been carried out as a result of the workshop 'Preparing Model Management Plan for Pidaung Wildlife Sanctuary', which took place in Myitkyina, Kachin State, Myanmar on 12-14 December 2000.

The workshop on 'Preparing Model Management Plan for Pidaung Wildlife Sanctuary' provides a useful example of planning a management strategy for a protected area. In formulating a plan, issues addressed include biodiversity conservation and conflicts between conservation and development. The objectives of the workshop and further information including recommendations for the management plan of Pidaung Wildlife Sanctuary are discussed in detail in the workshop report (Part III of this publication).

"it was formerly well known for large mammals such as rhinoceros, deer, bison, and wild elephant"

A number of successful ventures provide useful examples for the development of a management plan for Pidaung Wildlife Sanctuary (see workshop report). A good example, the PPP of Nepal, is discussed below.

The Parks and People Project of Nepal (DNPWC 1999b)

The Department of National Park and Wildlife Conservation (DNPWC) has been implementing the Parks and People Project (PPP) in seven protected areas of Nepal with the following primary objectives: (1) to ensure the socioeconomic well-being of the buffer-zone communities and (2) to undertake biodiversity conservation in parks and reserves and their surroundings (see Executive Summary, DNPWC 1999b).

In order to achieve the true participation of buffer-zone communities in this developmental endeavour, the programme recognises that in line with the government's approach of partnership for conservation, the buffer-zone communities must become more vociferous and active in pursuit of what they want and they must learn about what is available to them and of the ways and means to access it.

Hence, to realise its objectives, PPP, funded through the United Nations Development Programme (UNDP) since early 1995, has implemented various community-based biodiversity conservation activities through the active involvement of self-governed, local organisations in the seven protected areas of Nepal.

The major activities initiated by the programme in 1999 are the expansion and strengthening of local organisations such as user groups, imparting skill enhancement training, income generation, productive infrastructural development, conservation education and awareness, buffer-zone community forest development, and promotion of ecotourism. Various park management activities such as grassland, wetland, and habitat management have also been successfully carried out with the aim of conserving habitats and ecosystems.

This example and others give ideas and frames of reference but ultimately each nature reserve has to find its own suitable method of management. I firmly believe a better future for Pidaung Wildlife Sanctuary will be realised through the efforts of all its stakeholders.

Conclusions

- Biodiversity is an important indicator of environmental status and its conservation is one of the key elements of sustainable development.
- Biodiversity conservation goes far beyond national boundaries and accommodates the interests of present and future generations.
- It is important to mobilise the initiative of all stakeholders for successful biodiversity conservation.
- The HKH ecoregion is an important key node for biodiversity conservation on a global level. At present protecting the ecosystems as a whole may be the best solution due to the lack of data. Any project related to biodiversity must work closely with the local people, the key stakeholders, and much attention should be attached to local-level activities.
- The management strategy for Pidaung Wildlife Sanctuary can provide valuable experiences for the improvement of management of some kinds of nature reserves. It will also ensure that Pidaung Wildlife Sanctuary fulfils its nature-conservation role.
- ICIMOD, as a well-known international organisation focusing on sustainable mountain development of the HKH ecoregion, is well positioned to fulfil the role of regional coordinator.

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The Characteristics of Biodiversity in the Grand Canyon of the Yarlung Zangbo River in the Eastern Himalayas

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Physical Geography of the Grand Canyon

The Unique Heat-island Effect

The Qinghai-Tibetan Plateau, with an average elevation of 4,500m, is topographically the highest relief feature in China, and the highest and largest in the world. It averages 4,000m in elevation in the south-east, and by a gradual ascent rises to 5,000m in the north-west. The surface of the plateau's main body is chiefly made up of low mountains, undulating terrain, and broad basins. On the edges of the plateau, high mountain ranges constitute its geomorphologic skeleton.

The Qinghai-Tibetan Plateau, a landmass as large as 2.5 million sq.km and towering from the earth's surface up into the troposphere, has a strong impact on atmospheric circulation that originates from the heat exchange between continents and oceans. This effect includes mainly the mechanical force exerted by the landmass on the atmosphere, the frictional effect of the land at the boundary layer on air movement, and the heating up of the landmass in response to the absorption of solar radiation.

Based on research on the climate of the Qinghai-Tibetan Plateau, Chinese meteorologists have confirmed that in winter the effect of the plateau on atmospheric circulation is mainly due to mechanical forces; in addition it exerts its effect on atmospheric circulation by virtue of heating. In spring and summer, especially in June, the Qinghai-Tibetan Plateau is a huge heat source. An area of one square centimetre may emanate 880 J/cm^2 day equivalent of heat energy. The plateau, can transfer to the atmosphere 4.60×10^{18} J/day, averaged over a year. In June, the plateau puts out as much as 2.095×10^{19} J/day.

Under such circumstances, in spring and summer, the plateau land surface directly heats the lower atmosphere, significantly modifying the temperature and humidity. At below 500 mb, a strong low atmospheric pressure cell is formed. The heated, ascending air leads to an upper-level, strong and stable, high-atmospheric-pressure region in the troposphere above 430 mb, reaching the strongest effect at 150-200 mb. This has triggered the formation of the unique warm high-pressure phenomenon over the Qinghai-Tibetan Plateau.

The Qinghai-Tibetan high-atmospheric-pressure region occupies the upper level of the troposphere over a vast subtropical area of Asia and Africa. It influences not only the atmospheric circulation of the Northern Hemisphere, but also that of the Southern Hemisphere. Along with the pronounced seasonal changes in temperature, the air pressure also demonstrates a remarkable seasonal contrast. The more significant variations are related to the wind direction. In summer, the surrounding wind converges towards the plateau. In winter, it diverges from the

"the wind can go through the narrow passages composed of numerous valleys cut deep by running water on the south edge of the plateau"

plateau towards its periphery. Thus, a unique seasonal monsoon wind pattern of the plateau is established. The special heat-island effect of the plateau exerts a tremendous influence on its climate.

The Qinghai-Tibetan Plateau monsoon reinforces the monsoon phenomenon between southern and northern hemispheres, resulting in more vigorous exchanges of air, water, momentum, and energy. Most importantly, it induces and thickens the south-west monsoon in the lower troposphere. As confirmed by the simulation studies of Habn and Manabe (see Habn and Manabe 1925), without the plateau the centre of the continental low pressure would be located around 45° N and 125° E. Thus in July the mean south-west monsoon cannot go beyond 15° N in South Asia. With the plateau monsoon, the wind can go through the narrow passages composed of numerous valleys cut deep by running water on the south edge of the plateau, and move further northwards into the plateau core. Influenced by the varied landforms, the south-west monsoon regularly releases the water and heat that it brings while moving northwards into the plateau. Overall, it affects the distribution pattern of the ecosystems of the Qinghai-Tibetan Plateau region.

"this passage supplies the largest amount of moisture to the plateau"

The Moisture Passage and Climatic Diversity

The Yarlung Zangbo River flows eastwards through the Qinghai-Tibetan Plateau until it reaches Mailing County. There it turns north-eastwards, cuts in a zigzag through the east tip of the Himalayas, then a sharp curve brings the river southward into the Ganges Plain, and the Grand Canyon with a cutting depth of 5,000m on average and several hundred kilometres long was formed around Namjagbarwa Peak. It is like a giant gap from north to south, cutting the south-east part of the Plateau. The warm, wet air currents from the Indian Ocean can enter the inner part of the plateau along this gap, which is a decisive factor affecting the climate.

"the largest moisture transportation to the Qinghai-Tibetan Plateau"

The meteorological significance of the moisture passage on the Grand Canyon of the Yarlung Zangbo River is due to (1) the effects of the warm, humid air from the Indian Ocean flowing along the Bramaputra River upstream and then the lower reaches of the Yarlung Zangbo River, which reaches the inner part of the Qinghai-Tibetan Plateau and (2) the fact that this passage supplies the largest amount of moisture to the plateau out of all the moisture sources around the plateau.

Records show that the largest moisture transportation to the Qinghai-Tibetan Plateau, out of all those around the plateau, is the one along the Brahmaputra-Yarlung Zangbo River (500-1,000g $cm^{-1}s^{-1}$). This amount is close to the value of moisture transferring from the south side to the north side of the Changjlang River in summer. Other observatories around the plateau only recorded 100-400 $cm^{-1}s^{-1}$, 1-5 times less than that through the Yarlung Zangbo valleys.

"is the one along the Brahmaputra-Yarlung Zangbo River"

Obviously the lower reaches of the Yarlung Zangbo River are the most important moisture passage. The direction of the passage is along the Brahmaputra River to the north-east, then along the lower reaches of the

Yarlung Zangbo River to the north, finally turning north-west at the Great Bend Gorge climate with its large contrast in water and heat regimes. The plateau is marked for its varied climatic types. Although it falls in subtropical latitudes, its influence in augmenting the south-west monsoon and in impeding the cold air masses from the north have allowed the tropical monsoon climate in the Indian subcontinent to extend up to the south edge of the plateau to form a zonal climatic type. This type of climate may even extend to 29° 30' N along the Yarlung Zangbo River Valley.

The variations of the Grand Canyon climate not only reflect its diversified zonal climatic types, but also its numerous vertical changes due to a vast mountainous area on the edge of the plateau with tall snow-capped mountains on the broad and flat plateau surface. The mountains in different climatic zones have distinct vertical climatic zones. For example, the southern slopes of the eastern Himalayas on the south-east edge of the plateau have the most complete vertical climatic spectrum amongst mountains in humid areas of the world. It begins at the foot-slopes with humid tropical conditions and changes with elevation in a gradual gradient with reference to temperature and precipitation. With an increase in altitude the climate shifts to montane polar and high alpine polar.

Finally, it is necessary to point out that owing to the complexity of the plateau geomorphology, the climate is controlled by the unique air circulation pattern. Hence, the climate is highly changeable through time and rather unpredictable. If the south-west monsoon is relatively strong the moisture-heat assemblages along its water-vapour passages vary remarkably, and if an area is influenced by the monsoons, with an annual mean temperature ranging between 0.4 and 7°C, the position of the latitudinal zonal boundary will vary by about 100m up or down. Without doubt, such effects will have far-reaching consequences on ecosystem development and the rate of species differentiation.

As mentioned above, because of the moisture passage on the lower reaches of the Yarlung Zangbo River, places along the passage and those nearby have a very different distribution of heat and water from other places, and this difference has made a strong impact on the biological features there. This effect is closely related to the intensity of the moisture flow along the passage. The moisture flow decreases as it goes further north.

Biodiviersity of the Crand Canyon

A Rich Diversity of Ecosystems

Biodiversity refers to the diversity and variation of living things and the ecological complexity on which their existence depends. It includes genetic diversity, species' diversity, and ecosystem diversity (at three different levels of observation). Ecosystem diversity refers to the diversity of habitats for flora and fauna and ecological processes within ecosystems. As described in the above section, the diversified climates resulting from the plateau's unique geographical position, atmospheric circulation, and complex surface configuration have directly engendered a diversity of habitats for flora and fauna in this region. This diversity in the plateau's biotic successional history has brought equally complex ecosystem types and their constituent ecological processes.

The rain shadow effect of the eastern Himalayas and Mount Kangrigarbo in the middle part of the Grand Canyon of the Yarlung Zangbo River cause two important effects. Firstly, regional climatic differentiation is in a horizontal direction, the humid area is in the southern part and the semi-humid area is in the northern part. Secondly, towering mountains have water and heat conditions that change with elevation, thus vertical climatic differentiation occurs in the Grand

"generally the most abundant rainfall occurs at 2,400-3,200m above sea level"

Canyon region: the annual mean temperature will rise or fall in accordance with elevation; rainfall increases with the rise in elevation from the foot to the peak of the mountain. Except for the foothills of the mountain range, generally the most abundant rainfall occurs at 2,400-3,200m above sea level in the southern part of the Namiagbarwa region, and in the northern part it occurs at 3,600-4,400m above sea level. Corresponding to the climatic changes, the vegetation of the mountain also presents obvious horizontal and vertical differentiation. The limits of the horizontal and vertical belts of the vegetation are closely related to important climatic factors such as the 1,000m line of annual rainfall, the limits of the snow mantle and frost in winter, cloud and fog limits in summer, and the permanent snow-belt.

The vertical distribution of the mountain ecosystem

"the vegetation of the mountain also presents obvious horizontal and vertical differentiation"

The Grand Canyon of the Yarlung Zangbo River is a mountainous area; each peak has its own particular vertical spectrum of the ecosystem, due to different geographic positions and elevations. We classified all vertical spectra into the following two types: (1) humid type, located in the southern part of the eastern Himalayas and Mount Kangrigarbo; and (2) semi-humid type, located in the northern part. It should be pointed out that a tongue-shaped humid area extends to the Baimagoxueng, Dongjug, Yiong, and Suotoug located in the northern part of the eastern Himalayan-Mount Kangrigarbo Range along the Yarlung Zangbo River Valley and is under the strong influence of the airflow from the Indian Ocean. In this area, there is a vertical spectrum of the humid type as in the southern part.

"closely related to important climatic factors such as the 1,000m line of annual rainfall"

(A) Standard vertical spectrum of the ecosystem for the humid mountains in the southern part

The standard vertical spectrum is composed of five vegetation belts.

(1) Evergreen and semi-evergreen monsoon forest belt

The latitude of this area covered by evergreen and semi-evergreen monsoon forest is much higher than that of other rainforests in the world, so the rainforest in this area has been formed under special topographic conditions. Its ecological environment and the characteristics of the plant community are quite different from those of the equatorial and seasonal rainforests located between the Tropic of Capricorn and the Tropic of Cancer.

Evergreen monsoon forest ecosystem sub-belt

This sub-belt is situated to the north of 28°30' N and the valley of the Yarlung Zangbo River and its tributaries below 900m above sea level. The climate is warm and moist, with a mean annual temperature of 22°-26°C and annual precipitation of over 3,000-5,000 mm. Eighty per cent of the annual rainfall occurs between May and October.

"there is a vertical spectrum of the humid type as in the southern part"

The vegetation is evergreen monsoon forest and the dominant species is the *Dipterocarpus turbinatus* family; it is an evergreen broad-leaf tree about

30- 40m tall. It forms part of the first tree layer in the forest, which has a discontinuous crown. The second tree layer of the community is generally composed of many semi-evergreen and deciduous broad-leaf trees such as *Canarium resiniferum*, *Shorea assamica*, *Terminalia myriocarpa*, *Mesua ferrea*, *Lagerstroemia minuticarpa*, *Mesua ferrea*, and *Toona ciliata*. The trees in this layer are shorter than the dominant ones. So the physiognomy of the rain forest is evergreen for the whole year.

Semi-evergreen monsoon forest ecosystem sub-belt

This sub-belt is situated to the south of 29°30' N on the slope of the valley of the Yarlung Zangbo River and its tributaries between 600 and 1,100m; it can rise above 1,400m in some places. The sub-belt reaches the limit of rainforest distribution. The mean annual temperature is 18-22°C and annual rainfall is 2,500-3,500 mm. There is severe drought in winter and spring, especially when the temperature rises rapidly in April and May.

Because of the above-mentioned climatic conditions, the evergreen monsoon forest ecosystem shows different characteristics from the semi-evergreen monsoon forest ecosystem. The first tree layer is mainly composed of semi-evergreen broad-leaf and deciduous broad-leaf trees which change their leaves at the end of the dry season. The dominant species are *Terminalia myriocarpa* and *Altingia excelsa* and other important plants of this layer include *Canarium resiniferum*, *Celtis tetrandra*, *Homalium zeyanicum*, *Lagerstroemia minuticarpa*, and *Toona ciliata*. However more than 80% of the tree species of the second tree layer are evergreen broad-leaf trees, including *Gynocardia odorata*, *Cinnamomum iners*, *Castanopsis indica*, and *Cleidion javanicum*. After the trees in the first layer have lost all their leaves during the dry season, the community shows a distinctive seasonal appearance of a mosaic, comprising the deep green tone of the crown of the second tree layer and brown tones of the bare branches of the first tree layer.

(2) Middle mountain evergreen and semi-evergreen broad-leaf forest ecosystem belt

This is a special belt in the middle and eastern Himalayan-Mount Kangrigarbo Range. The upper sub-belt of this belt is composed of semi-evergreen broad-leaf forest, which is endemic in the moist mountains. It differs greatly from the corresponding belt of the mountains in south China.

Middle mountain evergreen broad-leaf forest ecosystem sub-belt

This sub-belt is situated to the south of Gan dae (29°47'N), on the slope of the valley of the Yarlung Zangbo River and its tributaries — between 1,100 and 1,800m; in some places it can rise above 2,200m or drop down to 900m. The mean annual temperature is 15-18°C and annual rainfall is 2,000-2,700 mm. Sino-Himalayan elements are the main components of this forest, which is characterised by dominant species such as *Castanopsis ceratacontha*, *C. hystrix*, and *Quercus ladicosa* (oak tree). The forest is 25-40m tall, with an evergreen physiognomy the whole year round.

Middle mountain semi-evergreen broad-leaf forest ecosystem sub-belt

This sub-belt is situated in the valley of the Yarlung Zangbo River and its tributaries to the east of Baimagoxueng and to the south of Yiong between 1,500 and 2,400m, but it can rise above 2,600m in the northern part of the Mount Namjagbarwa Range. The mean annual temperature is 11-15°C. Because this sub-belt is just under the belt of the highest annual rainfall in these mountains, annual rainfall reaches 3,000 mm. The climax vegetation of the sub-belt is semi-evergreen broad-leaf forest composed of three communities: *Cyclobalanopsis lamellosa*, *C. xizangetsis*, and *Quercus tongmaiensis*. These forests exist only in the moist mountains of the

"there are obviously different vegetation vertical spectra in the alpine scrub and meadow belt"

eastern Himalayas and its eastward range. During the end of the dry season, the trees of the first layer of this forest change their leaves and the physiognomy of the forest is exactly like the deciduous broad-leaf forest in autumn. The forest keeps its evergreen appearance in the other seasons.

(3) Sub-alpine evergreen coniferous forest ecosystem belt

The differences of the vertical vegetation spectra between the southern part and northern part of the Namjagbarwa Region are shown by the sub-alpine evergreen coniferous forest belt; in the southern part, the lower sub-belt is hemlock forest and in the northern part of the sub-belt is spruce forest.

Sub-alpine hemlock forest ecosystem sub-belt

"alpine evergreen scrub and herbaceous meadow"

This sub-belt is similar to the middle mountain semi-evergreen broad-leaf forest belt. The elevation is 2,400-2,800m, the mean annual temperature is 8-11°C, and annual rainfall is 3,000 mm. The climatic conditions of this sub-belt are suitable for the sub-alpine evergreen coniferous forest belt.

The climax plant community is hemlock forest, which is composed of the construction species *Tsuga dumosa*. This species is 40-70m tall and forms the first tree layer, which has a discontinuous crown. The second tree layer is mainly composed of deciduous broad-leaf trees. The surface of the soil in the forest is very moist and shady and branches and trunks are covered by thick mosses.

Sub-alpine fir forest ecosystem sub-belt

"alpine deciduous creeping willow scrub and *Kobresia* meadow"

This sub-belt occurs between elevations of 2,600 and 4,100m. The mean annual temperature is 2-8°C and annual rainfall is 2,000-3,000 mm. The climax plant community of fir forest is composed of the construction species *Abies delavayi* var. *mothoensis*, and *Abies delavayi* is the accompanying species of the first tree layer. The second tree layer of the forest is mainly composed of deciduous broad-leaf trees, but this layer is not well developed. Mosses grow luxuriantly in the forest.

(4) Alpine scrub and meadow ecosystem belt

There are obviously different vegetation vertical spectra in the alpine scrub and meadow belt between the southern part and northern part of the Haniagbarva Region. In the southern part, this belt is composed of the alpine evergreen scrub and herbaceous meadow sub-belt and the alpine deciduous creeping willow scrub and *Kobresia* meadow sub-belt. In the northern part, there is an alpine evergreen scrub and *Kobresia* meadow sub-belt,

Alpine evergreen scrub and herbaceous meadow ecosystem sub-belt

"evergreen broad-leaf scrub and herbaceous meadow"

This sub-belt appears between elevations of 3,800 and 4,300m, the mean annual temperature is –2-2°C, and the annual rainfall is 2,000-2,500 mm. The climax vegetation is composed of evergreen broad-leaf scrub and herbaceous meadow. The former generally grows on sunny slopes and the

tops or ridges of mountains where snow melts in early spring. The azalea scrub, which needs a relatively long time to complete its growth cycle, can grow well. The scrub is mainly composed of the neriifloru *Rhododendron wardii*, *R. neriiflorum*, *R. laudandum*, *R. repens*, *R. lepidotum*, and *R. brachyanthum* subsp. *hypolepidotum*. The herbaceous meadow generally grows on shady slopes and in valleys where snow cover is heavy in the winter and melts completely in the late spring. The meadow is mainly composed of herbaceous communities, such as *Caltha sinogracilis f. rubriflora*, *Potentilla coriandrifolia var. dumosa*, *P. stenophylla*, and *Bergenia purpurascens*.

Alpine deciduous creeping willow scrub and *Kobresia* meadow ecosystem sub-belt

This sub-belt is situated between 4,200 and 4,500m in altitude, the annual mean temperature is 2-3°C, and annual rainfall is 2,000-2,500 mm. Snow cover is very heavy and it melts very slowly, so the plants here have the ability to survive under heavy snow cover for many years. The climax vegetation, which has a clear mosaic structure, is comprised of deciduous creeping willow scrub and *Kobresia* meadow. The willow communities include *Salix souliei*, *S. flabellaris*, *S. pilosomicrophylla*, *S. acuminatomicrophylla*, *S. annulifera* var. *maeriula*, *S. floccosa*, and *S. faxonianoides*. The height of the willows is less than 10m and their branches and twigs creep over the surface of stones and soil. There are some accompanying plants which are evergreen broad-leaf creeping shrubs. These include *Diapensia himalaica*, *Vaccinium modestum*, *Rhododendron pumilum*, and *Diplarche multiflora*. The *Kobresia* meadow is composed mainly of *Kobresia cercostachys* and *K. nepalensis*.

(5) The Alpine sub-niveal ecosystem belt

Alpine sub-niveal ecosystem sub-belt

This sub-belt is situated on slopes, between 4,400 and 4,800m. The climate is very severe, with an annual mean temperature of –3·5°C and annual precipitation of 1,000-1,500 mm. The majority of precipitation falls as snow and hail. The plants here grow under snow cover for more than nine months. The vegetation of this sub-belt is composed of pioneer plant groups, with the edification plants of these groups generally belonging to the lichen, moss, and composite families; they include mustard, pink, orpine, sedge, knotweed, and saxifrage. The vegetation is discontinuous.

(B) Standard vertical spectrum of the ecosystem for the semi-humid mountains in the northern part

The standard vertical spectrum is composed of four vegetation belts.

It should be pointed out that a tongue-shaped humid area extends to the Baimagoxueng, Dongjug, Yiong, and Suotoug located in the northern part of the eastern Himalayan-Mount Kangrigarbo Range along the Yarlung Zangbo River Valley and is under the strong influence of the airflow from the Indian Ocean. In this area, the vertical spectrum of the humid type is as for the southern part.

(1) The evergreen broad-leaf sclerophyllous forest ecosystem belt

This is the basic belt of the standard vegetation vertical spectra in the northern part. It contains only one sub-belt.

The evergreen broad-leaf sclerophyllous forest ecosystem sub-belt

This sub-belt is situated in the northern part of the eastern Himalayas and Namgrigarbo Range, except in the tongue-shaped humid area (mentioned previously) which extends to the

"evergreen broad-leaf sclerophyllous forest"

Baimagoxueng, Dongjug, Yiong, and Suotoug located in the northern part. The elevation is 2,500-3,200m, the annual mean temperature is 8-10°C, and annual rainfall is 500-700 mm. The climax vegetation is evergreen broad-leaf sclerophyllous forest, which is one of the survivors of Palaeo-Mediterranean vegetation of the Tertiary period. The vegetation is composed of a *Quercus aquifolioides* community. It is about 20-30m tall and the dense crown of the community keeps a yellow-green appearance throughout the year.

(2) The sub-alpine evergreen coniferous forest ecosystem belt

This belt is composed of spruce and fir sub-belts.

"the dense crown of the community keeps a yellow-green appearance throughout the year"

The sub-alpine spruce forest ecosystem sub-belt

This sub-belt is similar to the evergreen broad-leaf sclerophyllous forest ecosystem sub-belt. It is situated at elevations between 3,200 and 3,600m the annual mean temperature is 2-8°C, and annual rainfall is 700 mm. The rainfall is obviously low and the spruce forest adapts to a semi-humid climate. The climax vegetation of this sub-belt is *Picea likiangensis* var. *linzhiensis* community. The forest is 30-60m tall. Because of the dry climate, the moss layer is not developed, but a lot of *Usnea longissima* hang on the branches of the spruce and the community has a conspicuous grey-green appearance.

The sub-alpine fir forest ecosystem sub-belt

This sub-belt is situated at elevations between 3,600 and 4,200m, but in some areas it can rise above 4,400m. The annual average temperature is 0.5°C. It is located in the highest rainfall belt in the northern part; the rainfall is 1,000 mm and the climate is moister. The climax vegetation of this sub-belt is of the fir community as in the southern part, but the edification plants of the community are *Abies georgei* var. *smithii* (silver fir), which is adapted to the semi-humid climate. The forest is moist, so the moss layer grows well.

"this sub-belt is of the fir community"

(3) Alpine scrub and meadow ecosystem belt

This belt is composed of the evergreen *Azelia subina* scrub sub-belt and the *Kobresia* meadow sub-belt.

The alpine evergreen *Azelia subina* scrub ecosystem sub-belt

This sub-belt is situated at elevations between 4,000 and 4,400m. The climax vegetation of this sub-belt is complex: the evergreen azalea scrub is generally distributed on the northern slope and the evergreen coniferous juniper scrub on the southern slope. These two communities form a mosaic with *Kobresia* meadow. The evergreen azalea scrub is mainly composed of communities such as *Rhododendron phaeochrysum*, *R. principis* var. *agglutinatum*, *R. forrestii*, *R. microgynum*, and *R. nivale*; the evergreen coniferous juniper scrub is mainly composed of *Sabina pingii* var. *wilsonii* and *S. saltuaria*; the *Kobresia* meadow is mainly composed of *K. prainii*, *K. pygmaea*, and *K. nepalensis*. A wide variety of herbs also grow here.

"evergreen coniferous juniper scrub"

The alpine *Kobresia* meadow ecosystem sub-belt

This sub-belt occurs at elevations between 4,200 and 4,800m. The annual mean temperature is 1-4°C and annual rainfall is 1,000 mm. Because the climate is cold and dry, it is very difficult for scrub to grow, apart from in microhabitats, and the vast majority of the area is covered by alpine *Kobresia* meadow. Alpine *Kobresia* meadow is the climax vegetation of this sub-belt and is mainly composed of *Kobresia pygmaea*, *K. cercostachys*, and *K. prainii* communities.

(4) The Alpine sub-niveal ecosystem belt

This only contains one sub-belt.

The alpine sub-niveal ecosystem sub-belt

This sub-belt occurs between elevations of 4,600 and 5,200m, the annual mean temperature is 3-6°C, and the rainfall is 1,000-1,500m. It is very cold and dry, and the vegetation of this sub-belt is similar to the corresponding sub-belt in the southern part.

A Centre of Species Differentiation and Variation

The moisture passage has the most profound influence on flora and fauna in the valleys on the lower reaches of the Yarlung Zangbo River. This has been described above. But for the majority, especially those plants and insects with a weak ability to move, the steep canyons form a powerful factor to separate them from the outside world. When the humid and warm air current passes through this area, it, together with the ground configuration, creates many unique micro-habitat pockets favourable for species' differentiation and variation.

The young Sino-Himalayan geo-element developed from the Indian-Malaysian geo-element and the eastern-Asiatic geo-element during the upheaval of the Himalayas. The valleys on the lower reaches of Yarlung Zangbo River are areas typical of this geo-element and of the species in the Himalayas. An initial survey disclosed 150 regional vascular-bundle plants growing in the moist area They include *Sphaerotylos medogensis* of the nettle family; *Parapteropyrum tibeticum* of the knotweed family; *Xizangia serrata* of the figwort family; and *Sinoleontopodium lingiatnum* of the chrysanthemum family.

They belong to the single species' genus. Many of the species are dominant species in their localities and have formed botanical colonies of their own, such as the communities of *Quercus lodicosa*, *Cyclobalanopsis xizanggensis*, *Quercus tungmaiensis*, and *Abies delavayi* var. *motuoensis*. They appear as the most attractive vegetation plants with distinct local characteristics along the passage area. All this shows that the valleys on the lower reaches of the Yarlung Zangbo River played an important, even decisive, role in forming the Sino-Himalayan geo-element.

Distinct species' differentiation in the passage is also seen in insects. There are quite a number of newly developed regional genera here such as *A. Serratus* and *Tenuifemurus** of Orthoptera and *Sigmacallis* and *Paraspitiella* of insects. Other kinds of species' differentiation are also apparent here. *Leptomia*, of the elytrum order, a special genus in the Himalayas, has 13 varieties along the passage. Eleven of the 15 species of *Tabanus* in Tibet are in the moisture conduit as special regional varieties.

Protection of New, Ancient, and Migrated Plant Species

Because of its favourable three-dimensional ecological environment and function as a corridor for the movement of living things, the moisture passage during the ice age in the Quaternary

"the favourable ecological conditions in the moisture passage protected ancient local plants"

period served as a refuge to protect many ancient plant species. Some have flourished up to the present day. They include *Takakia lepidozioides*, a living fossil of Bryophyta; *Alsophila spinulosa* and *Sphaeropteris brunoniana* of Pteridophyta and *Dipteris wallichii*; *Podocarpus neriifolius*, *Gnetum pendulum*, *Cephalotaxus hainanensis*, *Amentotaxus argotaenia*, *Taxus yunnanensis*, *Tsuga dumosa* (gymnosperms); and *Tetracentron sinense* and *Euptelea pleiospermum* (angiosperms). Regarding lower plants, some ancient rusts have been preserved with their hosts, such as *Uredinopsis*, considered a living fossil, *Milesina* and *Hyalopsora*.

Rich in Species

The favourable ecological conditions in the moisture passage protected ancient local plants, exotic ones and cultivated many new species. Thus this area has the largest variety of flora and fauna in the Qinghai-Tibetan Plateau. According to a survey, there are 3,600 types of vascular-bundle plants that make up two-thirds of the total in Tibet. There are 400 types of macrofungi, accounting for 80% of Tibet's total, or about 60% of China's total. The passage also has 200 kinds of rusts which are about 25% of the country's total, and 2,000 kinds of insects, that is, 60% of Tibet's total. In addition, there is a greater variety of mammals, amphibious animals, reptiles, and birds.

"the passage also has 200 kinds of rusts"

The unique ecological environment in this region also has a profound influence on the growth of local plants and animals. This is shown by their extremely high biological reproductive rate. The dragon spruce and fir forests reach an accumulated volume of 2,300 cubic metres of timber per hectare. Their biological productivity is greater than 1,200t/ha. One giant dragon spruce, 73m tall and 2.5m diameter, has a volume of 50 cubic metres of timber. All these characteristics are rarely seen in forests in other areas.

The high productivity of plants in the passage provides sufficient food for insects and herbivorous animals. Their prosperity in turn stimulates birds and carnivorous animals to thrive. It is estimated that in the hilly lands in the passage there are over 1,000 *Budorcas taxicolor*, a precious animal under state special protection. The valleys on the lower reaches of the Yarlung Zangbo River, as a passage for air currents from the Indian Ocean to Tibet, are a treasure trove of species.

"high productivity of plants in the passage provides sufficient food for insects and herbivorous animals"

An Abnormal Biological Distribution

Benefiting from the warm, wet air current, large-scale humid tropical forests in southern Motuo on the lower reaches of the Yarlung Zangbo River stretch northward until latitude 29°30', forming the northernmost tropical mountain environment in the Northern Hemisphere. This makes it possible for many typical plants and animals to thrive at a much higher altitude and height of vertical distribution than they usually do. These plants and animals include *Porphyrellus graeilis*, *Pleurotus sajor-caju*, and *Goplana mirabilis* from lower plants; *Terminalia niyriocarpa*, *Altingia excelsa*, *Chukrasia tabtilaris*, *Homalium zeylanicum*, *Lagerstroemia minuticarpa*, and *Dysoxyltim gobara* from higher plants; *Python molurus*

bivittatus, *Naja hannah*, and *Ophisatirus gracilis* from reptiles; *Pycnonotus jocosus*, *Dicrurus acneus*, *Arachnothera ma*, *Prcsbyils entellus*, and *Accros nipalensis* from birds; *Panthera tigris zintliak*, and *Viverricula indica* from mammals; and *Parrhinotermes khasii* and *Indopodisma kindoni* from insects.

The establishment of a canyon for flora and fauna on the northern and southern sides of the Gangrigabu Mountains and the Eastern Himalayas helps these species intermingle.

For instance, typical vegetation of the mountains' southern slopes, semi-evergreen broad-leaf forests and *Tsuga dumosa* forests, have migrated to Tongmai, Yigong, Pulong, and other places on the mountains' northern side. Plants and animals have also traversed along the passage to the mountains' northern side; these include lower plants such as *Quercus tungmaiensis*, *Tsuga dumosa*, *Cupressus torulosa*, and *Alnus nepalensis* of higher plants, *Pleurotus citrinopileatus* and *Battarrea phalloides*, animals such as *Macaca mulatta*, birds such as *Cissa flavirostris* and *Dicaeum ignipectus*, and insects such as *Melampsalta chaharensis*. Life forms from the northern side have also moved to the southern side. For instance, *Pinus dendata* and *Quercus aquifolioides* from the northern side are seen in Gandal and Lugu on the southern slopes.

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An Introduction to the Biodiversity of a Mountain Ecoregion

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A new animal geographical area?

"six animal geographical area divisions of the world have been recognised"

Chen Yiyu, a member of the Chinese Academy of Sciences, has proposed the Qinghai-Tibetan Plateau as the seventh animal geographical area, based on studies on the space-time distribution of fish and on biota differentiation in the Qinghai-Tibetan Plateau (Chen Yiyu 1999).

Traditionally six animal geographical area divisions of the world, as proposed by renowned British scientist Wallance, have been recognised. Eurasia was categorised as part of the Paleoarctic area and part of the east-ocean area. Since the 1930s, scholars in China and abroad have considered the Qinghai-Tibetan Plateau as part of the Paleoarctic area and part of the east-ocean area. From the point of view of demonstrating geological history, the differentiation of biota, and space-time variation, the Qinghai-Tibetan Plateau was proposed as a juxtaposed first-level area, the seventh animal geographical area.

"the inland plateau belongs to the Paleoarctic area"

The present flora and fauna of the Qinghai-Tibetan Plateau (Table 7) have originated from two systems, which have very different genetic and ecological features (Zhang Rongzu 1982). For fauna, the inland plateau belongs to the Paleoarctic area and the south-eastern part belongs to the oriental realm. For flora, the inland plateau belongs to a pan-arctic area (the Qinghai-Tibetan Plateau sub-area) and the south-eastern part belongs to the Sino-Himalayan sub-area (Wu Zhengyi 1979). The plateau consists of two biogeographic regions for plants, the pan-arctic and the paleo-tropical, and two for animals, the paleoarctic realm and the Indo-Malayan region (Li Bosheng 1995). Figure 4 presents the biogeographical divisions of China that are popularly recognised. Table 8 gives an explanation of Figure 4 on the bio-geographical distribution/ divisions of China (Zheng Zuoxing and Zhang Rongzu 1959), which can be seen as the biogeogaphical classification system and description of the mapping areas.

Table 7: Species diversity in the Qinghai-Tibetan Plateau Plateau of China

Types of species	Number of species in the Qinghai-Tibetan Plateau Plateau (QTP)	QTP/China (%)
Vascular plants	12,000	34.3
Fungi	5000	41.67
Mammals	210	46.67
Birds	532	44.97
Fish	115	6.28

Source: Li Bosheng (1995)

The Qinghai-Tibetan Plateau has had an important influence on the biodiversity of

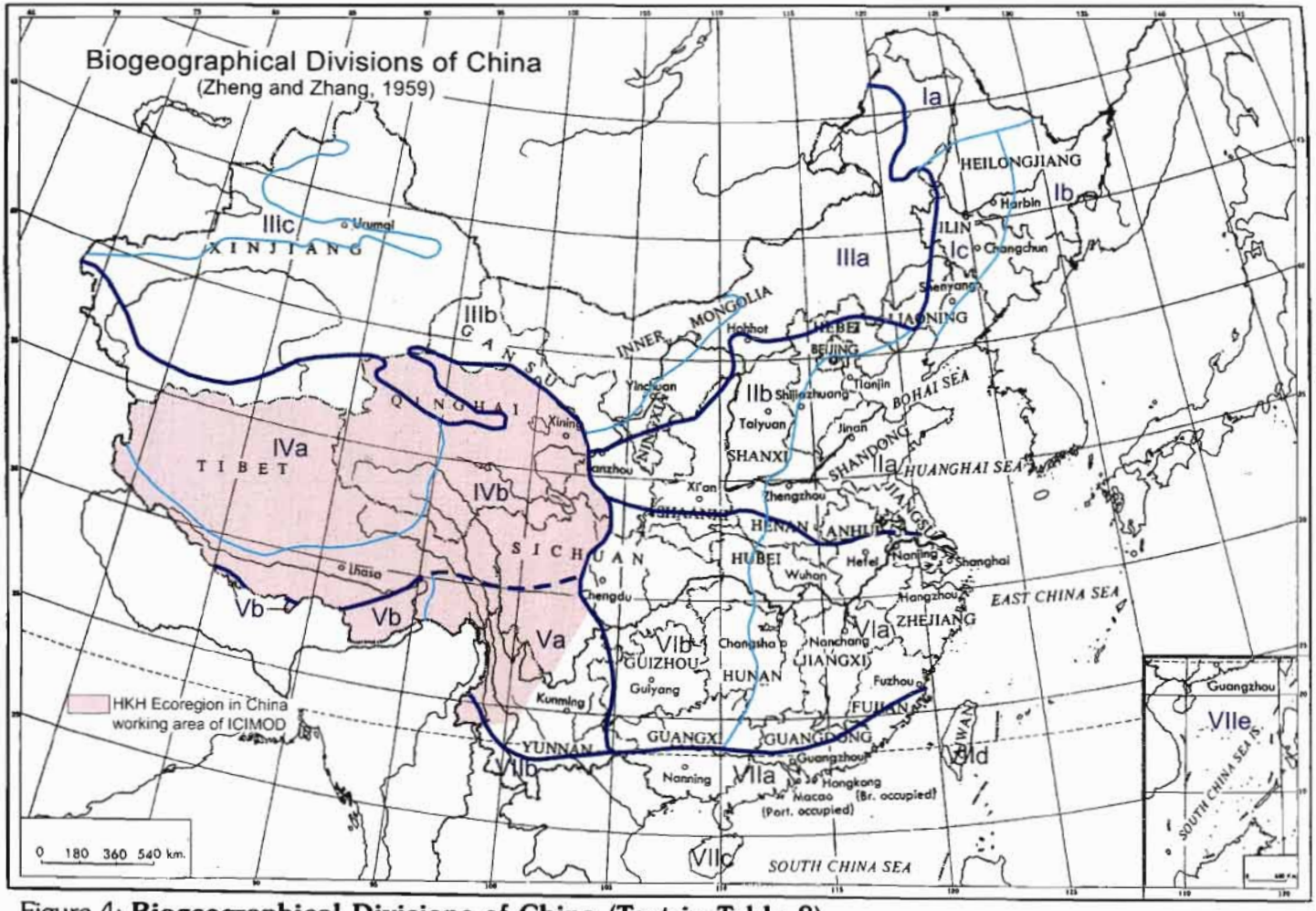


Figure 4: **Biogeographical Divisions of China (Text in Table 8)**

Source: Editorial Committee of China's Physical Geography, Chinese Academy of Sciences, Physical Geography of China Zoogeography, Science Press 1979, Beijing

Table 8: Biogeographical Divisions of China (see Figure 1)				
Realm	Region group	Region	Sub-Region	Description
Paleo-arctic Realm	North of Monsoon Region	North-eastern Region (cool temperate and temperate, moist and semi-moist)	IA (Daxingan Mountains and Altay Mountain)	Coniferous forest
			IB (Changbai Mountains)	Mixed coniferous and deciduous forest
			IC (Songliao Plain)	Forest-grassland-meadow
		North China Region (warm temperate, semi-moist and semi- arid)	IIA (Huang-Huai Plain)	Deciduous and forest-grassland
			IIB (Loess Plateau)	Deciduous and forest-grassland
	West Plateau	Mongo-Xinjiang Region (temperate and warm-temperate, arid and semi-arid)	IIIA (East Grassland)	Dry grassland
			IIIB (West Desert)	Desert and semi-desert
			IIIC (Tianshan Mountains)	Mountain forest and forest-grassland
		Qinghai-Tibetan Plateau Region (semi-moist, semi-arid and arid)	IVA (Qiangtang High Plateau)	Meadows and mountain forest
			IVB (Qinghai-Zangnan)	Forest, meadows, and grassland
Oriental Realm	South of Monsoon Region	Southwest Region (Hengduan Mountains)	VA (Western Mountains)	Mountain meadows and mountain forest
			VB (Himalayan)	Mountain meadows and mountain forest
		Mid-China Region (mid and north subtropical, moist)	VIA (Eastern Hillock-Plain)	Deciduous, evergreen forest and mixed forest
			VIB (Western Mountainous)	Deciduous, evergreen forest and mixed forest
		South China Region (tropical and south subtropical, moist)	VIIA (Min-Guang Coastal)	Evergreen, subtropical, and tropical monsoon rainforest
			VIIB (Diannan Hill)	Monsoon tropical rainforest
			VIIC (Hainan Island)	Tropical monsoon rainforest
			VIID (Taiwan Island)	Tropical monsoon forest and subtropical mountain forest
			VIIE (South Sea Islands)	Ocean island tropical forest

Source: Zheng Zuoxing and Zhnag Rongzu (1979)

the Northern Hemisphere. Considering higher plants, the Qinghai-Tibetan Plateau is the centre of origin and differentiation for some of the world's alpine plants (Li Bosheng 1995).

"the Qinghai-Tibetan Plateau is the centre of origin and differentiation for some of the world's alpine plants"

If animals, in particular mammals, are to survive in the Qinghai-Tibetan Plateau (Qinghai-Tibetan) Plateau, they need to be adapted to the ecological environment (low temperatures, a long frozen period, thin air, specific food availability in the region (for example short growing season or coarse fibres of grass), and regeneration conditions. The hard conditions of

the Qinghai-Tibetan Plateau compared with other ecological zones of China are presented in Table 9.

Table 9: Environmental conditions of the Qinghai-Tibetan Plateau Plateau compared with other ecological zones in China

Ecological zone	High elevation	Rare oxygen	Low rainfall	Low temperature	Strong wind	High radiation	Vertical change
Qinghai-Tibetan Plateau Plateau	x	x	x	x	x	x	x
Hengduan Mountains	+, -	+, -		+, -			xx
Eastern Subtropical Hill of China							
North-east Mountains of China				x			+,-
Inner Mongolian Plateau of China			x	x	x	x	

X, present; XX, strongly present; +,-, variable

There are no plants above 4,000m in the Alps in Europe. But there are more than 100 species of plants in the northern part of the Tibetan Plateau, and 52 species in the belt from 5,200 to 5,400m in this area; this is due to the heat effect of the Qinghai-Tibetan Plateau. Thus there are resources to support animals as part of an ecosystem. The endemic animal species have been brought up to the Qinghai-Tibetan Plateau as the plateau has risen in geological time (Table 10).

The discoveries of two Hipparion fauna in the Tibetan Plateau were reported in the summer of 1975, in Bulong Basin, Biru County and Gyrong Basin, Girong County. The Bulong Hipparion fauna are considered to be early Pliocene in age and equivalent to the Vallecian of Europe. The Gyrong Hipparion fauna have the same characteristics as the Hipparion fauna of north China of

Table 10: Rare and special endemic fauna in the Hindu Kush-Himalayan Ecoregion of China

English name	Scientific name	Geographical region/Division no.	Protection class
Asiatic wild ass	*Equus hemionus*	Mongo-Xinjiang and Qinghai-Tibetan Plateau (QZ)/III, IV	I
Giant panda	*Ailuropoda melanoleuca*	Hengduanshan, southwest mountains/VA	I
Golden-hair monkey	*Rhinopithecus roxellanae*	Hengduanshan, southwest mountains/VA	I
Red panda	*Ailurus fulgens*	Hengduanshan, southwest mountains/VA	II
Takin	*Budorcas taxicolor*	Hengduanshan, southwest mountains/VA	I
White-lipped deer	*Cervus albirostris*	QZ/IV	I
Argali sheep	*Ovis ammon*	QZ/IV	II
Blue sheep	*Pseudois nayaur*	QZ/IV	III
Stone marten	*Martes foina*	QZ, IV	III
Tibetan antelope	*Pantholops hodgsoni*	QZ/IV	II
Wild yak	*Bos grunniens*	QZ, IV	I
Tibetan eared pheasant	*Crossoptilon harmani*	QZ/IV	II
Black-necked crane	*Grus nigricollis*	QZ/IV	I
Snow cock	*Tatraogullus* spp.	QZ/IV	III

Source: Zhang Rongzu (1979)

"there has been an on-going evolution of flora and fauna to adapt to the very-high-elevation"

the middle Pliocene and are equivalent to the Pontian fauna from Eurasia. This suggests that the Bulong area has risen about 4,000m and the Gyrong area about 3,000m since the middle Pliocene. All these data suggest great changes in elevation and physical environment in the Qinghai-Tibetan Plateau (Ji Hong-Xiang et al. 1981). Thus there has been an on-going evolution of flora and fauna to adapt to the very-high-elevation ecological environment along with geological change.

Schizothoracine fish provide an example of this evolution. Morphological, paleontological, and zoogeographical evidence demonstrates that these fish arose from primitive Barbine* fish distributed over the area of Qinghai-Tibet during the late Tertiary period. Schizothoracine fish constitute a natural group which has adapted itself to the special conditions of the plateau. According to the modification of scales, pharyngeal teeth, and barbels, the eleven genera of the subfamily Schizothoracine can be divided into three ranks with different degrees of specialisation, representing three developmental stages during the course of evolution. Based on the degree of specialisation of the oropharyngeal organs, each rank may be subdivided into a trunk genus and several branch genera. Moreover, the trunk genus of the lower rank could further evolve to form the next trunk genus of a higher rank, which in turn would give rise to certain branch genera of the corresponding rank (Cao Wen-Xuan et al. 1981).

"this town in western Tibet is located at 4,300m above sea level"

In the central part of the Qinghai-Tibetan Plateau, the Tibetan antelope (*Pantholops hodgsoni*), the yak (*Bos grunniens*), and *Montigringilla* represent the special species that have adapted to the high elevation-cold-arid environment with low oxygen content, high radiation, and strong wind. They have a high vital capacity and strong hooves to break snow and ice cover to find food. More research on their regeneration capacity should be conducted. Due to the short time that the present environment has existed and due to severe physical conditions, the number of species inhabiting this area is small. These species could not be replaced by other species from outside the area.

Ritu County Town provides an example of specialised use and habitation. This town in western Tibet is located at 4,300m above sea level and there are 6,500 people living here in an area of 75,400 sq.km. These specific physical conditions are made use of as sports training grounds, which have been sited at Xining, Qinghai (2,600m); the aim is to increase the special capacity of sportsmen and women. In the future the training grounds could be built even higher, for example, at 4,000m.

The Hindu Kush-Himalayan (HKH) Ecoregion, which extends further than the Qinghai-Tibetan Plateau, accommodates more complicated components of flora and fauna and highly differentiated ecosystems (Figures 5 and 6). In geological history the HKH was an important refuge for many species that can be traced back to the Tertiary period or even earlier (including *Cycas*, *Ginkgo biloba*, and *Cercidiphullum japonicum*). More recently the HKH Ecoregion has also become a place for the

"in the future the training grounds could be built even higher"

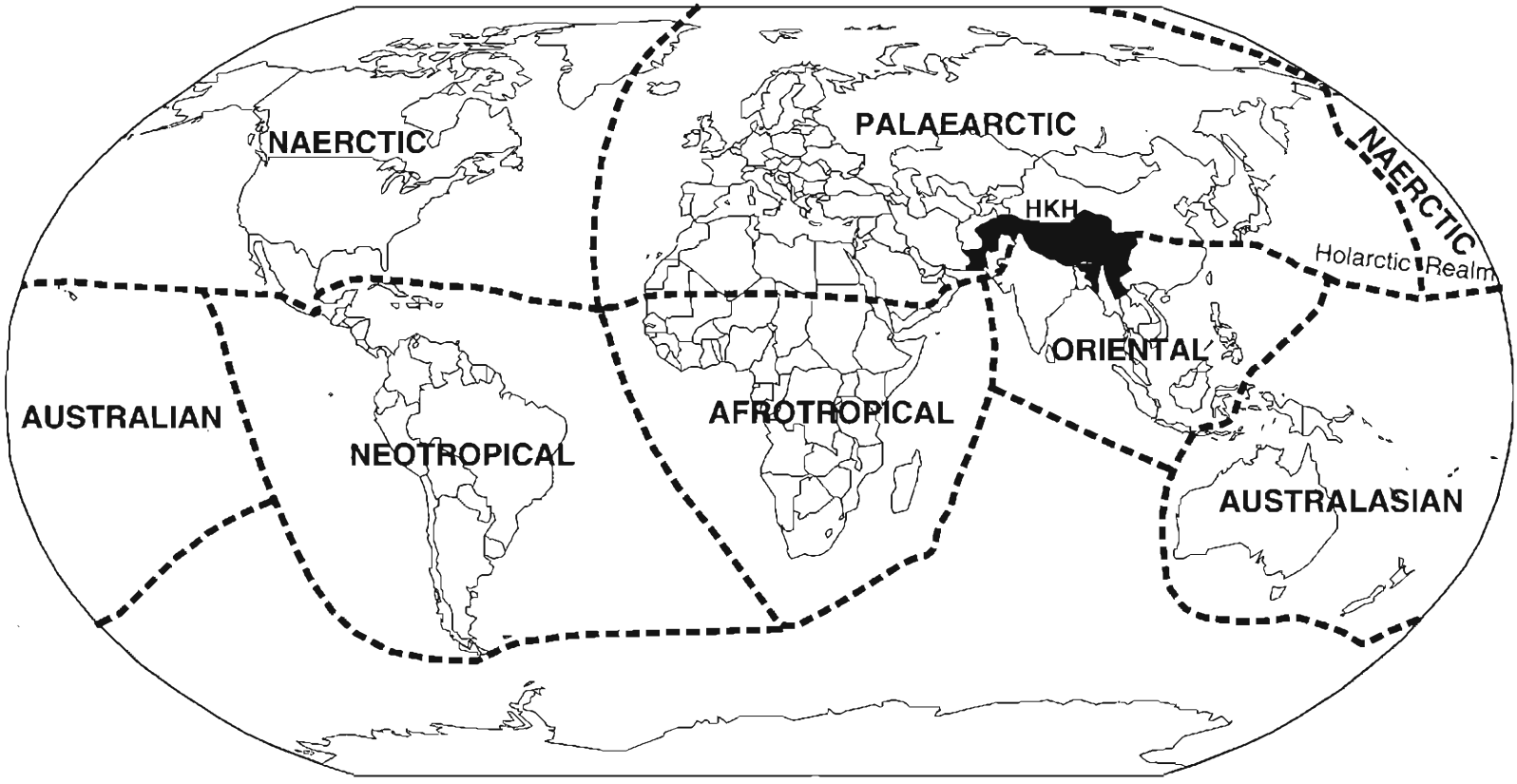
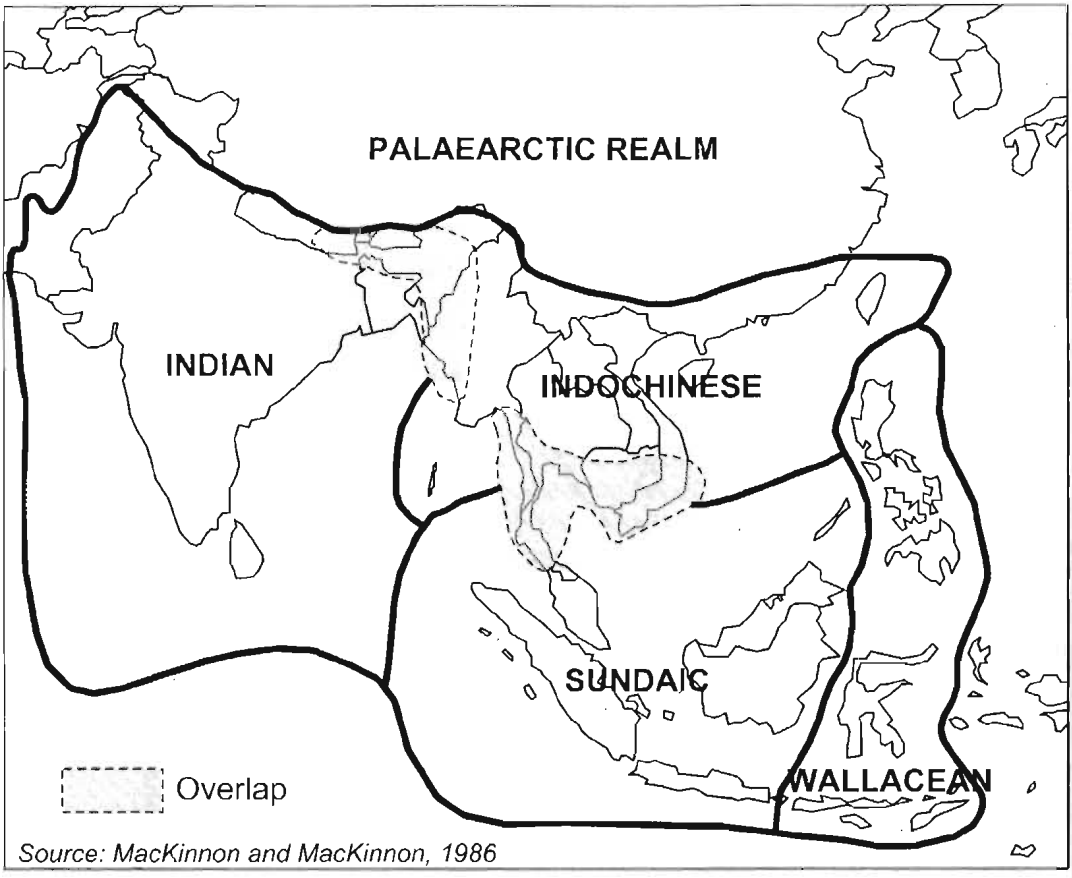


Figure 5: **World Biogeographic Regions and location of the HKH**
(Physical Geography of China - Zoogeography, 1979)



Source: MacKinnon and MacKinnon, 1986

Figure 6: **A biogeographical perspective of Nepal**

"discoveries have led to assertions that this region is a unique Pleistocene refuge"

evolution of new species (for example, *Rhododendron* and *Garuiar* (bird)). Five species of large mammals have recently (1993-1998) been discovered or rediscovered in the mountain regions of Laos and Vietnam, of which three are muntjac (*Muntiacus* spp.). These discoveries have led to assertions that this region is a unique Pleistocene refuge. Another muntjac was discovered and reported using diagnostic Deoxy Ribonucleic Acid (DNA) characters in the remote area of Putao of north Myanmar (the eastern wing of the HKH Ecoregion) during a recent biological survey expedition (23 February-29 April 1997) (Amato et al. 1999). This mountainous region contains floral communities of Miocene origin isolated since the last glaciation (Ward, 1936, 1944). All this indicates rich biodiversity within the transition zone from the Indo-Malaysian to the Sino-Himalayan Region.

There is a wide diversity of ecosystems, species and genetics and a very specific vertical change of ecosystems from a few hundred to six thousand metres or more (as described by Li Bosheng) for the Grand Canyon of the Yarlung Zangbo River. Plate 1 shows the summit of Jialabailei, (7,151m) Plate 2 the Yunnan Golden-Haired Monkey that lives in the coniferous mountain forest between 3,000-4,000m, and plates 3 and 4 show the leaf deer.

Hundreds of millions of years are required to develop a new animal geographical area with its specific species and environment. Due to the short development history and unstable physical dynamics, as well as lack of supporting data, it is still too early to define a new animal geographical area of Qinghai-Tibetan Plateau.

Plate 1: **A view of Jialabailei (7,151m) in South-eastern Tibet** — Chen Guangwei

The definition of 'alpine' in the Hindu Kush-Himalayan Ecoregion

'Alpine' represents high-mountain environments, this is accepted worldwide; hills, mountains, sub-alpine, and alpine are used to describe physical environments; and sub-alpine and alpine are commonly employed by scientists to classify mountains higher than 3,000m above sea level. Unlike mountain regions in Europe, most of the HKH Ecoregion is above 3,000m (Figure 7).

Plate 2: **Yunnan Golden-Haired Monkey, a rare animal endemic to north-west Yunnan. It lives in mountain coniferous forest (3,000-4,000m)** — (Xu Zhihui 'Yunnan Wildlife' p203,Yunnan Education Press 1999)

The valley of the Lhasa River could be defined as a valley in an alpine region. The Qinghai-Tibetan Plateau is generally higher than 4,000m. The Global Observation Research Institute in Alpine Environment (GLORIA) observation should include the Qiangtang Plateau or the Zangbei Plateau (the North Tibet Plateau). This region is characterised by high elevation, low temperature, low precipitation, and fragile ecosystems. It could be described as a dry, cold desert, for example Ritu County, located in the northwest part of the Tibetan Plateau, has an area of 75,400 sq.km along with 16,000 sq.km of water surface. In this vast area there are 6,300 permanent residents. The average elevation is 4,500m and the highest is 6,800m. Annual mean precipitation is 70-80 mm. Within its ecosystems fauna include wild crane, geese, yellow duck, golden-haired yak, blue sheep, and antelope bear. There is no observation station in the vast plateau of north Tibet and there is a lack of data. Because of the diversity of alpine regions in the world, subclasses could be widely used to present a more complete picture of the alpine world. The richest alpine areas exist in the HKH Ecoregion and these deserve particular attention.

Plate 3: **Leaf dear in Yangon Zoo (U Saw Tun Khaing)**

"it is important to propose indicators to identify sub-alpine and alpine zones"

Plate 4: **A local hunter emerging from the forest with a freshly snared deer, identified as a new species, the leaf muntjac** — (Alan Rabinowitz)

Plates 3 & 4: **A new species of barking deer *Muntiacus putaoensis* (leaf deer) was discovered in this region in 1997.**

Examples of sub-alpine and alpine vertical zones are given in Table 11 to illustrate the variation in alpine environments. Thus it is important to propose indicators to identify sub-alpine and alpine zones and these should include climatic regimes, vegetation, and geological and geomorphological processes.

"there have been many studies on the principal vertical vegetation regimes but now a comparative study seems necessary"

Vertical vegetation regimes in the Hindu Kush-Himalayan Ecoregion

Vertical change is a common and important feature of vegetation distribution in alpine environments. The base vegetation belt starts with tropical-subtropical rainforest in the southeast mountains of the HKH Ecoregion. Temperate forest of broad-leaf or mixed deciduous starts in the areas north of the subtropical climate. The grass-bush belts of the base vegetation may change to coniferous forest belts in the upper areas. There have been many studies on the principal vertical vegetation regimes but now a comparative study seems necessary. Table 11 reflects the general situation, showing a variety of sites with differences in characteristics such as degree and exposure of slopes, base rock, and soil type.

A research network for alpine studies in the Hindu Kush-Himalayan Ecoregion

A lot of data have been presented in the ICIMOD publication 'Banking on Biodiversity' (Pei Shengji 1996) as part of a review of biodiversity

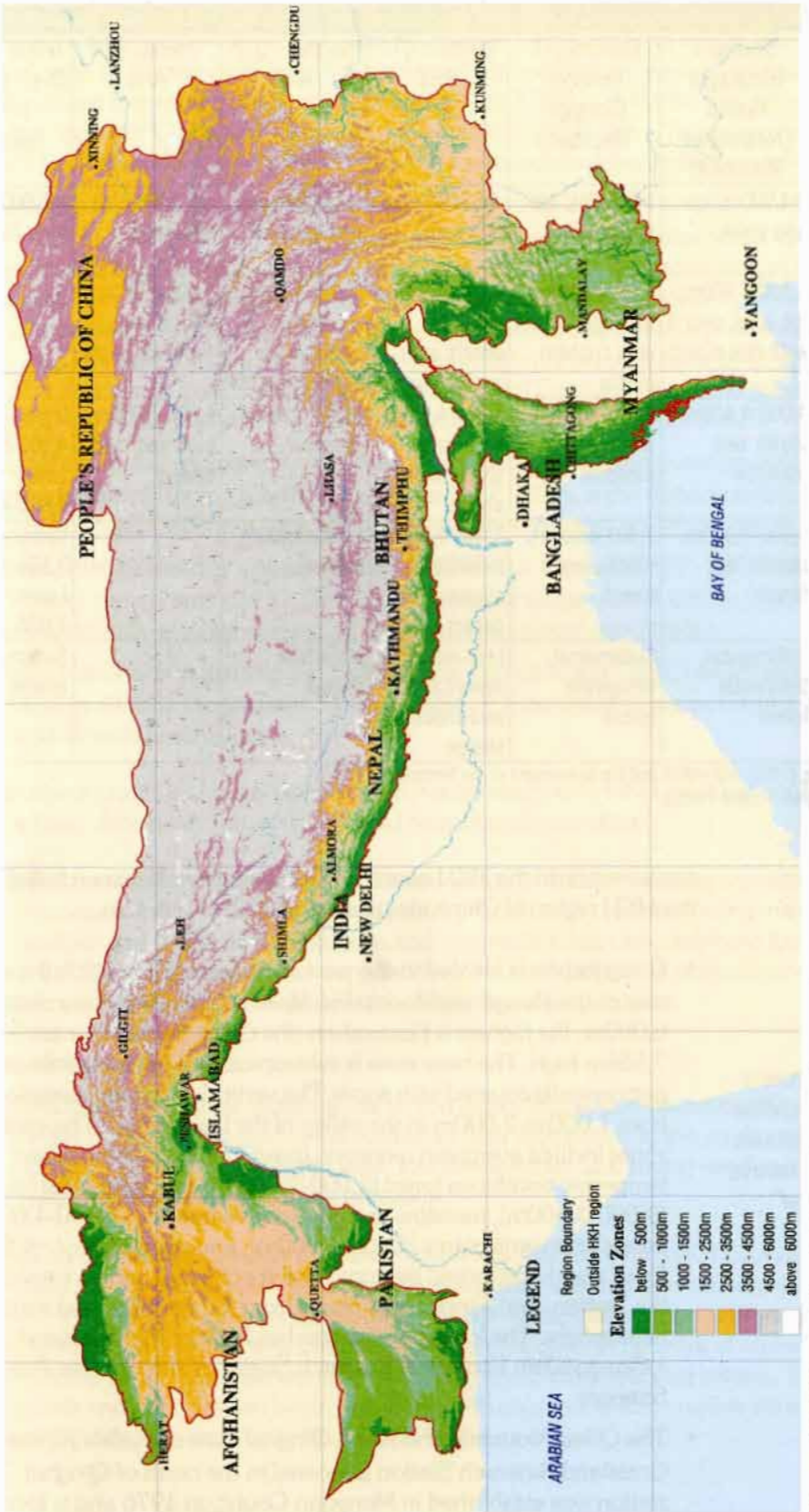


Figure 7: **Hindu Kush-Himalayas Ecoregion**

Table 11: Sub-Alpine and Alpine zones in different locations of the Hindu Kush-Himalayan Ecoregion

Climatic zone	Southern Himalayas Humid (Nanjabawa Mountain)	Eastern QTP Monsoon (Gonggar Mountain)	Western QTP Arid	Northern QTP Arid	Interior QTP Arid	Nepal Monsoon (high mountains and high Himalayas)
Polar alpine ice-snow climatic zone	>4,900m, ice and snow	>5,000m, ice and snow	>4,800m, ice and snow	>4,800m, ice and snow	>5,400m, ice and snow	>5,000m, nival, high Himalayas
Alpine cold-freezing climatic zone	4,400-4,900m, ice edge, debris with rare plants	4,600-5,000m, ice edge, debris with cushion plants	4,600-4,800m, ice edge, debris with cushion plants	3,800-4,800m, ice edge, debris with cushion plants	5,000-5,400m, debris with cushion plants	
Alpine cold climatic zone	4,000-4,400m, shrub and meadow	3,600-4,600m, shrub and meadow	4,300-4,600m, high-cold shrub and steppe	3,400-3,800m, meadow	4,500-5,000m, high and cold desert	Upper line = 4,501-5,000m Lower line = 4,001-4,500m
Sub-alpine zone	2,800-4,000m, needle-leaf forest	2,500-3,600m, needle-leaf forest	3,000-4,300m, mountain steppe and desert	2,800-3,400m, steppe		Upper line = 3,501-4,000m, Lower line = 3,000-3,500m
Base zone	Subtropical, temperate forest	Subtropical, temperate forest	Low-mountain desert and mid-mountain steppe	Mountain desert		Subtropical, temperate forest

Source: Li Bosheng (1995) and HMGN and the Government of the Netherlands (1995)
Note : QTP = Qinghai-Tibetan Plateau

conservation in the HKH countries. Some ecological research stations in the HKH region of China also provide useful information.

"the base zone is subtropical and the mountain peaks are permanently covered with snow"

- Gonggashan is located in the west of Sichuan, China; it is the central part of the Hengduan Mountains. More than 45 peaks are above 6,000m, the highest is Daxueshan (the Great Snow Mountain) which is 7,556m high. The base zone is subtropical and the mountain peaks are permanently covered with snow. The vertical change in elevation ranges from 1,000 to 2,000m in the valley of the Dadu River. The vegetation zones include evergreen monsoon forest (under 2,000m), warm temperate deciduous forest (2,000-3,000m), cool temperate forest (3,000-3,600m), meadow and grass above tree-line (3,600-4,600m), debris with some plants (4,600-4,900m), and snow cover (>4,900m). Flora are characterised by numerous species that can be traced back to the Tertiary and a mixture of plants from the northern and southern hemisphere. The lowest glacier reaches 2,850m into the forest. There is a Gonggashan Ecological Research Station of the Chinese Academy of Sciences.
- The Qilian Mountain and North Qinghai Plateau Haibei Alpine Grassland Research Station is located in the north of Qinghai. The station was established in Menyuan County in 1976 and is located at

37°29'-37°45' N and 101°12'-101°33' E. The station is situated in the Lenglong Ling (mountain) of the east range of the Qilian Mountains. Lenglong Ling ranges from 4,600 to 4,800m, with its highest peak of 5,076m covered with permanent snow. The south foot of Lenglong Ling is meadow grassland and ranges from 3,200 to 3,400m. The annual mean temperature is 0.6°C and annual mean precipitation is 531.6 mm. The station belongs to China's Ecological Research Network. There are research facilities and a research team.

- Gaoligongshan is located in the west of Yunnan at 24°56'-26°09'N and 98°34'- 98°50' E and has an area of 1,239 sq.km. The highest peak is 5,128m and the difference in elevation ranges from 1,090 to 3,900m. Three natural reserves with administration offices have been established. The Gaoligongshan Nature Reserve was established in 1983 to protect its complete vertical forest strata, subtropical evergreen broad-leaf forest, alpine coniferous forest, and rare flora and fauna. A number of international projects have been conducted here. The Worldwide Fund for Nature (WWF) reviewed Gaoligongshan and gave it a rating of 'A' (global significance and in very good condition) (Mackinnon et al. 1996).
- Linzhi Forest Ecological Experimental Station is located in the south-eastern mountains of the Tibet Autonomous Region (Linzhi City, situated at 2,900m, is the district centre). The famous Yaluzangbu Great Canyon is located in this area. Several snow peaks are above 7,000m.
- Qiangtang Nature Reserve was established in 1993. It is located 33°10'- 37°10'N and 80°10'-91°40'E and has an area of 247,120 sq.km. Altitudes range from 4,800 to 5,000m. It is a kind of inland high-plateau steppe and desert and has global significance.
- Zhu Feng National Nature Reserve (Everest) was established in 1988, has an area of 33,810 sq.km and its altitude ranges from 5,000-8,848m. It is designed to protect alpine primary forest and mountain ecosystems.

There are also a number of national parks and nature reserves in HKH member countries that undertake basic data collection, research, and conservation activities.

There are few mountain ecological research stations due to difficult working conditions and lack of funds. Successes in China have been achieved by most nature reserves being matched with research facilities and linked with institutions and universities that can contribute towards manpower and data collection. These experiences demonstrate that the research and observation network should be integrated with nature reserves and parks.

Conclusions

The proposal for a new animal geographical region merits further consideration. New species and subspecies could be discussed in the context of their adaptation to the environment (their tolerance to high elevation, low oxygen level, low temperature, and strong wind and radiation), which has occurred alongside geological evolution.

In any case, in terms of biodiversity conservation on a global level, the HKH Ecoregion is an important key node where several biogeographical regions meet and great change is taking place. Due to the harshness of the environment, there are few alpine observation stations, so it is necessary to establish a system and methods for data collection. A network of alpine research stations, national parks, and reserves may be the best choice as a working system. The gathering of existing data and analyses can begin and along with geographic information system and remote sensing data can lay a basic foundation for future action.

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Introduction to Part 2

A study on Hkakaborazi National Park of North Myanmar

This part of the book presents and discusses information and data on Hkakaborazi National Park within the context of conserving its unique ecosystems and biodiversity. A wide range of aspects are addressed. There are reviews of the flora and fauna of the area and detailed information about endemic species, in particular orchids, rhododendrons, large mammals, and birds; and threats to their survival are also considered. Details of the physical geography of the area and social, economic, and cultural conditions of local communities are presented. Also discussed are organisations involved in conserving this area, the prospects for ecotourism in the area, and community-based approaches to conservation in the region. Most of this was presented at a workshop 'Sub-regional Consultation on Conservation of Hkakaborazi Mountain Ecosystems in the Eastern Himalayas' held in Putao, north Myanmar, from 25-29 October 1999, and the workshop report is included.

Biodiversity in north Myanmar

North Myanmar is one of the most important and biologically diverse regions in Indo-China. It contains the headwaters of major river systems in Myanmar, and it is a transition zone between the tropical Indo-Malaysian fauna and flora from the south and the temperate and alpine Sino-Himalayan fauna and flora from the north. Much of north Myanmar is sparsely populated and contains good areas of forest and other habitats. However, continued degradation of north Myanmar's resources not only threatens the future biological wealth of the country, but also could threaten the abundant water resources that emanate from this region.

Hkakaborazi National Park

At about 3,812 sq.km Hkakaborazi National Park is the largest in Myanmar. It is located between north latitude 24°-28° and east longitude 97°-99° in Naung-Mung Township of Putao District in the north of Kachin State, in the northernmost part of Myanmar. It is bounded by India in the west and by China in the north and east and the southern boundary is demarcated along the Nam Tamai and Taron rivers. It incorporates 11 villages with a population of 948. It was designated as a protected area in January 1996 and as a national park in October 1998. Of particular interest in this area are the country's highest peak (Mount Hkakaborazi –

"Hkakaborazi region is recognised to be one of the richest areas in the world in terms of biological resources"

5,881m), snow-capped mountains of the eastern Himalayas, the richness of flora and fauna, a unique ecosystem, and unspoiled primary forests. The area is entirely mountainous and is characterised by broad-leaved evergreen rainforest, sub-tropical and temperate, up to 2,438-2,743m, then broad-leaved, semi-deciduous forest, and finally needle-leaved evergreen, snow forest. Above 3,352m the highest forest zone is alpine.

Hkakaborazi region is recognised to be one of the richest areas in the world in terms of biological resources incorporating rare, endangered and, highly likely, unknown flora and fauna. Within the Eastern Himalayan Ecoregion with its unique biodiversity, a particular significance of the Hkakaborazi region lies in the fact that it is considered an Asiatic centre of endemism and a repository of origin of the angiosperm flora. Thus conservation of the region should be addressed as an important priority.

NGO Collaboration in the Development of Hkakaborazi National Park in Northern Myanmar

Saw Tun Khaing
Country Programme Coordinator of WCS, Myanmar Programme

Background

The Wildlife Conservation Society (WCS), New York

The Wildlife Conservation Society (WCS) is one of the leading non-government organisations (NGOs) in the World. In cooperation with other NGOs and government organisations it contributes towards the conservation of the Earth's wildlife and ecosystems through research, training, and education. It was founded in 1895 as the New York Zoological Society and has organised more than 250 field projects in 52 countries throughout Africa, Asia, Latin America, and North America.

Although the formal presence of WCS in Myanmar is relatively recent, contact goes back to the early nineteenth century. William Bee travelled to northern Myanmar in 1906 in search of pheasants, afterwards publishing a book titled 'Jungle of Pheasants'. Oliver Milton and Richard D. Estes explored the Chaukan Pass area to investigate the feasibility of transboundary conservation and their 'Trails of Takin' have been recorded on film. These expeditions were sponsored by WCS and biophysical accounts of northern Myanmar were recorded.

The Wildlife Conservation Society Myanmar Programme

Dr Alan Rabinowitz has made a significant contribution to the WCS Myanmar Programme. He took the initiative for setting up the programme by signing the memorandum of understanding (MoU) with the Forest Department in 1994. A second MoU was signed in 1998 to extend the programme up to 2002. He also organised the first ever training course on wildlife conservation at Alaungdaw Kathapa National Park in January 1995. With a view to developing WCS activities in Myanmar, a country programme coordinator was appointed in March 1995. Since then, the implementation of wildlife conservation activities by WCS in Myanmar has been gathering increasing momentum, with the cooperation of the Nature and Wildlife Conservation Division (NWCD) of the Forest Department.

Framework of the Myanmar Programme

Following the conservation guidelines set out by WCS New York, the Myanmar Programme operates within the following framework.

- Programme development
- Basic training in wildlife conservation and protected area management for junior staff of NWCD
- Provision of small grants for research, with a particular emphasis on conservation of species, to staff of NWCD and researchers from Yangon University

"organising and undertaking biological expeditions to investigate new areas with conservation potential"

- Financial support to NWCD for park development
- Evaluation of NWCD's existing protected areas
- Organising and undertaking biological expeditions to investigate new areas with conservation potential. This helps the Forest Department increase the extent of its protected area system
- Coordination among related institutions such as the Department of Fisheries, universities, zoos, other NGOs and United Nations agencies
- Promotion of professional translation of wildlife and conservation-oriented books into Myanmar; publishing conservation and education posters and calendars in order to increase public awareness about conservation

Activities of the Myanmar Programme

Since its inception in 1995, the WCS Myanmar Programme, with its two professional and three administrative staff, has successfully implemented a variety of activities as laid down in the framework.

"the team will investigate the status of tigers in the whole country"

(a) Programme Development

The WCS office in Yangon is now equipped with essential facilities for both internal and external communication. In 1999 the office was extended to integrate an eight-member National Tiger Survey Team, which the Forest Department and WCS recruit for jointly. The team will investigate the status of tigers in the whole country for a consecutive period of 3 years. The National Fish and Wildlife Foundation, Save the Tiger Fund of the USA provides the project funding. The outcome of the survey will help in the development of a National Tiger Action Plan for Myanmar.

The WCS Myanmar Programme is also looking into integrating a survey and research on captive breeding of the endemic star tortoise in Myanmar. A herpetology team from WCS New York has recently completed a feasibility study of this species in the central arid zone of Myanmar.

(b) Basic Training

As agreed in the MoU, the Research and Training Coordinator of WCS has, since 1995, provided basic training on wildlife conservation to the field staff of NWCD. So far, 9 basic training courses for nearly 200 staff of NWCD of 9 protected areas have already been conducted.

"WCS has provided small research grants"

(c) Small Research Grants

With the objectives of providing skills in research and increasing knowledge in basic data collection, WCS has provided small research grants to the staff of NWCD and postgraduates at the Zoology Department of Yangon University. So far, research grants covering species' conservation have been provided to 12 staff members of the NWCD, 6 researchers of the Yangon University and 3 researchers from elsewhere.

Initially research grants are provided in order to identify potentially skilled candidates; few come out as competent researchers. However, the

provision of small research grants will be continued to identify promising candidates from NWCD and other related sectors of conservation.

(d) Park Development

To help the staff of NWCD increase their professional capabilities, WCS is providing financial and field trip facilities for some of the protected areas where there is great potential for conservation. So far, four areas have been targeted based on the undisturbed nature of their vegetation, a viable wildlife population and remoteness of access. In these areas, additional salaries and uniforms for staff, transport facilities such as motor boats and motorcycles, protection signboards and guard posts have been provided.

In order of development priority the targeted areas are Hkakaborazi National Park, Htamanthi Wildlife Sanctuary, Natmataung National Park and Meinmahla Kyun Wildlife Sanctuary. Although park development activities were initiated in 1995, the provision of additional salaries and transport facilities to enhance these activities only became possible in 1998. In 1998 and 1999, WCS provided US $21,000 worth of development facilities for these four areas and the target for provision for 2000 was US $20,000 (with greater emphasis on Hkakaborazi National Park).

(e) Evaluation of Existing Protected Areas

Myanmar now has 9,491 sq.km of protected area in 31 established national parks and wildlife sanctuaries covering 2.26% of the total area of the country (Figure 8).

Although these sanctuaries were established some time ago (some as early as 1918), most of them have not been intensively managed due to lack of manpower and security. As a result of this neglect, little is known about their conservation value. The major objective of this activity is to evaluate the existing sanctuaries so that their conservation values can be assessed. This information will be used to help with the selection and prioritisation of areas for future intensive management.

So far, 16 out of 31 existing sanctuaries have been evaluated. This activity will continue until the remainder have been evaluated.

(f) Biological expeditions

The programme's most relevant accomplishment for this workshop is the emergence of Hkakaborazi National Park, which is the outcome of the biological expeditions jointly undertaken by the Forest Department and WCS in northern Myanmar. The Wildlife Conservation Society has organised six expeditions to the region and has identified new areas for conservation (see Table 12). Two trips were made to the southern part of the country to designate Lampi Island as a marine national park, one was made to the northwest along the Chindwin River, which supports Htamanthi, to create a wildlife sanctuary and three were made to the northern corner of Myanmar, resulting in the creation of Hkakaborazi as the country's largest national park.

(g) Coordination

In recent years, the Myanmar government has allowed NGOs to carry out their activities. Among wildlife conservation-oriented NGOs, WCS is the only one which has a solid base in the country. Therefore the WCS Myanmar Programme is helping other NGOs accomplish their conservation activities in Myanmar. This has resulted in better understanding and relations between WCS and other NGOs.

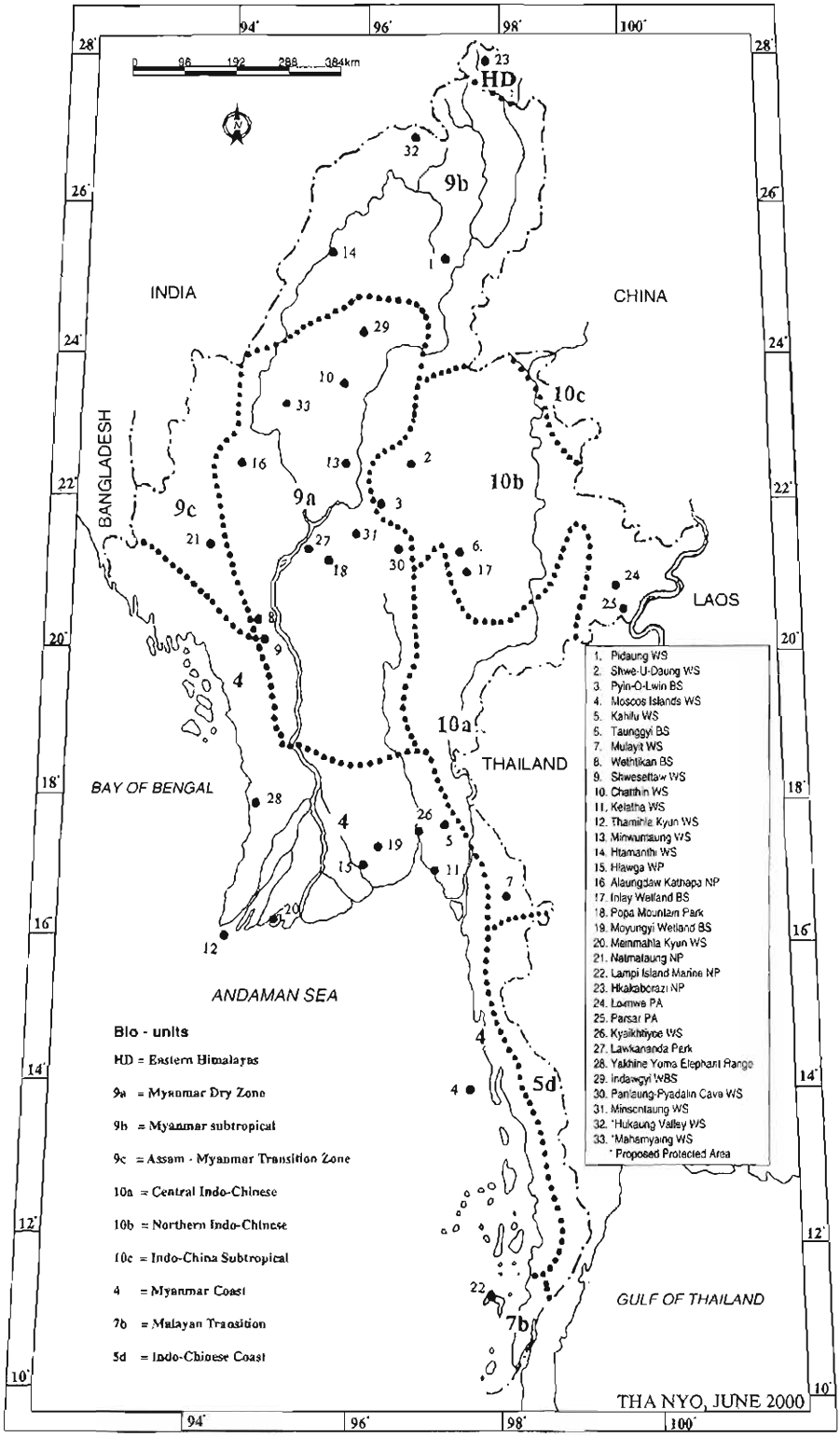

Figure 8: **Protected Area Network of Myanmar**

Table 12: Existing and Proposed Protected Areas as at 1 September 1999

S.N.	Name	Year	Area (sq.km)	General location	Bio Unit	Key species protected	Manage -ment
1	Piduang Wildlife Sanctuary	1918	698	Kachin State	9b. Terrestrial	Elephant, gaur, banteng, sambar, tiger, leopard, bear	NWCD
2	Shwe-U-Daung Wildlife Sanctuary	1918	207	Mandalay Division	10b. Terrestrial	Rhinoceros, elephant, gaur	
	Shwe-U-Daung Wildlife Sanctuary	1929	119	Shan State	10b. Terrestrial	Banteng, sambar, serow, tiger, bear	NWCD
3	Pyin-O-Lwin Bird Sanctuary	1918	127	Mandalay Division	10b. Terrestrial	Barking deer, pheasant	FD
4	Moscos Island Wildlife Sanctuary	1927	49	Taninthayi Division	4. Island Marine	Barking deer, sambar, swiftlet	FD
5	Kahilu Wildlife Sanctuary	1928	161	Karen State	4. Terrestrial	Rhinoceros, serow, mouse deer, hog deer	FD
6	Taunggyi Bird Sanctuary	1930	16	Shan State	10b. Terrestrial	Avifauna	FD
7	Mulayit Wildlife Sanctuary	1936	139	Karen State	10a. Terrestrial	Barking deer, tiger, leopard	FD
8	Wethtikan Bird Sanctuary	1939	5	Magwe Division	9a. Wetland	Wetland birds	FD
9	Shwesettaw Wildlife Sanctuary	1940	553	Magwe Division	9a. Terrestrial	Eld's deer, sambar, barking deer, gaur	NWCD
10	Chatthin Wildlife Sanctuary	1941	269	Sagaing Division	9a. Terrestrial	Eld's deer, sambar, barking deer, gaur	NWCD
11	Kelatha Wildlife Sanctuary	1942	24	Mon State	4. Terrestrial	Serow, avifauna	FD
12	Thamihla Kyun Wildlife Sanctuary	1970	1	Ayeyarwaddy Division	4. Marine	Marine turtle	FD
13	Minwuntaung Wildlife Sanctuary	1972	206	Sagaing Division	9a. Terrestrial	Barking deer, avifauna	FD
14	Htamanthi Wildlife Sanctuary	1974	2151	Sagaing Division	9b. Terrestrial	Rhinoceros, elephant, gaur, tiger	NWCD
15	Hlawga Wildlife Park	1982	6	Yangon Division	4. Terrestrial	Enclosed wildlife park, sambar, barking deer, hog deer, eld's deer, mythum, migratory birds	NWCD
16	Alaungdaw Kathapa National Park	1989	1606	Sagaing Division	9a. Terrestrial	Elephant, tiger, leopard, gaur, sambar, serow, bear	NWCD
17	Inlay Wetland Bird Sanctuary	1985	642	Shan State	10b. Wetland/Lake	Wetland and migratory birds	NWCD
18	Popa Mountain Park	1989	129	Mandalay Division	9a. Terrestrial	Barking deer, leopard, geomorphologic features	NWCD
19	Moyungyi Wetland Bird Sanctuary	1988	104	Bago Division	4. Wetland reservoir	Migratory birds	NWCD
20	Meinmahla Kyun Wildlife Sanctuary	1994	137	Ayeyarwaddy Division	4. Marine	Mangroves, crocodile, birds	NWCD

Table 12: Cont.....

S.N.	Name	Year	Area (sq.km)	General location	Bio Unit	Key species protected	Manage -ment
21	Namataung National Park	1994	723	Chin State	3c. Terrestrial	Gaur, seerow, goral land avifauna	NWCD
22	Lampi Island Marine National Park	1996	205	Taninthayi Division	7b. Marine	Coral reefs, mouse deer, Salon ethnic culture	FD
23	Hkakaborazi Protected Area	1996	3812	Kachin State	Hd. Terrestrial	Takin, Musk deer, red goral, black barking deer	FD
24	Loimwe Protected Area	1996	43	Shan State	10b. Terrestrial	Tiger, bear, pangolin, pheasant	FD
25	Parsar Protected Area	1996	78	Shan State	10a. Terrestrial	Jungle fowl, Chinese pangolin	FD
26	Kyaikhtiyoe Wildlife Sanctuary	1998	181	Mon State	4. Terrestrial	Tiger, goral, gaur, sambar, monkey	NWCD
27	Lawkananda Wildlife Sanctuary	1997	0.5	Mandalay Division	9a. Terrestrial	Avifauna, cultural diversity	NWCD
28	Rakhine Yoma Elephant Range	1997	1756	Rakhine State	4. Terrestrial	Elephant, gaur, leopard, jackal, bear	NWCD
29	Indawgyi Wetland Bird Sanctuary	1999	775	Kachin State	9a. Wetland/Lake	Elephant, tiger, sambhur deer, leopard, bear, serow, gaur	NWCD
30	Panlaung-Pyadalin Cave Wildlife Sanctuary	1999	334	Shan State	10b. Terrestrial	Elephant, tiger, leopard, gaur, banteng, golden cat, clouded leopard, serow, gibbon	NWCD
31	Minsontaung Wildlife Sanctuary	1999	23	Mandalay Division	9a. Terrestrial	Barking deer, rabbit, dhole, reptiles, land tortoises, wild cat, snakes	NWCD
32	*Hukaung Valley Wildlife Sanctuary	1999	6460	Kachin State	9b. Terrestrial	Elephant, tiger, leopard, wild boar, sambhur deer, barking deer, bear	FD
33	*Mahamyaing Wildlife Sanctuary	1999	3354	Sagaing Division	9a. Terrestrial	Sambhur deer, wild boar, barking deer, banteng, cat family, gibbon, wild dog, bear, rabbit	FD
	Total		25094				

*Proposed protected area

Total land area of Myanmar = 676,756 sq.km
Percentage of existing protected areas to total land area of Myanmar = 2.26%
Percentage of Proposed protected areas to total land area of Myanmar = 1.45%

Hd = Eastern Himalayas; 3c = Assam-Myanmar Transition; 4 = Myanmar Coast; 5a = Indochinese Coast; 7b = Malayan Transition; 9a = Myanmar Dry Zone; 9b = Myanmar Subtropical; 10a = Central Indochina; 10b = Northern Indochina; 10c =Indochina Subtropical

Source: MacKinnon, J.; MacKinnon, K. (1986) *Review of the Protected Areas System of the Indo-Malayan Realm.* Gland, Switzerland: IUCN

In 1996 WCS coordinated with the International Crane Foundation (ICF) to study the status of cranes in Myanmar. One ICF-sponsored researcher from Myanmar who was also assisted by WCS is now studying in India at the Wildlife Institute of India (WII). The Wildlife Conservation Society has also helped the Worldwide Fund for Nature (WWF) in selection of candidates and provision of financial assistance for training in Nepal.

The Wildlife Conservation Society also coordinated with the Smithsonian Institute and the Wild Bird Society of Japan to provide financial assistance to study the status of Eld's deer and avifauna in Myanmar.

In the future, WCS will continue to coordinate with other NGOs to promote close cooperation in order to advance the cause of wildlife conservation in Myanmar.

(h) Conservation awareness

To promote public awareness about wildlife conservation, WCS publishes educative posters, pamphlets, calendars, and books. With some financial support from WCS and the cooperation of Ava Publishing, 'Large Mammals of Myanmar' has been published. It is by a local eminent writer Dr Sein Tu and is aimed at the general public.

The 'Wildlife Field Research and Conservation Training Manual' written by Dr Alan Rabinowitz has been translated so that staff of NWCD can read it in their own language. An educational calendar about Hkakaborazi was published in 1998, after the biological expedition was completed in the same year. Another educational calendar about the outstanding protected areas of Myanmar was published in 2000.

In future, WCS will put more emphasis on publishing articles and books, which will enhance conservation awareness not only among the general public but also among the decision-makers of the country.

The Development of Hkakaborazi as a National Park

The Wildlife Conservation Society has invested a lot of time, energy, and money into the development of Hkakaborazi as a national park. The preliminary study around Putao in 1996, the biological expedition to Hkakaborazi in 1997 and the expedition to Naung Mumg area in 1998 have all contributed to this development.

Hkakaborazi was merely an unnamed site when the Ministry of Forestry first designated it as a protected area on 30 January 1996. Only when its biological richness was unearthed by the expeditions was the importance of the area recognised and its status was upgraded to that of a national park by the government on 10 November 1998. In a further development, on 19 November 1998, the Ministry of Forestry sanctioned the appointment of 61 NWCD staff in Putao to help with the development of Hkakaborazi.

In order to carry out future development activities, WCS is committed to support NWCD. From the very first day the staff reported for duty at Putao, where the headquarters of the park is going to be, WCS has provided financial support for the staff in terms of additional salaries, transport facilities and field equipment. In 1999, US $7,000 worth of these facilities were provided and, in 2000, US $13,000 worth of facilities for construction of an education centre at Putao and a guard post at Parandir, the entrance of the park, were provided. In view of this, WCS is committed and will continue to support Hkakaborazi until the park is fully developed.

Collaboration with non-government organisations

"a unique area in Myanmar"

Hkakaborazi is a unique area in Myanmar because it has been a treasure trove for botanists, mammalogists, and explorers since the early nineteenth century and has much more to offer for many years to come. This protected area will not only serve as a national park of the country but will also play an important role as a transboundary conservation area with both neighbouring countries, China and India. It also includes within its boundary the crucial headwaters of the mighty Ayeyarwaddy that flows from the northern tip to the southern delta region of the country. From another perspective, this river is the lifeline waterway for the people of Myanmar.

From the very outset the Government of Myanmar has been committed and, as a supporting NGO, WCS is also decidedly involved in the development of Hkakaborazi. From its status of protected area in 1996, it is now being upgraded to a national park and, if conditions are favorable, it will further be developed as a World Heritage Site, the first of its kind in Myanmar.

"it also includes within its boundary the crucial headwaters of the mighty Ayeyarwaddy"

In trying to marshal support for the development of Hkakaborazi, close scientific and financial cooperation among the conservation groups, either from the government sectors or NGOs, is not merely desirable, it is imperative. Furthermore, any cooperation needs to be coordinated so that the development of the protected area strictly follows a management strategy.

Vegetation and Key Floristic Features of Hkakaborazi National Park

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and
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Introduction

Hkakaborazi National Park is the region north of the 27° parallel wherein lies the highest peak of Myanmar, Mount Hkakaborazi, and its environs. It is entirely mountainous and is characterized by broad-leaved evergreen rainforest, sub-tropical and temperate, up to 2,438-2,743m, then broad-leaved, semi-deciduous forest and finally needle-leaved evergreen, snow forest. Above 3,352m the highest forest zone is alpine, different not only in kind from the forest, but different in history and origin.

Within the overall framework of the International Centre for Integrated Mountain Development (ICIMOD) and Myanmar Forest Department's Programme on Regional Collaboration in Conservation of the Hkakaborazi Mountain Ecosystem, a special effort has been made to gather information on mountain flora and vegetation of national parks. The vegetation analysis is the result of an investigation into the spatial and biophysical characteristics of mountain environments by remotely sensed satellite data with a geographic information system (GIS). The data on flora are based on 440 entries collected between 2 March and 14 April on the biological expedition by The Wildlife Conservation Society (WCS). The analysis of flora included previous botany work by F.K. Ward (1914-1957), F.C. Syndam (1961), J. Keenan (1962), and K. Soe (1981).

History of Botany in Northern Myanmar

In 1931 the F.C. Syndam Cutting Sikkim Expedition of the field museum brought back about 25 fern specimens from the Myanmar-Tibet frontier.

The late F.K. Ward collected assiduously from the mountainous and virgin regions of northern Myanmar and discovered numerous novelties and rare plants not known to the world. He published a series of papers on the botany of the region in the 'Journal of the Bombay Natural History Society' and in the UK.

The following summary of northern Myanmar expeditions by Waŕd is based on the account in a biographical introduction by W.T. Steam, in 'Pilgrimage for Plants' (1960).

- 1914 — North Myanmar, by way of Myitkyina. Described in 'In Farthest Burma' (1921). Collection numbers — 1,000-3,000.
- 1919 — North Myanmar, to Imaw Burn and Hpimaw. Collection numbers — 3038-3721.
- 1922 — Yuman and Szechwan, Tibet and North Burma, by way of Bhamo, Teng Chung, Tali, Yungning, Multi, Likiang, Kari Pass, Beima-shan, Atuntzu, Takala, across the Mekong-

"a great many of the specimens were in the vegetative state and seem to have been impossible to identify"

Salween Divide, Chamutong, across to the Tarom River and the Nam Tamai River, Fort Hertz, Myitkyina. Described in 'From China to Hkamti Long' (1924) and articles in 'The Gardeners' Chronicle' (1922-23). Collection numbers — 5384-5602.

- 1926 — North Myanmar and Assam, by way of Myitkyina, Fort Hertz, Nam Tamai, Seinghhu, Diphuk-la, Lohit (Luhit) Valley, Sadiya. Described in 'Plant Hunting on the Edge of the World' (1930) and articles in 'The Gardeners' Chronicle' (1926-28). Collection numbers — 6605-7698.
- 1930-31 — North Myanmar and Myanmar-Tibet Frontier, by way of Myitkyina, Fort Hertz, Nam Tamai, Adung Valley, Nammi-la, and back by some route to Myitkyina. Described in 'Plant Hunters Paradise' (1937) and articles in The Gardener's Chronicle (1932-33). Collection numbers — 9001-10,239.

"seed or specimens of 118 rhododendrons"

- 1939 — North Myanmar and Tibet, by way of Myitkyina, Fort Hertz, Nan Tamai, Adung Valley, Gamlang Valley, Hkakaborazi, and back by the same route to Myitkyina. Described in 'Burma's Icy Mountains' (1949) and articles in 'The Gardeners' Chronicle' (1938-39) Collection numbers — 12,600-13,573.
- 1930-39 — North Myanmar, by way of Myitkyina, Htawgaw, Imaw Bum, Hpimaw, Panwa Pass, Hpare Pass, back to Myitkyina. Collection numbers — Vernay-Cutting Expedition (1938-39).
- 1953 — North Myanmar, by way of Myitkyina and Sumprabum to Hkinlum and back. Collection numbers – 20,301-21,716 and 22,001-22,100.
- Ward's 1909 – Ten specimens are at the Botany School, Cambridge, UK; those of 1913-22 are at the Royal Botanic Gardens, Edinburgh, UK; those of 1924-28 are at the Royal Botanic Gardens, Kew, UK; those of 1929 are at the Chicago Natural History Museum, those of 1930-38 and 1946-57 are at the British Museum (Natural History), London, UK; those of 1938-39 are at the New York Botanical Gardens, USA with some duplicate specimens in other herbaria, notably those of 1956-57 in Gothenbuzg Botanical Gardens, Sweden,

"107 specimens are in the herbarium of the Royal Botanic Gardens, Edinburgh"

Between November 1961 and April 1962, James Keenan with three Myanmar foresters, carried out a botanical collection on a hitherto scientifically uninvestigated part of north Myanmar. Two attempts were made, the first in December 1961 and the second more successful effort in February 1962. Most of the observations are based on the second trip, and despite a collection number in excess of 1,000, because of the season, a great many of the specimens were in the vegetative state and seem to have been impossible to identify.

In 1920, Reginald Farrer collected Myanmar rhododendrons from northern Myanmar. Farrer collected material, seed or specimens of 118 rhododendrons. Of these, 107 specimens are in the herbarium of the Royal Botanic Gardens, Edinburgh. Of these, 24 have been described as new species discovered by Farrer. The Farrer rhododendron specimens fall into two sets. Only six rhododendrons were found in the expedition around

"24 have been described as new species"

Kansu in 1914-1915, but three of these have been described as new species. All the other specimens were collected in 1919-1920 in northeast Upper Myanmar. In this area Farrer found many of the species previously discovered by Forest and Ward. Moreover, he discovered 21 new species in this region.

In the summer of 1981, Dr Kyaw Soe, then Associate Professor of the Botany Department, University of Yangon, together with two members from his department undertook a botanical expedition to northern Myanmar. They collected nearly as many specimens, especially medicinal plants, which are now deposited in the herbarium of the Botany Department, University of Yangon.

Vegetation

The investigation into the spatial and biophysical characteristics of mountain environments has focused on Hkakaborazi National Park, Kachin State, Myanmar. The National Park is of topographic variability resulting in strong biophysical gradients that shape the vegetation landscape. Its spatial and biophysical complexity and its relative inaccessibility have necessitated the development of an analytical framework that integrates remotely-sensed satellite data with a GIS for spatial analysis.

Our research within Hkakaborazi National Park has been organised around five main objectives.

- Development of a GIS to support spatial and biophysical studies of processes and feature distributions
- Observation of these studies through the manipulation of a GIS database, the identification of new species and evaluation of forest assessment
- Examination of plant biomass and patterns of species
- Preparation of a land-use map of the National Park area using visual interpretation
- Preparation of a map depicting the status of the forest, using remotely sensed satellite data as input, for wildlife management of the National Park

The time provided for the research is very short and the study area is remote. Therefore at the time of writing the ground data collection had not yet been completed.

Study Area

Hkakaborazi National Park is one of the protected areas for biodiversity in Myanmar. The area is hilly with elevations ranging between 1,400 and nearly 6,000masl in the Hindu Kush-Himalayan region. It has an area of about 3,812 sq.km. The highest peak of the Southeast Asian region is 5,891m.

Data used

- Topographic maps from the Survey Department of Myanmar
  Index numbers: 91 H, 91 L, 92 A, 92 E, 92 1
  Scale: 1:250,000 (1" = 6kms)
- Remote-sensing satellite data (Landsat multi-spectral scanning (MSS) data)

Number	Path/row	Date of acquisition
1.	143,040	20 Oct: 1981
2.	142,041	18 Dec: 1973
3.	143,041	6 Dec: 1979
4.	144,041	24 May: 1977

"degraded forest is found mainly near the snow area, along the stream and near the village"

Methodology

The land use of the National Park was examined through the development of a GIS in which satellite data sets were interpreted and integrated with remote sensing. The basic steps in the process are outlined below.

- The National Park boundary, the stream, the village location, the highest point and the administrative boundary have already been traced on topographic maps on a scale of 1:250,000 and have been digitised using Arc/Info Software,
- Classification of satellite (Landsat MSS) data to categorise features for land-cover differentiation in the alpine environment by visual interpretation
- The next important step is the tic point (Ground Control Point) for transforming the digitised image into the world coordinate system.
- Generation of the land-use map from overlay analysis
- Creation of a database of land use, using attribute tables — data analysis was carried out using Microsoft Excel software.

Classification

Manual interpretation is classified as follows.

"on the imagery it is dark grey with a coarse texture. It may be bare, rocky land or agricultural land"

Closed forest area (CF)

This includes MUMD (moist upper mixed deciduous), evergreen, hill forest and alpine forest. These areas are reddish pink on the MSS bands of the 457 colour composites.

Degraded forest area (DF)

Some of this area is whitish pink on the MSS imagery. Degraded forest is found mainly near the snow area, along the stream and near the village.

Cloud and snow area (Cl and S)

These can be distinguished by shadow, the clouds having shadow and the snow without.

Non-forested area (NF)

This area is very near the permanent snow area. Sometimes it can be seen near the village. On the imagery it is dark grey with a coarse texture. It may be bare, rocky land or agricultural land.

Biophysical Study

Closed Forest (CF)

In north Myanmar the forest arrays are clearly defined zones, almost entirely dependent on altitude and very little on latitude -- the whole country covers no more than 5° from south to extreme north latitude. Even so latitude does make a difference, and the flora of the Nmai Hkha Valley and ranges to the east differ a good deal from those of the Mali Hka Valley and ranges to the west, at the same altitude. The reason for this is the proximity of an entirely new type of flora – that of China or the

"latitude does make a difference"

Eastern Asiatic flora. The meeting line of this with the Indo-Malaysian flora is probably along the Ayeyarwaddy. However, the major climatic influence, the Thanlwin Divide, runs north to south, as one might expect, and east to west following the alignment of the high peaks between 28° and 30°.

In north Myanmar, the same conditions may be found at altitudes differing by as much as 610m. Nevertheless the vegetation obviously does change more or less regularly with increasing altitude, as anyone will admit, and the average altitude where one type of forest passes into another type can be identified. Thus at 1,829m, hill jungle with its tropical evergreen trees, its palms and screwy pines, its tree ferns and woody lianas separates from temperate forest with its more familiar northern trees, many of which are deciduous.

When one is faced with what appears to be different types of forests on every mountain, the difficulty of a simple classification is obvious. The best one can do is to achieve some sort of generalisation. Of course an intensive study of all the species and their relative abundance is necessary before one can construct a complete classification of forests. In addition, it is not possible to say, without much study and comparison, what local influence important factors such as light, humidity, and temperature may have in effecting small alternations.

At 27° latitude, the rain forest is not so very different from the equatorial forest nearly 3,218 km away. The watershed between the Malihka and the Mai Hka is formed by multiple ranges all parallel to each other, and roughly, to the streams they separate. The country site is almost uninhabited, and covered with evergreen forest; only in the valleys are there three scattered, small Nung or Daru villages. Real sub-tropical hill jungle becomes apparent at 1,524m and over. Here, crossing the ranges at 1,829m, one can find a great many trees and herbaceous plants not seen before, as well as some common to lower altitude.

Degraded Forest area (DF)

Near villages, much vegetation cover has been reduced to a dense growth of scrub and fern by cutting for firewood.

North Myanmar is almost entirely covered with forest of one kind or another. The several forest climates depend mainly on altitude, which determines temperature and atmospheric humidity as well as rainfall and its seasonal availability. Differences by latitude are so small as to be negligible; but distances from permanent to semi-permanent snow are an important factor.

There are three exceptions to the general statement that the whole of North Myanmar is covered with forest.

<u>The banks of the rivers between low water (winter) and high water (spring-summer)</u>

At Myitkyina the river rises and falls between 9 and 12m (summer and winter), exposing considerable areas of rock and sand. This difference in level decreases steadily as the river divides and sub-divides; but remembering the hundreds of kilometres of waterways, it certainly amounts to a significant area of constant change. The annually exposed areas begin a few hundred feet above sea level, and are still perceptible at 1,829m. Upstream there are always large rocks in the river beds, more exposed in winter.

The river level falls in September. A variety of shrubs form a dense, even impenetrable scrub, at – or below -- high floor level; the flora vary with the nature of the ground-rock sand, pebbles,

"shrubs which will stand a certain amount of intermittent submergence are *Rhododendron simsii* Planch, *Ficus pyriformis* Hook and Arn, *Phyllanthus* sp. and *Salix* sp"

and mud. There are numerous species in the river bed flora which have been seen nowhere else, leading to the conclusion that the river gorges afford a direct link between plains and mountains, open spaces await colonisation, and that plants make use of them for the purpose of migration. They are not by any means one-way streets.

Amongst shrubs which will stand a certain amount of intermittent submergence are *Rhododendron simsii* Planch, *Ficus pyriformis* Hook and Arn, *Phyllanthus* sp. and *Salix* sp. Other important river bed shrubs are *Ligustrum massalogianum Vis, Camellia* spp., *Euonymus* sp. and of course, *Homonoia riparia* which positively enjoys prolonged submergence.

Plants found near or below high-water level vary considerably with the substratum, and so with the force of the currents, which determines it. Such plants reach only a very limited size. An undershrub usually found growing in sand, but not in pebbly beaches, is *Rhabdia lycioides* Mart.

Village sites and clearings

"these clearings are manmade, and were quite recently covered with forest"

These clearings are manmade, and were quite recently covered with forest. Sometimes they are found isolated from the village, completely surrounded by virgin forest, on slopes as steep as 60°. The limit of cultivation is 1,828-1,981m, so that they only affect the sub-tropical to warm temperate belt.

The succession that follows the abandonment of such a clearing is interesting but need not be followed in detail here. The main changes brought about by clearing the forest are loss of shade (only south- and west-facing slopes are cultivated), inability of the slope to retain moisture and impoverishment of the soil. Parasitic and saprophytic fungi gradually appear on the stumps of the trees, though fire must have done a certain amount of sterilisation, including, no doubt, the killing of useful soil bacteria.

The mountaintops above 3,048m

"these mountain tops are covered with scrub and with alpine plants, scattered or in colonies"

The area included, though discontinuous, is far from negligible. A rough calculation suggests that it maybe about 5% of the whole — perhaps more. These mountain tops are covered with scrub and with alpine plants, scattered or in colonies; but there are always many bare patches, which of course increase the limit of flowering plants. To a considerable degree the plants depend on the nature of the terrain, especially below the top-most limit. Cliff faces of igneous rock, which are bare except along and across the joints, which are usually confined to south-facing slopes, have only a few and scattered species; but small areas of meadow carry a rich variety of species, as do most sheltered slopes.

The alpine zone is not only a different vegetation type, but also a different floral region altogether; and the fact that there are two distinct floral regions in North Myanmar — the one superimposed on the other — has

certain implications. They must be of different origin, and are probably of quite different age; and they are in contact in three dimensions, instead of only two as in the plains.

The alpine flora are isolated, in contrast to the forest flora which are continuous and in direct contact with other floral regions. This difference is being slowly intensified all the time. The alpine flora are disarranged, like the chessmen towards the end of a game of chess.

Cloud and Snow area (Cl and S)

North Myanmar gets so much rain and snow, especially during the winter monsoon, because it is not very remote from the sea.

The Hkakarbo snow peaks are not the only snow peaks in North Myanmar, the whole length of the Salween-Ayeyarwaddy Divide for some 322 km north of latitude 26° is sprinkled with snow peaks.

From the top of the Hkakarbo range in fine weather one looks due north, across the gorge of the Tamai River to the Tamai-Dablu Divide, 32 km distant and to the snow-clad mountains at the source of Dablu 32 km beyond that.

The furthest visible range is the massive headland, part of the Tami-Taron Divide, whence spring both the Dablu and Tazu Rivers; and it owes its existence as a separate feature to the curiously erratic course of the Upper Nam Tamai or Adung River. This headland, carved out of the ancient Ayeyarwaddy Plateau, has a uniform altitude of 4,267-4,572m, and is snow covered for 8 or 9 months of the year.

Non-Forested area (N.F)

The high alpine valleys of the far north of Myanmar really look like where plant life comes to an end and where glaciers begin.

Between Pananding and Tazundun, at about 2,438m, a relative alpine top, the whole belt of conifer forest is missing, at least 914m below the level beyond which trees cannot grow, whatever the shelter. There are several reasons for this; because their life process is geared to lower temperatures or to shorter spells of activity or even to a different light intensity or to the absence or presence of actinic rays at high levels. But, whatever the reason, though alpine plants in these mountains will descend far below their normal habitat, they never descend below a certain critical altitude, which here is about 2,743m.

The area for some miles up the Adung Valley, high above the last forest and more than 4,572masl, is under snow for more than half the year.

Flora

A biological expedition was sent to Mount Hkakaborazi an area in the northernmost part of Myanmar, during March and April 1997. That area is still virgin land full of untouched flora and fauna. The arrangements and funds for this venture were jointly provided by Myanmar Forest Department, Ministry of Forest and WCS. The team was composed of an orchidist from Myanmar Floriculturalists' Association, a zoologist, an ornithologist, two survey personnel, a geographer, three foresters, two conservationists from WCS and U. Myo Khin as the representative academician of the Botany Department, University of Yangon.

"a number of peculiar and seemingly rare plants can be found"

The main aim of this expedition was to make a botanical collection in a hitherto scientifically uninvestigated part of northern Myanmar, as well as to record information on geography, climate, forestry, and ethnobotany.

Collection Area and Collection Route

The area studied was from Putao to the Tibetan frontier (N. Latitude: 27.4' 30", E. Longitude: 97.4' 40"-98). Of particular interest were the highest mountain, Hkakaborazi, 5,881m, and its environs.

The route taken from Putao (1,342') was by way of Machanbaw (1,350'), 22 km, to Htanga (2,000'), 22 km. From Htanga, the route taken was in a northeasterly direction along the river to Babaw (1,700'), 48 km. Still going in a northeasterly direction, the route led to Rabbaw (1,750'), 14 km, to Gardhtu (1,750'), 9 km, to Lanser (1,830'), 6 km, to Gawli (2,200'), 12 km; to Shinshanku (4600'), 14 km, to Pangnandim (3,670'), 9 km. From the Pangnandin, the route led in a northwesterly direction along the Meikha River to Lon Nut (3,400'), 12 km, to Ngawa (3,600'), 12 km, to Wangsiwang (4,000'), 14 km, to Gawai (4,350'), 5 km, to Tazungdaung (4,730'), 19 km. From Tazungdam the route divided into two; one led west (the Indian Frontier) and the other went east (the Chinese frontier). The western route from Tazungdam to Guba-Madain (6,667') was 15 km. The eastern route taken from Tazundaung to Tahundam (6,300') was by way of Thlahtu (5,000'), 6 km, Adung Long (5,600'), 8 km and Tazuntu (4,850'), 9 km. From Tahundan (the base camp) the route led to the northernmost part of Myanmar near the base of Hkakaborazi by way of Garman (7,232'), Similar (7,531'), Apikut (8,248'), Naradome (2,324m) and Talihtu (8,021') along the river Adung Long.

"seventy-one specimens were collected in this expedition"

Results from Recent Research

Nearly 500 specimens — including lower plants, ferns, gymnosperms, and angiosperms — were collected from Putao to Talihtu. The specimens were collected almost every day along the road through the hills as well as through the most luxuriant jungle. Examination of the roadside banks rewards the botanists with a good cross section of the hill jungle; a number of peculiar and seemingly rare plants can be found. In all seasons the road is littered with such clues, indicating what trees compose the jungle and often what species a particular tree is. Most of the plants collected were properly pressed, dried and mounted on herbarium sheets. Identification was carried out by matching them with existing specimens from the herbarium of Yangon University and both the multi-volumed 'Flora of India' and 'Flowers of the Himalaya' by Polunin and Stainton (1992) were used to settle most matters of taxonomic uncertainty. All the collected specimens have been deposited at the herbarium of Yangon University.

Ferns and Fern allies

"55 species have already been identified from current literature and 14 new species for Myanmar have been recorded"

Seventy-one specimens were collected in this expedition. Of these, 55 species have already been identified from current literature and 14 new species for Myanmar have been recorded. The remaining unidentified specimens were sent to world fern associations and Kew Gardens, UK, and the results will be announced in the future.

Gymnosperms

Nine species were collected and identified by consulting the literature. Usually firs and other gymnosperms grow widely 3,048m above sea level. The small number of gymnosperms collected was due to the lower altitude of the route, about 2,743m above sea level at its highest.

Monocotyledons and Apetalous

Many specimens were collected and among them 14 monocot species and 17 apepetalous species have been identified. A large number of orchid specimens were collected from this area. But the identification of species proved uncertain and unsatisfactory due to incompleteness of specimens and the nature of the orchid flower. Every botanist who has attempted to examine the flowers of dried specimens of orchids, particularly those of the smaller species, knows how very difficult it is to understand the structure of the column. For, in common with those of so many of the petaloid monocotyledons, the flowers of orchids, owing to the delicacy of their tissues, lose their form during the process of drying, however carefully conducted; and they do not recover it when moistened for study purposes. For this reason only a few of the collected orchids could be identified with certainty.

Apepetalous

Forty-eight species belonging to 35 genera and 23 families were collected.

Sympetalous

Although time for collection was limited, about 170 sympetalous species were collected and identification was carried out at the herbarium of Yangon University. Sixty species belonging to 33 genera and 21 families have been identified.

Analysis of Previous Work

General features

It has been remarked that for each 610-914m of ascent in the Myanmar alps, we enter upon a new zone of vegetation, distinguished not only by different species in different proportions, but also by differences in growth habit, as meadow differs from forest, forest from scrub, broad-leaved forest from needle-leaved forest and deciduous forest from evergreen.

Moreover, in north Myanmar, there are degrees of alpine vegetation. Alpine scrub is a knee-deep tangle of stunted, gnarled bushes, chiefly rhododendrons confined to sheltered slopes where the snow melts gradually. Alpine turf consists of a discontinuous carpet of herbaceous plants and dwarf rhododendron tufts found on more exposed slopes. Alpine scree, though largely naked, also has flora of its own. But the overall impression of the alpine region is dwarfness, whether of woody or herbaceous plants, together with a wide range of variation. There are in fact an astonishing multiplication of species in many alpine genera; witness for example, *Rhododendron, Saxifraga, Gentiana, Meconopsis* and *Primula.* On the other hand, some genera, such as *Diapensia, Omphalogramma, Fritillaria* and *Diplarche*, have few or even one species only. At extreme altitudes, plants are very sensitive to water supply, wind and to protection from direct sunlight. A slight alteration in aspect alters these values, and so alters the vegetation. Not only does snow lie longer on the northern and eastern than on the southern slopes, but also there is an infinite series of gradations between the two extremes. This is reflected in both the type of vegetation and in the flora.

In north Myanmar, above 3,048m, there are actually more plants in flower in October (including late summer flowers, autumn flowers and delayed spring flowers) than there are in June. It is

"in October there are plants flowering up to 4,572m. Even a few early summer rhododendrons open an odd flower or two"

chiefly the red blaze of acres of rhododendrons which makes June appear a month of flowers. There may be more colour in June as wide drifts of *Primula* splash into flower, with molten lakes of rhododendrons and other social plants setting the hillside, but for number of species, October leads. For in June much of the ground above 3,048m is still under snow, while above 3,657m on sheltered slopes and 3,962m on exposed slopes, hardly a plant is in flower, whereas in October there are plants flowering up to 4,572m. Even a few early summer rhododendrons open an odd flower or two, enough to reveal what they are. In the first half of October, nearly a hundred species of rhododendron flowers can be found.

Bamboo, or tree grasses of all kinds, are found in every forest zone in north Myanmar, right up to 3,657m, though the greatest variety occurs between 610 and 1,524m. There are several types of bamboo thicket, which might be classified roughly according to altitude as follow.

- Bamboo of the lower forest (1,219-1,525m)
- Bamboo of the temperate forest
- Bamboo of the moss forest
- Dwarf bamboo (cane brake) everywhere from 2,743m upwards

Both *Ericaceae* and *Vacciniaceae* form an important and conspicuous element in the flora of north Myanmar at all levels above 914m; but it can be estimated that even lumping both families together the number of rhododendrons exceeds that of all other species put together by 2 to 1.

"bamboo, or tree grasses of all kinds, are found in every forest zone in north Myanmar"

Generally speaking, June is the month of flowering shrubs, October the month of herbaceous plants. Many of the former lay down the framework of their flowers in the previous growing season, in the form of resting buds. Only warmth and water are required to complete their development. Herbaceous plants, however, die down to the ground in the winter.

Flora Zone I — between Putao and Pangnandin

From Putao to Pangnandin on the Nam Tamai is about 145 km.

There is always a great variety of herbaceous plants on the road banks during the rain; particularly prominent are the herbaceous species of *Thunbergia*, a dwarf banana with scarlet bracts (*Musa sanguinea*), giant Paris, the enormous solitary leaf of an *Amorphophallus* and various *Impatiens* with brightly coloured flowers. Between the big trees grow clumps of a short slender palm with a stem like a bamboo (*Pinanga*), snake-like prickly climbing palms (*Calamus*), screw pines with saw-edged leaves and many shrubs and hedge herbaceous plants. Clumps of *Begonia* with long falchion-shaped leaves instead of the usual elephant ear grow in the rocky torrent beds. On the next range at 1,829m on the hog's back ridge grows an epiphytic *Begonia* with thin, curiously narrow, heart-shaped leaves. The flowers of both species are white.

"between the big trees grow clumps of a short slender palm with a stem like a bamboo (*Pinanga*)"

In the forest here, at about 914m altitude, grow *Wightia gigante* (an epiphytic tree), *Elaeocarpus* (a beautiful tree bearing huge numbers of thin

white flowers), *Neplelium*, *Carcinia*, *Schima*, *Engelhardtia*, *Bauhinia*, *Michelia* and other *Magnoliaceae*, *Dipterocarpus alatus*, *Unona*, the white trumpet-flowered *Fagraea*, the scarlet-flowered *Aeschynanthus*, mosses, ferns and small orchids. There are also many climbers; the trunks of the trees are almost entirely hidden.

At about 1,524m in hill jungle where oaks, chestnuts, birch, and yew grow, *Altingia excelsa*, *Terminalia myriocarpa*, *Bucklandia populnea* and aromatic laurels, *Litsaea*, and *Cinnanmomum*, are prominent. On the bank grow violets, begonias of several kinds, dwarf *Chirita* with yellow-throated, blue-violet flowers, *Selaginella*, *Impatiens*, *Torenia*, tiny *Sonerila* and the golden-flowered *Lysimachia*. On the summit ridge grow the strange-leafed *Begonia*, the first *Rhododendrons*, *R. vaccinioides*, the larger-leafed *R. dendricola* with trumpet-shaped flowers and the tawny bold tree species *R. stenaulum*, with curiously shaped, delicate-looking, pink flowers.

All along the top a splendid white-flowered *Begonia* grows on the bank; lower down is a species with pale yellow flowers. Altogether there are not less than six species of *Begonia* here; some of them have still not been described. Dense forest clothes the flanks of the ridge, the trees heavily draped with moss, which hangs in festoons from the stumpy malformed branches. Mosses and ferns, gesnerads, gingerworts, aroids and other plants thrive in deep gullies. Woody climbers are rarer in the upper strata of the hill jungle than they are lower down, while the number and variety of epiphytes steadily increases as one ascends, reaching a maximum at 1,829-2,133m in north Myanmar. The reason seems to be that climbers need heat before humidity, while epiphytes need humidity first.

The range crossing from the watershed between the Mali Hka and its tributary the Nan Tisang is the most interesting region hitherto, containing many new species of plants, some of unusual beauty. Of note amongst these are two species of *Eugenia*, shrubs with heads of flowers having the appearance of a rounded bottle brush, deep crimson in one, mauve in the other, a slipper orchid *Paphiopedilum wardii*, *Rhododendron dendricola*, several *Begonias* and *Gesneriaceae*.

On the bank of the Tisang River, or Nan Tisang, grow large clumps of an aggressively armed palm (*Zalacca*) and a ditch by the path side was full of orange and violet flowered *Burmannia*. At less than 610m, it is really the tropical forest region.

Between Noungmun and Pangnandim, ascending through a forest of oaks and chestnuts, are *Magnolia*, *Michelia*, *Ilex*, birch, maple, alder and finally rhododendrons, *Bucklandia*, *Illicium*, and other almost warm temperate trees. It is a little peculiar that *Rhododendron arboreum*, which in the Khasi Hills is common as low as 1,524m, should hardly be found in north Myanmar. The only tree species here is *R. stenaulum*. Below the crest of the ridge, in the newly exposed earth, little saplings, herbs, and shrubs are found. There are many small birch trees, *Bucklandia*, alder and rhododendron, and other competitors such as *Gaultheria*, *Luculia pinceana*, *Rubus lineatus*, *Carex baccans*, *Lycopodium* and the common fern *Gleichenia*. From the top-most stratum descending to lowland tropical rainforest at 1,829m at the Nan Hat Gorge, the notable trees are *Ficus*, *Caryota urens*, *Dysoxylum*, *Terminalia myriocarpa* and *Goniothalamus*.

At Shinhangku, the last and highest range between the Mali Hka and the Nan Tamai, or the real watershed between the eastern and western branches of the Ayeyarwaddy, there is a limestone outcrop where a sleek-leafed Asarum (*A. cordifolium*) and a peculiar *Begonia* grow. A whole grave of *Albizzia* trees has taken possession of the place since the forest was felled. Other trees

"in spite of the altitude and the nearness of the snow-clad mountains, the vegetation of the valley is still sub-tropical"

and shrubs, which spring up in secondary growth at this altitude, are *Ficus cunia*, *F. obscura*, *Callicarpa arborea*, *Saurauja*, *Litsaea* and *Alnus*.

Flora Zone II — between Pangnandin and Tazundun

In spite of the altitude and the nearness of the snow-clad mountains, the vegetation of the valley is still sub-tropical, though temperate pine forest begins to appear in higher valleys and the flanking ranges. Tree ferns (*Alsophila*) grow in the deep gullies and many kinds of bamboo, both large and small, including climbing bamboo, but there are very few erect palms, this being the northern limit of the sago palm on the eastern Ayeyarwaddy.

There is also a falling off in the number and variety of figs; the large strangling species being almost entirely absent. The commonest tree figs are *Ficus cunia* with edible fruits, *F. obscura*, which has curiously lop-sided leaves, *F. hirta* and *F. clavata*, though not growing to a large size. In the rocky river beds the gregarious *F. pyriformis* is a common shrub, and there are a number of other small shrubby and climbing species.

"it is all the more surprising to meet with such temperate plants as forget-me-not"

On rocks above high water *Rhododendron simsii* is still found, with *Ficus pyriformis*, *Astilbe* and a few ferns and grasses. Where a sandy cave occurs above normal flood level, a greater variety is found including *Polygonum capitatum*, *Thalictrum*, *Oxyspora*, *Equisetum*, *Pueraria* and other creeping *Papilionaceae*, *Gnaphalium*, *Carex* and *Neillia thrysiflora*. A little higher up, and well above any likely flood, grow *Albizzia julibrissin*, *Dobinea vulgaris*, *Ficus cunia* and other species of fig, *Rubus*, *Saurauja*, *Luculia* and a number of climbing and scrambling plants like *Vitis*, *Mussaenda* and *Streptolirion volubile*. It is therefore all the more surprising to meet with such temperate plants as forget-me-not, a fern-leafed umbellifer, anemone (*A. Hupahensis sp*), valerian, a small crucifer and the blue pea (*Parochetus*) growing by the path; while under the trees the banks are still covered with pink begonias, *Sonerila*, *Hedyotis* and other sub-tropical herbs.

Somewhere between Pangnandim, at a latitude 27° 45' and the Seinghku confluence just north of 28° 0' there is a sharp change in the flora with sub-tropical hill forest giving way to temperate pine forest; here sub-tropical plants, when they occur, are incidental. In a transition zone so dominated by the proximity of high mountains, the flora are bound to dovetail into one another often in the most bewildering way. Pine, in the Tamai Valley, appears at 1,524m, where hemlock occurs in quantity; up to 3,657m, almost pure conifer forests cover the slopes. It is certain that a great variety of temperate species such as oak, maple, birch, chestnut, walnut, and many more occur. A little further south, in the valley of the Nmai Hka, many sub-tropical trees grow by the river. Wherever the path runs through jungle it is fringed with a pretty labiate, *Plectranthus macranthus*, bearing long spikes of slim tubular pink flowers and white anemones (*Anemone tetrasepala*).

"up to 3,657m, almost pure conifer forests cover the slopes"

A stiff ascent of 610m to the top, through forest with a fairly thick undergrowth of *Arundinaria*, a bamboo of medium height which does not

form clumps but sends up separate halums from its rhizome, was seen. At first the trees were those characteristic of the upper sub-tropical hill jungle. Oaks, chestnuts, and laurels were abundant; *Magnoliaceae* occurred sparingly with *Bucklandia* and many other species. Small epiphytic shrubs were also conspicuous, amongst them *R. nuttallii* and *R. bullatum*, representing a cool, damp atmosphere. From the east towards the main north-south watershed and the peak, the forest was still thick and luxuriant with a great variety of trees, not outwardly very different looking than 914m below. Epiphytic shrubs are more numerous here than lower down, and there is plenty of bamboo undergrowth, and rhododendrons replace shrubs like *Lasianthus, Ardisia* and others, so it is clear that you are changing into another zone of vegetation altogether, sub-tropical and temperate.

Over 2,133m, on a rock outcrop, herbaceous flowering plants are rare in the forest, but wherever rock outcrops, there is no difference between the trees along the ridge and those on the flanks. There is no sign of bush rhododendrons, a sure herald of an approach to alpine conditions. There are many epiphytic shrubs, but rhododendrons seem to be very rare or absent and conifers almost totally absent. Rhododendrons need light and unless they grow on trees, or are themselves trees, they have no chance in such thick forest as on this mountain.

The undergrowth is chiefly a species of *Arundinaria*, dense and impenetrable in places but sometimes very open. Few plants take advantage of the open spaces — small *Impatiens, Lysionotus* on rocks and one or two small orchids, even a *Cymbidium*. The forest is plain temperate evergreen rainforest, but the absence of conifers is puzzling. *Pinus excelsea*, which a little further northwest is plentiful at 1,524m, disappears completely somewhere east of longitude 98°, to be replaced by *P. insularis*, which is found also in the Khasi Hills.

At about 2,438m or a relative alpine top, one considers the wealth of vegetation nearby. There is stunted oak (*Quercus pachyphylla*), a yellow *Impatiens*, a tiny *Panax*, isolated clumps of bamboo and eastwards five species of rhododendron — *R. tephropeplum, R. martirianum, R. megacalyx, R. madennii* and *R. pruniforum*, with *Gaultherias, Vaccinium glaucoalbum, Daphniphyllum, Skimmia laureola* and other shrubs. There is undergrowth of moss, dwarf *Gleichenia* and twining gentian beneath the rhododendron bushes, and below *Clethra delavoyi*, small trees of rowan, crab apple, *Cinnamomum* and several others. But even more surprising than rhododendrons is the discovery, under the bushes, of a creeping dwarf *Cornus*, indistinguishable from the alpine *C. succica* of northern UK and Greenland. Another surprising point is that there seem to be only three conifers in the area. Thus it can be concluded that, between 2,133 and 3,048m in north Myanmar, there is no true alpine belt.

Most of the trees are thickly padded with moss, which covers their trunks and hangs, dripping, from their branches, like bunches of seaweed from a pier when the tide is out. In this sponge mass are embedded the roots and even the stems of epiphytic shrubs, notably species of *Gaultheria, Vaccinium, Rhododendron, Agapetes, Leucothoe* and *Aeschynanthus*. A minute *Utricularia* is also commonly met with on rocks and tree trunks, and a filmy fern. The undergrowth gregarious fern, *Lomaria*, occurs abundantly, with scattered flowering plants like *Sarcopyramis, Arisaema, Globba, Polygonatun* and colonies of *Elatostema*. This moss forest contains a fairly constant assemblage of species, with well-marked characteristics, and may be regarded as a distinct type of local vegetation.

The steep ridge which runs northwards is clothed with bamboo brake, through which mixed shrubs, including some juniper, grow. Both flanks are thickly wooded, and the precipitous east face is covered with a particularly dense growth of small trees, *Quercus pachyphylla*, maples

"in the middle temperate forest at about 1,829m, the most abundant species is bamboo (*Arundinaria* spp.)"

and rhododendron being abundant, together with a large-leafed *Ilex*, willow, *Daphne*, a *Laurus*, *Viburnum*, *Cotoneaster*, white bean, *Enkiantus*, *Daphniphyllum*, *Berberis*, *Hypokerina* and *Sorbu harroviana*. There is no fir forest, and with the exception of juniper and an occasional *Taxus*, no other conifer. Between 2,743 and 3,048m several interesting sub-alpine plants grow, but no exclusively alpine species. There are aromatic-leaved rhododendrons *(R. pruniflorum)*, the gregarious shrub *Gaultheria hookeri*, *Berneuxia thibetica*, with glossy leaves and a compact teasel-life of white flowers, *Vaccinium glaucoalbum*, *V. modestum* and a *Nomocharis* in fruit.

In the middle temperate forest at about 1,829m, the most abundant species is bamboo (*Arundinaria* spp.), with long creeping, not clump-forming rhizomes, the hollow stems bearing a ring of spikes round each node. At about 1,829m, there are several blue pines and through a dense undergrowth of *Arundinaria* the beautifully coloured broad-leaved fern, *Dipteris*, and another fern, *Gleichenia*, crop up. At 1,524m, with *Bucklandia*, there are large-leaved *Castonopsis*, small stemless palms, climbing palms and large root climbers like *Raphidophora*.

"the Tamai Valley is thickly covered with temperate plants"

As far north as Gawai, the Tamai Valley is thickly covered with temperate plants. *Hydrocotyle* is common in marshy places and parsley, *Plantago*, *Epilobium* and *Valeriana* are other common weeds. There are also a number of small, pea-flowered undershrubs, some of them prostrate, of the genera *Lespedeza*, *Crotalaria* and *Desmodium*.

From the gully to the point of the forest on the ridge at about 1,829m, there are broad-leaved evergreen trees with an occasional blue pine towering above the canopy, or a graceful juniper. Other trees here are maple, *Machilus*, *Cinnamomum*, *Schima*, *Engelhardtia*, *Bucklandia* and *Eriobotrya*. The appearance of the last two and the disappearance of such trees as *Saurauja*, and the loss of the climbing palms (*Calamus*) and the larger fig trees at about 1,829m, marks a change in the type of forest, from sub-tropical hill jungle to temperate forest and the beginning of conifer forest. Among large-leaved trees, there are *Gamblea ciliata* (tree), *Magnolia rostrata* and two rhododendrons (*R. sinogrande* and *R. sidereum*); also oaks (*Quercus pachyphylla* and *Q. lanuginasum*) *Illicium*, birch, hemlock, spruce, sorbus, *Ilex*, *Rhododendron neriiflorum* and a species with a tawny bole related to the Chinese *R. irriratum*. (Renanthera orchid) With silver fir ushering in the highest belt of forest, there is a great candelabra of *Rhododendron arizelim*, *Tsuga*, *Acer wardii* and other rhododendrons (*R. chartomallum*, *R. pruniflorum* and *R. megeratum)*. However, though such temperate plants as *Roscoea*, *Adenophora*, (campamula family) *Fritillaria*, *Delphinuum*, *Astillbe* and *Rodgersia* (plant) grow here, there is no *Primula*.

"at about 3,200m, there is a silver fir-hemlock forest"

At about 3,200m, there is a silver fir-hemlock forest, mixed with a few broad-leaved deciduous trees such as *Rhododendron arizelum* and *Arundinaria*. The ground is covered with a thick felt-like carpet of moss, soft as a feather bed, in which nestle tiny orchids and a minute chocolate-

flowered umbellifer with linear leaves, dwarf-creeping *Rubus*, *Vaccinium* and *Clintonia alpina*. The tree trunks also are fat with a monstrous sponge-like growth of moss.

At a peak 3,352m high, there is no *Tsuga* but *Abies* grows, and often *Rhododendron arizelum* also grows. Wherever rocks give some protection from the wind, small bush rhododendrons grow in great variety -- the flashy yellow of *R. triflorum*, the crimson of *R. chartomallum*, the purple of *R. tephropeplum* and the deep plum of *R. pruniflorum*. Other common shrubs are species of *Viburnum*, *Pieris*, *dwarf Ilex*, *Pyrus*, *Berberis*, *Juniper* and *Litseae*.

Flora Zone III - between Tazunden and Tahundun

There are many species here, both alpine and temperate. These include *Rhododendron imperator* of which a solitary plant is to be found in the Seinghku Valley, *R. myrtilloides* to be found in the Chawngmaw Valley, *Meconopsis violacea* (a few plants within a small area in the Seinghku Valley), *Paphiopedilum wardii*, *Meconopsis villosa*, *Rhododendron fulgens*, the *Sorbus*-like *Zanthoxylum* and *Hypericum*. The forest is composed mainly of broad-leaved evergreen trees, including several *Ficus* (such as *F. cunia* and *F. obscura*). Ferns particularly revel in the cool, damp atmosphere of the deep Adung Gorge, and occur in great variety. The bird's nest fern (*Aspidium*) is a common epiphyte, together with a yellow brown spotted gesnerad and a fleshy *Peperomia*, and shrubs such as *Aeschynanthus* and the white-flowered *Rhododendron taronense*. Many of the tree trunks are completely concealed by large-leaved climbing plants, which cling close to them; *Pothos* and *Raphidophora* are particularly noticeable.

There are many laurels and figs here, also *Albizzuia julibrissin*, *Eugenia*, oak, maple and alder, mixed with tree ferns and enormous climbers. The rocky river banks below the forest level are in places covered with a moss-like creeping plant with little shining leaves and tiny violet berries (*Rubiaceae*).

Flora Zone IV - between Tahundan and Mount Hkakaborazi

Within the Adung Gorge, the type of forest changes abruptly. This zone is the last hint of tropical vegetation. Most conspicuous is *Rhododendron magnificum* and, together with hemlock spruce, it lines the gorge. The angle of slope in the gorge is about 15°. Dense forest, sombre in colour, lines the river at flood level. But in spring the rising note of the water is matched in melody by the clash and ring of colour of the hot, breathless glow of rhododendron against the faltering greens and brave yellows of unfurling maple leaves, the sharp green bristling larches studded with crimson cones like prehistoric sea anemones and the cold marble white globes of *Magnolia*, which glimmer in the darkness with an unearthly light.

The gullies immediately above the river where alluvial fans spread out into the forest were examined. The forest consists of a mixture of evergreen, broad-leaved, deciduous and coniferous trees, the latter including blue pine, hemlock spruce and yew, with occasional larch and *Picea*. A thousand feet higher up conifers become as common as broad-leaved trees. Deciduous trees include birch, maple, cherry, walnut, ash and *Tetracentron*. Evergreens include species of *Ilex*, several rhododendrons and oaks and *Schima wallichii*, a fine tree with a dark handsome crown. Some of the massive-limbed rhododendrons have been growing for a century; but so close grained and heavy is the timber that they have attained no great size in that time A wide-meshed network of creepers – vines, *Clematis*, *Kadsura*, *Aristolochia* and others – has spread itself over the canopy and dangles long festoons between the tree trunks.

Between the Gamlang and the Adung, across the slope there was a thin forest of hemlock and pine, with occasional larch and *Picea*, but this has been replaced gradually by mixed forest

containing many broad-leaved trees, both evergreen and deciduous. At 2,743m, many small irises (*I. decora*) grow in earth fans. The other species are rhododendrons (*R. sinogrande, R. arizelum* and another) and a welter of small trees and shrubs, the most notable of which are a species of *Euonymus* and the prickly hazelnut, *Corylus ferox*.

"at 3,048m, when the snow melts, hundreds of alpine flowers bloom on the alluvial cones"

At 3,048m, when the snow melts, hundreds of alpine flowers bloom on the alluvial cones, especially *Saxifraga*, *Cyananthus*, *Pedicularis*, *Geranium*, *Primula*, *Mimulus*, *Parochetus*, *Astragalus*, *Gentiana sp*, *Ranunculus* and *Nomocharis*. Some of the slopes are covered with taller herbs one metre high or more, mostly rather coarse, large-leaved plants such as *Rodgersia*, *Astilbe*, *Aconitum*, *Adenophora*, *Lactuca*, *Impatiens*, *Cnicus* and *Artemisia*. Passing through a patch of forest there is a tangle of rhododendrons that overhang the river. Amongst them are several rhododendrons different from any seen before and they appear to be hybrids. It is a remarkable fact that, although rhododendrons hybridise easily, amongst the thousands of square kilometres almost solidly covered by them, cross pollination takes place, interspecific pollination also occurs and allied species are not in flower at the same time; an unmistakable hybrid is rather rare. Other forest plants noticed here are *Panax*, *Podophyllum*, dwarf *Euonymus*, and creeping *Rubus*.

"Galang Valley is like a long, narrow stairway"

At 3,657m the north flank, which is high and steep, is fringed with a band of vivid green vegetation. But the south slope fluxes out thinly to moist earth where hundreds of shabby-looking alpine plants die down as they shed their seeds. This results in the curious spectacle of alpine plants scattering their ripe seeds on one side of the snow bed, and just beginning to open their flowers on the other side, less than a hundred yards away. In this condition are golden *Trollius* (*T. yunnanensis*), sky-blue poppies (*Meconopsis betonicofolia*), *Primula sikkimensis*, *Pedicularis*, *Allium* and several others

"at lower altitudes a carpet of *G. trichophylla* with blackberries occurs"

Galang Valley is like a long, narrow stairway, leading to the conclusion that the abrupt petering out and disappearance of the vegetation at the parting of the stream is more a mechanical than a climatic effect. Various woody plants help to prepare the ground for a more complex society. One of the earliest pioneers is *Rhododendron repens*, then larger species of *Gaultheria*. There seem to be two varieties of the latter, one with dark blue, the other with light blue berries. At lower altitudes a carpet of *G. trichophylla* with blackberries occurs. There may be other different species — two have milk-white berries and one grows as a prostrate mat. Two scarlet-berried *Gaultherias* which also have white berries like hailstones, also grow here. So there are at least five good species, and several varieties or possibly hybrids.

"in the Dandi Valley, mosses grow everywhere"

In the Dandi Valley, mosses grow everywhere. A species of *Saussurea* can also be found, its dark inflorescence enclosed in thin, papery, yellow bracts, giving the impression of a large porcelain lamp globe. Amongst survivors at high altitudes are *Saxifraga*, a grass and a *Luzula*. And by the streams are rosette-shaped composites, dwarf rhododendrons (*R.*

campylogynum) and strangely, orchids. The variety of vegetation on the floor of the valley rapidly increaseds with dwarf rhododendron, *Gaultheria*, *Ilex*, *Vaccinium*, *Cassiope*, *Salix*, *Berberis*, *Lonicera* and *Prunus*, *and* rock covered with the pink stars of *Diapensia*, the shimmering blue *Corydalis cashmeriana*, *the* deeper blue *Gentiana wardii* and a crimson-purple *Pedicularis*.

The vegetation by now is pure alpine. In spring the landscape is a mass of colour. Rhododendrons surge everywhere -- *R. cerasinum* and *R. chaetomallum* both with blood-red flowers, *R. pruniflorum* with glaucous purple and *R. selense* with ivory, saffron and sometimes salmon, apricot or cerise. Scattered through the mead, the skeletons of dead June flowers such as *Primula serratifolia*, *P. muscarioides*, *P. sikkimensis* and *Omphalogramma souliei* rattle in the wind. Even at this height a few drifts of yellow *Primula melanodonta* delayed by snow shine like clusters of fairy lamps against the soiled snow at the foot of an alluvial fan. Genuine autumn flowers are few but here and there are ripples of the gleaming blue *Gentiana sino-ornata*.

At the Gamlang-Dandi ridge, less than 4,876m in altitude, there are some of the highest flowering plants in north Myanmar, including, besides moss and lichens, dwarf *Rubus*, *Polygonum*, *Saussurea gossypiphora* (high altitude plant), a sedge and a *Luzula*. All are widely scattered, though here and there small colonies of *Primula serratifolia* flourish.

Recommendations for Future Research

Hkakaborazi National Park is recognised to be one of the richest areas of biological resources in the world. Extraordinarily rich flora and fauna, ranging from lowland tropical to alpine species, still await proper research and identification. They have barely been studied, and the park remains an excellent centre for field study for students of botany, geology, zoology and geography.

In addition, due to its very wide biological diversity, research should continue to focus on ethnobotany, conservation, and community development. As conservation becomes increasingly oriented towards understanding plant resource management, there will be additional emphasis on forming multi-disciplinary and multi-cultural teams of researchers who can examine local plant use from various perspectives.

Spurred on by the urgency of the conservation issue, there will be a tendency to support rapid participatory ethnobotanical inventories followed by detailed studies on selected resources. Attention will be given to posing hypotheses about the link between resource use and conservation as well as developing an empirical method to test this idea.

Particular support will be given to local ethnobotanical promoters and to scientists who collaborate in the design of resource use studies, because they are in a unique position to apply results to community development and nature conservation. Collaborators in local communities will not be the beneficiaries of these initiatives, but rather full partners in the process. They will participate in the design and implementation of the research as well as the application of the results. In addition to receiving monetary returns, they will expect assistance in analysing and reinforcing their traditional forest management practices and in designing ways of ensuring that knowledge is passed along from one generation to the next.

Conservation organisations (such as WCS) and the general public that supports them will be increasingly perceptive in their assessment of the successes and failures of ethnobotanical exploration. From the perspective of conservation and community development, the way ahead

"the Forestry Department and WCS sponsored the botanical research that has made this work possible"

for ethnobotanists is to follow a path of participatory research guided by explicit research agreements and contracts that define the rights and obligations of all participants at each stage of the project. The potential of ethnobotany to contribute to conservation and community development has been well publicised, but the world is now waiting for results.

Acknowledgements

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We have made every effort to trace errors, but if we have inadvertently overlooked any, we will be pleased to make the necessary arrangements for correction at the first opportunity.

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Herbarium, Department of Botany, University of Yangon
Flora of Hkakaborazi National Park
Checklist Of Identified Gymnosperms

	Scientific Name	Family	Locality	Altitude (m)	Voucher Remark No.
1	*Abies* sp.	Pinaceae	Tahundan to Shanmalar	1,920	MK-013
2	*Abies ciliciea*	Pinaceae	Shanmalar	-	MK-044
3	*Abies* sp.	Pinaceae	Shanmalar	-	MK-045 & X
4	*Abies spectabilis* *Pseudotsuga forrestii* (Craib)	Pinaceae	Tazundun	-	MK-013
5	*Picea* sp.	Pinaceae	Tazundun to Shanmalar	1,442	MK-011
6	*Picea likiangensis* (Franch)	Pinaceae	Tazundun to Shanmalar	1,920	MK-59
7	*Picea brachytyla* (Franch)	Pinaceae	Talihtu	-	-
8	*Pinus wallichiana* (Jackson)	Pinaceae	Tazundun to Shanmalar	1,920	MK-018
9	*Taxus baccata* (L.)	Taxaceae	Putao	409	MK-G-2

Herbarium, Department of Botany, University of Yangon
Flora of Hkakaborazi National Park*
Checklist of Identified Ferns

	Scientific Name	Family	Location	Voucher Remark No.
1	*Asplenium nidus*	Aspleniaceae	Putao	MK-2
2	*A ensiforme* (Wall.) Var (bifid)	Aspleniaceae	Gaman	MKT-69
3	*Athyrium* sp.	Anthyriaceae	Kaung Mulon	No data
4	*Asplenium heterocarpum* (Wall.)	Aspleniaceae	Shinshaku	MK-161
5	*Antrophyllum latiforum*	Grammitidceae	Shinshaku	MK-154
6	*Angiopteris evecta* (Hoffin)	Angiopteridaceae	Hyanga	MK-82
7	*Alsophila glabra*	Cyatheaceae	Machanbaw	MK-28
8	*Amaranthus tricolor*	Amaranthaceae	Gawai	MK-283
9	*Aspidium polymorphua* (Wall.) ex Hook	Aspidiaceae	Shmshaku	MK-156
10	*Adiantum* sp.	Adiantaceae	Pangnamdm	MK-159
11	*Adiantum* sp.	Adiantaceae	Shiushaku	MK-201
12	*Blachnum orientale*	Blechnaceae	Machanbaw	MK-21
13	*Cyathea spinulasa* (Wall.)	Cyatheaceae	Guba	MK-329
14	*Campteria wallichinana* (Ag.)	Pteridaceae	Talihtu	MK-2
15	*C. biaurita* (L.)	Pteridaceae	Wanshiwan	MK-266
16	*Dipteris wallichii* (Br.)	Dipteridaceae	Putao	MK-8
17	*Dictyopteris tenerifromis* (Hook)	Polypodiaceae	Gaw-Lei	MK-48
18	*Diacalpe aspidioides* (Bl.)	Cyatheaceae	Putao	MK-4
19	*Equisetum arvense*	Equisetaceae	Shinshaku	MK-162
20	*Gymnopteris costata* (Wall.)	Polypodiaceae	Alan	MK-25
21	*Goniopteris prolifera* (Roxb.)	Polypodiaceae	Shinshaku	MK-156
22	*Gleichenia linearis* (Burm.)	Gleicheniaceae	Putao	MK-9
23	*Gleichenia* sp.	Gleicheniaceae	Putao	-
24	*Hemidicryum ceterach* (L.)	Aspleniaceae	Gaman	MK-67
25	*Humata pedata* (Sm.) Var *alpina* (Blume)	Davalliaceae	Pangnandim	MK-203
26	*Leucostegia* sp.	Davalliaceae	Wansiwang	MK-233
27	*Lycopodium carinatum*	Lycopodiaceae	Alanga	MK-57
28	*Lycopodium* sp.	Lycopodiaceae	Alanga	MK-73
29	*Lastrea affuscipes* (Wall.)	Aspidiaceae	Alanga	-
30	*Monogramme* sp.)	Grammitideae	Apikut	TMK-033
31	*Meniscium cuspidatum* (Bt.) Var *longifrons* (Clerk)	Grammitidaceae	Gawle	MK-149
32	*Microlepia majuscula* (Lowe)	Davalliaceae	Putao	MK-6
33	*Merinttosorum* sp.)	Davalliaceae	Putao	-
34	*Niphobolus stigmosum*	Polypodiaceae	Shmshaku	MK-158
35	*Nephrolepis penduncularis*	Nephrolepidaceae	Lon-Ngaw	MK-151
36	*Pleopeltis lehmanni* (Mett)	Polypodiaceae	Lon Nut	MK-204
37	*Polypodium cornigerum* (Baker)	Polypodiaceae	Lon Nut	MK-263
38	*Polystychum ilicifolium* (Don)	Aspidiaeae	Lon Nut	MK-53
39	*Pellia* sp.	Pelliaceae	Pangnandim	MK-272

* Altitudes were not available for this table.

Herbarium, Department of Botany, University of Yangon
Flora of Hkakaborazi National Park
Identified Monocot And Apepetalous Checklist

	Scientific Name	Family	Locality	Altitude (m)	Voucher Remark No.
1	*Arisaema wattii* (Hook)	Araceae	Putao	409	MKG-001
2	*Castanea* sp. (Tourn)	Fagaceae	Taliltu to Shanmalar	-	MKT-060
3	*Quercus* sp. (L.)	Fagaceae	Taliltu to Shanmalar	-	
4	*Castanea* sp. (Tourn)	Fagaceae	Taliltu to Shanmalar	1,920	T-027
5	-	Fagaceae	Babaw to Rabaw	533	MK-104
6	*Polygonum alatum* (Han.)	Polygonaceae	Shinshaku	1,402	MK-171
7	*Polygonum serrulatum* (Lag.)	Polygonaceae	-	670	MK-142
8	*Polygonum* sp. (L.)	Polygonaceae	Shinshaku	1,402	MK-164
9	*Polygonum* sp. (L.)	Polygonaceae	Langa to Gawlw	670	MK-137
10	*Polygonum alatun* (Han.)	Polygonaceae	Alanga	670	MK-075
11	*Aconogonum molle* (D.Don)	Polygonaceae	Gawai to Tazandom	1,442	MK-262
12	*Polygonum serrulatum* (Lag.)	Polygonaceae	Langa to Gawlw	670	MK-143
13	*Polygonum chineses*	Polygonaceae	A Longa	670	MK-065
14	*Polygonum capitatum* (L.)	Polygonaceae	Machariverban	463	MK-039
15	*Ficus lepidosa* (Wall.)	Moraceae	-	-	-
16	*Picus cunia* (Bush)	Moraceae	Gawai to Tazundaom	-	-
17	*Ficus roxburghii* (Wall.)	Moraceae	Rutao to Machanhow	1,442	MK-269
18	*Ficus lepidosa* (Wall.)	Moraceae	Lunga to Gawle	411	MK-013
19	*Pilea scripta* (Weld)	Urticaceae	-	558	MK-139
20	*Elastostema platyphyllum* (Wedd)	Urticaceae	Ahtanga	-	-
21	-	Urticaceae	Langato Gawle	670	MK-087
22	*Aritolochia* sp. (L.)	Aristolochiaceae	Tazandam to Shanmarlar	558	MK-129
23	*Hatropha* sp. (L.)	Urticaceae	-	1,920	MK-003
24	-	Amaranthaceae	Alanga	670	MK-085
25	*Paris polyphylla* (Smith)	Liliaceae	Smshaku	1,402	MK-168
26	*Engelhardtia spicata* (Blume)	Juglandaceae	-	1,441	MK-273
27	-	Zingiberaceae	Larnut to Ngawar	1,097	MK-218
28	*Setaria* sp. (Beauv.)	Gramineae	Kaumgmulon	-	-
29	-	Gramineae	Talihtu	-	MKT-041
30	-	Gramineae	Gawai to Tazaumdom	1,097	MK-266
31	-	Gramineae	Kaumgmulon	1,441	-
32	-	Gramineae	Tazaumdom to Sharjmalar	1,920	MKT-019
33	-	Gramineae	Lommut to Nyawar	1,097	MK-221
34	-	Gramineae	Gawai to Tazaumdom	1,441	MK-282
35	-	Gfamineae	Kaumgmulon	-	-
36	-	Gfamineae	Gawai to Tazundom	1,441	MK-275
37	-	Gfamineae	Lomlut	1,119	MK-199
38	*Viscum* sp. (L.)	Loranthaceae	Ngawar to Wangsiwang	1,364	MK-234
39	*Castanopsis* sp. (Spach)	Fagaceae	Ngawar to Wangsiwang	-	-
40	*Polygonum* sp. (L.)	Polygonaceae	Ngawar to Wangsiwang	-	-
41	*Polygonum serrulatum* (Lag.)	Polygonaceae	Guba to Madone	2,033	MK-309
42	*Corylopsis (aff) sinensis*	Hammelidaceae	Guba to Madone	-	-
43	*Corylopsis* sp.	Hammelidaceae	Tazjmdom to Shanmalar	1,920	MK-020

Herbarium, Department of Botany, University of Yangon
Flora of Hkakaborazi National Park
Identified Apopetalous Checklist

	Scientific Name	Family	Locality	Altitude (m)	Voucher Remark No.
1	*Impatiens urticifolia*	Balsaminaceae	Longa to Gawle	558	MK-131
2	*Vitis* sp.	Vitaceae	Gawai to Tazundom	1,441	MK-263
3	*Polygala arillata*	Polygalaceae	-	-	MK133
4	*Elaeocarpus varunua* (Most)	Elaeocarpaceae	Babaw	558	MK-122
5	*Elaeocarpus* sp.	Elaeocarpaceae	Bgawar to Wangsiwang	1,364	MK-245
6	*Chaerophyllum* sp.	Umbelliferae	Tazjmdun	1,478	MK-133
7	*Oxalis* sp.	Oxalidaceae	Taibtu	-	MK-168
8	*Capsella bursopastoris* (L.)	Cruciferae	Taibtu	-	MK-816
9	*Aesculus punduana* (Hern)	Sapindacea	Tazjmdam to Shanmalar	1,920	MK-362
10	*Holboellia latifolia* (Kosi)	Lardizabalaceae	Wamshiwn	1,219	MK-236
11	*Clematis acuminata* (DC)	Ranunculaceae	Guba to Mudone	2,032	MK-311
12	*Berberis wallictriana* (DC)	Berberidaceae	Putao	409	MK-3
13	*Mahonia* sp.	Berberidaceae	Tazundom to Shanmajar	1,920	MK-008
14	*Mahonia nepalensis* (DC)	Berberidaceae	Tazundom to Shanmajar	1,920	MK-009
15	*Albizzia* sp.	Mimosaceae	Alango to Tazundum	-	-
16	*Melastoma normale* (Don)	Melastomaceae	Rabbaw	518	MK-109
17	*Eurya acuminata* (DC)	Theaceae	Gawai	1,326	MK-249
18	*Eurya acuminata* (DC)	Theaceae	Machanbaw to Alonga	463	MK-38
19	*Begonia lociniata* (Roxb.)	Begoniaceae	Gawle to Smsaku	670	MK-179
20	*Begonia* sp.	Begoniaceae	Machanbaw to Alonga	1,402	MK-43
21	*Begonia* sp.	Begoniaceae	Alanga	670	MK-71
22	*Begonia* sp.	Begoniaceae	Gawle to Smsaku	1,402	MK-179
23	*Magnolia campbellii* (Hook)	Magnoliaceae	Tahumdum	1,920	MK-344
24	*Polyalthia* sp.	Annonaceae	Vabaw	533	MK-103
25	*Viola pilosa* (Blume)	Violaceae	Alanga	670	MK-63
26	*Viola pilosa* (Blume)	Violaceae	Putao	411	MK-12
27	*Lindera* sp.	Lindaceae	Ipilcat	-	MK-29
28	*Cinnamomum* sp.	Lauraceae	Babaw	533	MK-100
29	*Cinnamomum* sp.	Lauraceae	Guba	2,032	MK-307
30	*Prunus persicum* (Benth)	Rosaceae	Langa	670	MK-153
31	*Prunus persicum* (Benth)	Rosaceae	Lannut	1,097	MK-217
32	*Fragaria* sp.	Rosaceae	Putao to Machanbaw	411	MK-12
33	*Fragaria nubicola*	Rosaceae	Gawai to Taztmdom	1,442	MK-279
34	*Prunus* sp.	Rosaceae	Tazundom to Shanmalar	1,920	MK-14
35	-	Rosaceae	Gawai	1,326	MK-251
36	*Rosa* sp.	Rosaceae	Wan Shiwon	1,219	MK-237
37	*Neillia* sp.	Rosaceae	Gawai	1,326	MK-257
38	*Rubus alpestris* (Blume)	Rosaceae	Gawai	1,326	MK-250
39	*Hedera* sp.	Araliaceae	Tahundum	192	MK-349
40	*Aralia* sp.	Araliaceae	Machanbaw to Atonga	463	MK-20
41	*Hedera* sp.	Araliaceae	Tohun dum	1,920	MK-248
42	*Schefflera* sp.	Araliaceae	Gawai	1,442	MK-261
43	*Trevesia* sp.	Araliaceae	Longa to Gawiw	558	MK-135

44	*Cardamine* sp.	Brassicaceae	Putao to Machanbow	411	MK-12
45	-	Rosaceae	Tazandom toTasugru	1,478	MK-336
46	-	Sterculiacea	Tazundomto Shanmalar	1,920	MK-363
47	-	Papilionaceae	-	-	-
48	-	Rosaceae	Babaw	533	MK-105
49	*Viola* sp.	Violaceae	Pangnandim to Lormut	1,636	MK-209
50	-	Araliaceae	Guba	2,032	MK-323
51	-	Rosaceae	Babaw to Rabaw	533	MK-104
52	*Cardamine* sp.	Cruciferae	Alangha	670	MK-066
53	*Crotalaria* sp.	Papilionaceae	Machanbow to Atanga	463	MK-033
54	*Dobinea* sp.	Sapindaceae	Gawai toTazundom	1,442	MK-270
55	*Corylopsis sinensis* (aff.)	Hamamelidaceae	Guba to Madone	2,032	MK-309
56	*Corylopsis* sp.	Hamamelidaceae	Tazundomto Shanmalar	1,920	NK-020
57	*Prunus carnesina* (Hera)	Rosaceae		-	MK-020

Herbarium, Department of Botany, University of Yangon
Flora of Hkakaborazi National Park
Identified Sympetalous Checklist

	Scientific Name	Family	Locality	Altitude (m)	Voucher Remark No.
1	*Symplocos theaefolia* (Han)	Symplococeae	Machanbow to Alonga	463	MK-036
2	*Symplocos paniculata* (Thunb.)	Symplococeae	Rabaw	558	MK-123
3	*Clerodendrum siphonathus*	Verbenaceae	Outao to Machanbow	411	MK-014
4	*Clerodendron* sp.	Verbenaceae	Alanga	670	MK-056
5	*Clerodendron* sp.	Verbenaceae	Alanga	670	MK-064
6	*Edgeworthia gardneri* (Wall.)	Thymelaceae	Gawai	1,219	MK-247
7	*Daphne* sp.	Thymelaceae	Ipikut to Talititu	-	MK-051
8	*Justicia adhatoda* (L.)	Acanthaceae	Kaungmulone	-	-
9	*Rauvolfia rivularis* (Merr)	Apocynaceae	Shinshaku	1,402	MK-147
10	*Crawfurdia speciosa* (Wall.)	Gentianaceae	Wanshinon	1,219	MK-240
11	*Crawfurdia speciosa* (Wall.)	Gentianaceae	Tazundum	1,442	MK-268
12	*Gentianella* sp.	Gentianaceae	-	-	-
13	*Plantago major* (L.)	Plantaginaceae	Alanga	670	MK-061
14	*Lonicera* sp.	Caprifoliaceae	Machanbaw	463	MK-035
15	*Androsace* sp.	Primulaceae	Alanfa to Babaw	670	K-054
16	*Primula geraniifolia* (Hook)	Primulaceae	Takilihtu	-	MK-057
17	*Primula geraniifolia* (Hook)	Primulaceae	Takilihtu	-	MK-065
18	*Buddleia* sp.	Buddleiaceae	Machanbaw	381	MK-030
19	*Buddleia* sp.	Buddleiaceae	Machanbaw	463	MK-031
20	*Buddleia* sp.	Buddleiaceae	Gabato Madone	2,032	MK-326
21	*Wendlandia glabrata* (DC)	Rubiaceae	Machanbaw	463	MK-32
22	*Wendlandia uvarifolia* (Hance)	Rubiaceae	Alaha	670	MK-76
23	*Jasminum* sp.	Oleaceae	Machanbaw to Alanga	463	MK-27
24	*Jasminum* sp.	Oleaceae	Gaba to Madone	2,032	MK314
25	*Jasminum pubescens* (Wild)	Oleaceae	-	-	-
26	*Maesa manipurensis* (Mer)	Myrsinaceae	Langa to Gawle	670	MK-150
27	*Maesa indica* (Roxb.)	Myrsinaceae	Alaha	670	MK-80

28	*Maesa indica* (Roxb.)	Myrsinaceae	Alaha	-	-
29	*Leucas aspera* (Spreng)	Labiatae	Machanbaw	463	MK-34
30	*Gomphostemma* sp.	Labiatae	Alanga to Babaw	670	MK-47
31	-	Labiatae	Pangamandin to Lormut	1,119	MK-208
32	-	Labiatae	Ngawar to Wangsiwang	1,219	MK-243
33	*Oscimum* sp.	Labiatae	-	-	MK-139
34	-	Labiatae	Langa to Gawlw	558	-
35	*Leucas* sp.	Labiatae	Tazandum	1,142	MK-280
36	*Gnaphalium luteolbum*	Compositae	Babaw to F.abaw	533	MK-108
37	*Lactuca longfolia* (DC)	Compositae	Babaw	533	MK-113
38	*Dichrocephala bicolor* (Roth.)	Compositae	Pangnandim to Lonnut	1,119	MK-212
39	-	Compositae	Alanga	670	MK-52
40	-	Compositae	Alanga	670	MK-89
41	-	Compositae	Ngawar to Wangeiwang	1,219	MK-242
42	-	Compositae	Gawai	1,326	MK-256
43	-	Compositae	Alanga	670	MK-70
44	-	Compositae	Gawai	1,326	MK-255
45	-	Compositae	-	-	-
46	*Vernonia* sp.	Compositae	Waskjiwon	1,219	MK-240
47	*Ainsliaea* sp.	Compositae	Gawai	1,326	MK-253
48	*Petasites* aff. *fragrans* (Vill.)	Compositae	Gawai to Tazundum	1,142	MK-278
49	*Gaultheria* sp.	Ericaceae	Gawai	1,326	MK-248
50	*Gaultheria* sp.	Ericaceae	Tazundom toTasuhtu	1,478	MK-342
51	*Gaultheria hookerii* (Clarke) var *hookeri I*	Ericaceae	Ngawar	1,219	MK-246
52	*Gaultheria fragrantissima* (Wall.)	Ericaceae	Gawai	1,326	MK-248
53	*Rhododendron* sp.	Ericaceae	Babaw	533	MK-107
54	*Rhododendron keleticum* (Bulf)	Ericaceae	Alanga	670	MK-66
55	*Rhododendron mucronatum* (Bl.)	Ericaceae	Putao to Machanbaw	411	MK-16
56	*Rhododendron* aff. Neriiflorum	Ericaceae	Talihtu	-	MK-064
57	*Rhododendron* aff. *Strigillosum*	Ericaceae	Gaba to Madine	2,032	MK-304
58	*Rhododendron* aff. *Strigillosum*	Ericaceae	Gaba Madain	2,032	MK-303
59	*Rhododendron* sp.	Ericaceae	Faba Madain	2,032	MK-305
60	*Rhododendron* aff. *yunnanensis* (Franct)	Ericaceae	Takundam Gaba Madam	2,032	MK-302
61	*Rhododendron* (Bl.)	Ericaceae	Bawbaw to Rabaw	533	MK-111
62	*Rhododendron fictolacteum* (Balf.)	Ericaceae	Ipikat	-	MK-032
63	*Rhododendron ctolacteum* (Balf.)	Ericaceae	Ipikat	-	MK052
64	*Rhododendron cariaceum* (Franct.)	Ericaceae	Guab to Madone	2,032	MK-302
65	*Cynoglossum* sp.	Boraginaceae	Gawai	1,326	MK-254
66	*Leycesteria gracilis* (Kurz.)	Caprifoliaceae	Guab to Madone	2,032	MK-317
67	*Viburnum* sp.	Caprifoliaceae	Guab to Madone	-	-
68	*Viburnum* sp.	Caprifoliaceae	Guab to Madone	-	-
69	*Lindernia* sp.	Scrophulariaceae	Guab to Madone	-	-
70	-	Ericaceae	Tazundom to shamnalar	1,920	MK-004
71	-	Ericaceae	Guab to Madone	2,032	MK-315
72	*Vaccinium* sp.	Vacciniaceae	Guab to Madone	2,032	MK-313
73	-	Labitae	Alnaga	670	MK-509
74	-	Scrophulariaceae	Alnaga	463	MK-77,37

An Introduction to Native Orchids of Myanmar in the Hkakaborazi Area

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"prime rivers of Myanmar are the Ayeyarwaddy, the Chindwin, the Sittaung, and the Thanlwin"

Introduction

Myanmar is geographically located in south-east Asia between 9° 58' and 28° 31' north latitude and 92° 9'and 101° 1' east longitude. From north to south it stretches 2,092 km and the farthest distance from east to west is about 917 km.

In Myanmar, the mountain ranges stretch and the rivers flow from the north to the south. The prime rivers of Myanmar are the Ayeyarwaddy, the Chindwin, the Sittaung, and the Thanlwin. The Ayeyarwaddy is the longest and most navigable river in the country and hence the best for commerce and communication. It is formed from the confluence of the Maikha and Malikha rivers, which flow from the Hkakaborazi mountain ranges in the northern part of Myanmar.

The Ayeyarwaddy River flows down through central Myanmar touching all the important points and towns and, through the centuries, it has formed the very fertile delta region from whence it flows through many tributaries into the sea.

Myanmar is composed of seven states and seven divisions. There are distinct mountain ranges, some, in Kachin State, of an altitude of over 3,048m. Other ranges are in Chin State, Shan State, and Tanintharyi Division. The Middle Yoma Range runs from north to south in central Myanmar. The Shwe Dagon Pagoda, one of the 'Wonders of the World', has stood at the end of the Middle Yoma Range for over 2,500 years. All these mountain ranges are covered with primary forests where many native orchids of Myanmar exist. Myanmar measures 677,103 sq.km. From 1998 statistics the area covered by forest was 344,031 sq.km which is 50.85% of the total land area.

The area covered by different forest types (due to different geographical conditions) are

"through the centuries, it has formed the very fertile delta region from whence it flows through many tributaries into the sea"

- Mangrove forests – 13,761 sq.km
- Evergreen forests — 55,046 sq.km
- Deciduous forests — 134,172 sq.km
- Dry forests — 34,404 sq.km
- Scrub forests – 17,201 sq.km
- High mountain and sub-tropical forests — 89,447 sq.km

Nature and Wildlife Conservation in Myanmar

In Myanmar, as of October 1998, the existing protected areas covered 13,691 sq.km, which is 2% of the country's total land area. The government's forest policy aims to expand the protected area up to 5% of the total land area. Currently the protected areas comprise 4 national parks, 19 wildlife sanctuaries, 1 elephant range, 2 mountain parks and 2 newly declared protected areas for conservation work by the Forest Department.

Since 1981, implementation of the Nature Conservation and National Park Project has been taking place with the cooperation of the United Nations Development Programme and the Food and Agriculture Organization. Some international non-government organisations have also assisted.

The numbers of species in Myanmar recorded by the Forest Department are

- Mammal species — 300
- Bird species — 1,000
- Reptile species — 360
- Tree species – 1,347
- Shrub species — 741
- Herb species – 1,696
- Bamboo species — 96
- Rattan species — 36
- Orchid species — 841

Hkakaborazi National Park

A map of Hkakaborazi National Park is shown in Appendix 1.

Expeditions in Hkakaborazi Area

Because this area has rich biodiversity, it is of interest to scientists from Myanmar and other countries too. Forest Department records show the following scientific teams to have studied this area.

		Subject of study
William Bee	1906	Pheasants
F.K. Ward	1920	Orchids and other plants
Farrer	1926	Rhododendrons
Lord Cranbrook	1931	Goral
Vernay Cutting Expedition	1935	Barking deer and shrews
Yein Nwe Par Team	1955	Chinese-Myanmar border area
Oliver Milton	1959	Wildlife and protected areas
Myanmar Medical Research Team	1962	Nutrition of the Taron Tribe
Kyaw Soe and team	1981	Medicinal plants
Alan R. Rabinowitz and U. Saw Tun Khiang	1996	Mammals in Putao Township
Myanmar Japanese Mountaineering Team	1994	The Joint Friendship Expedition to Mount
	1996	Hkakaborazi
Biological Expedition Team	1997	Biology in the Hkakaborazi area
Biological Expedition Team	1998	Biology in Naung Mung Township

"the Hkakaborazi expedition took place in 1997"

The 1997 and 1998 biological expeditions, jointly co-sponsored by the Forest Department of Myanmar and the Wildlife Conservation Society (WCS) of the USA, undertook the task of surveying the flora and fauna of this region.

The Hkakaborazi expedition took place in 1997 between 2 March and 13 April and covered about 290 km. During the expedition, Tong camp, a three-night journey away from Myanmar's northernmost village of Tahandam, and Guba Village from where there is access to India, were reached and studied. With 14 people taking part it was the largest expedition to this region to date. Deputy Director U. Khin Maung Zaw of the Nature and Wildlife Conservation Division of the Forest Department led the Botanical Study Group and U. Saw Lwin of Myanmar Floriculturists' Association and Assistant Lecturer U. Myo Khin of Yangon University took part as members.

The aims of the Hkakaborazi expedition were

"with 14 people taking part it was the largest expedition to this region to date"

- to find unrecorded and rare fauna and flora and incorporate them into Myanmar conservation law so that they may be protected;
- to support the development of Hkakaborazi National Park;
- to participate in activities of NGOs, universities and other institutions as well as those of the expedition, and to promote the park's nature conservation programme among the public.

The botanists collected orchids, ferns, gynmosperms, microorganisms, and ethnobotanical plants; 469 plant species were collected. At the time of writing, 233 species had been recorded and the remainder were still under observation. Forest types were also observed.

The second expedition, in the Naung Mung area (a buffer zone of Hkakaborazi National Park), was a follow-up to the first expedition. The expedition took place in 1998 from 24 April to 17 May

The aims of the expedition were

- to observe and record the rare little leaf Muntjac; the Naung Mung area is the only place in the world that it is found;
- to record the rare orchid species growing in the dense forests of this area; and
- to observe and record the birds and the forests of this area.

From these expeditions the zoological team, led by Alan R. Rabinowitz from WCS, discovered the new species of little leaf Muntjac, *Muntiacus putaoensis.*

"the botanists collected orchids, ferns, gynmosperms, microorganisms, and ethnobotanical plants"

The survey routes of the Hkakaborazi and Naung Mung expeditions are shown in Appendix 2.

The Rare Orchids of Myanmar

World orchidologists and orchid hunters have been interested in and recording Myanmar's orchid species since the nineteenth century. Among these reasearchers, Reverend Parish, Dr Helfer, Dr Griffith, Sir William Hooker and Professor H.B. Reichenbach have carried out much research and written about their findings. In 1895, Captain Bartle Grant compiled all the papers about Myanmar orchids written by various writers and published a book called 'Orchids of Burma'. Starting in 1914, the well-known botanist and naturalist F.K. Ward conducted several floristic surveys in Kachin State. He discovered many new orchid species in the northernmost part of Myanmar. In 1920, he discovered a new species of ground orchid in the Naung Mung area. Later, that orchid was botanically named *Paphiopedilum wardii* in honour of him. Local natives call this orchid, 'the black orchid' because of the dark maroon colour of its flowers. The Naung Mung area is the only place in the world where the black orchid is found.

During the expeditions, the botanists climbed up to about 1,219m in the mountains that provide the habitat for the black orchid; they took photographs and collected some sample plants as well. The black orchid grows well in the leaf humus on the rock ridges as well as under the small bushes in low light conditions and it was learned from local people that it blooms from December to February. Most of the black orchids collected were nurtured successfully in the Pyin-Oo-Lwin Research Nursery, which is located 914 masl. Here the weather is cool and mild and very similar to that which occurs where the black orchid grows naturally. Nearly all the plants flowered in January-February 1998. Other interesting and rare Myanmar orchid species were also collected and nurtured in Pyin-Oo-Lwin.

Terrestrial orchids were also observed growing at about 2,133m; at this height large trees are rarely seen.

On the first expedition, due to heavy rain, time restrictions and the period in which the expedition took place (off season), not as many orchid species as expected were collected. However the habitat of *Paphiopedilum wardii* was studied extensively and recorded, and *Cymbidium eburneum*, native to Myanmar, was recorded for the first time. Seventeen orchid species were recorded in this expedition.

On the Nuang Mung expedition, the botanists collected and studied some 39 orchid species. The following orchids were of particular interest.

- The growing and propagation conditions of the endemic *Paphiopedilum wardii* were studied in detail.
- Although the orchids listed below had previously been recorded as growing in Myanmar, this was the first time they had been recorded as true natives.
  - *Bulbophyllum odoratissimum*
  - *Dedrobium brymerianum*
  - *Dedrobium stuposum*
  - *Phalaenopsis parishii*
  - *Dendrobium transparens*

- The following orchids were recorded for the first time (they are native to Myanmar).
  - *Platystele spp.* (orchid)
  - *Epipogium roseum*

"the blue sheep, the black barking deer and the little leaf Muntjac were discovered"

- *Microspera rostrata*
- *Pholidota chinensis*

Many orchid fruits containing seeds were also collected and grown in the laboratory for further examination. Some rare and endangered orchid species that had been collected were propagated in the laboratory using tissue culture techniques. Promising results were obtained. The Myanmar orchids recorded in the two expeditions are shown in Appendices 3 and 4.

Discussion and Recommendations for Future Research

- On the Hkakaborazi expedition, as a result of collective endeavour, the blue sheep, the black barking deer and the little leaf Muntjac were discovered. In addition, the team took the opportunity to observe the rapid development of a national park from a protected area.
- On the second expedition, the little leaf Muntjac and rare orchids and birds were observed. In addition to examining the existing condition of Hkakaborazi National Park, an assessment was made of the conservation measures required for the park.

"the expeditions found no evidence of the collection and sale of orchids on a large scale"

- Some Myanmar orchid species, including *Vanda caerulea*, *Dendrobium cruentum*, *Renantheraim schootiana*, and all *Paphiopedilum* sp. are listed in Appendix 1 of 'The Convention on International Trade in Endangered Species of Wild Flora and Fauna as World Endangered Orchid Species' (CITES).
- It was learned that about five years previously some traders from China came and purchased *Cymbidium* orchids in the Hkakaborazi area. However the expeditions found no evidence of the collection and sale of orchids on a large scale. It was noticed that small numbers of black orchids, having been collected by local people, were being sold in the Naung Mung market place and being given to visitors as mementoes. Considering the long-term interests of this rare orchid, the local people should be given an educational talk on orchids asking for their cooperation in its conservation.
- The season in which the expeditions took place was not the flowering season. If it had been, more orchid species would have been collected.
- The expeditions established that there is an abundance of naturally occurring orchid species in the Hkakaborazi area. It is necessary to monitor the growth, propagation and estimated numbers of these species. Orchid expedition(s) could take place separately or with other expeditions. Through the joint endeavours of internal and external scientists, we could exchange practical experiences and the internal scientists could acquire knowledge on orchids of an international standard.

"there is an abundance of naturally occurring orchid species in the Hkakaborazi area"

- Hkakaborazi National Park has great potential to be upgraded from a National Park to a World Heritage Site.
- An education centre should be established in Hkakaborazi National Park, with an exhibition for the public providing information about

orchids of the area. A model orchid garden with the orchid species of Hkakaborazi area could also be made.

- Because there are evergreen rainforests, mountains over 3,048m, and sub-tropical forests in Hkakaborazi, there is a wide variety of orchids to be studied. As well as botanical and orchid expeditions, educational tours could also be organised in the area.
- There might be new and unrecorded orchid species still waiting to be discovered in Hkakaborazi National Park. It is recommended that a cooperative expedition and research programme, involving local scientists and knowledgeable scientists from abroad, be organised in the area to search for any rare, undiscovered Myanmar orchids.

Acknowledgements

I would like to express my profound gratitude to the Forest Department and WCS for giving me the opportunity to participate in the biological expeditions that they organised. I also thank Myanmar Floriculturists' Association, for the support they gave me to go on the expeditions and the Forest Department and the International Centre for Integrated Mountain Development for the opportunity to present this paper at the Workshop for Regional Collaboration in Conservation of the Hkakaborazi Mountain Ecosystem (October 1999).

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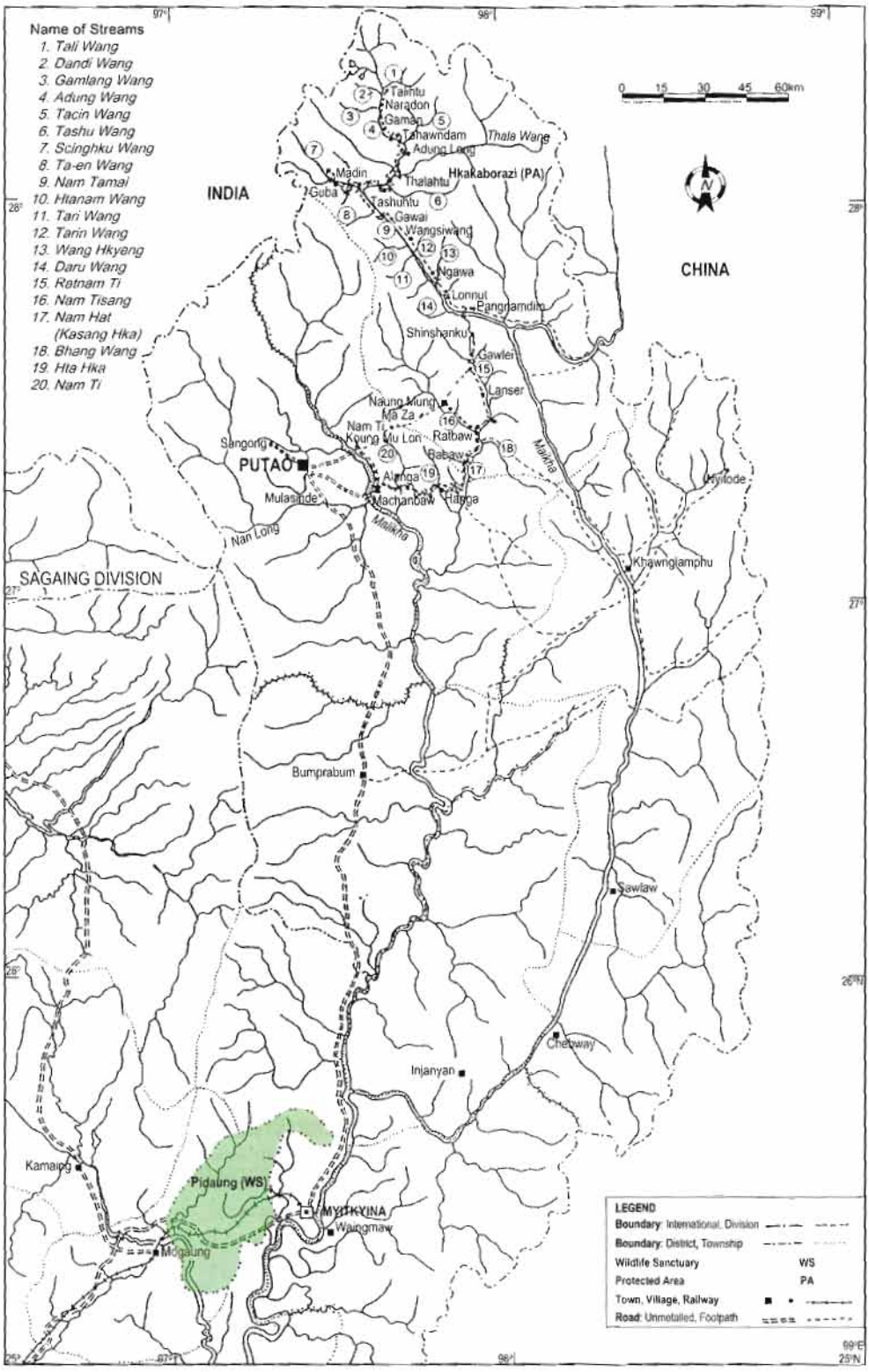
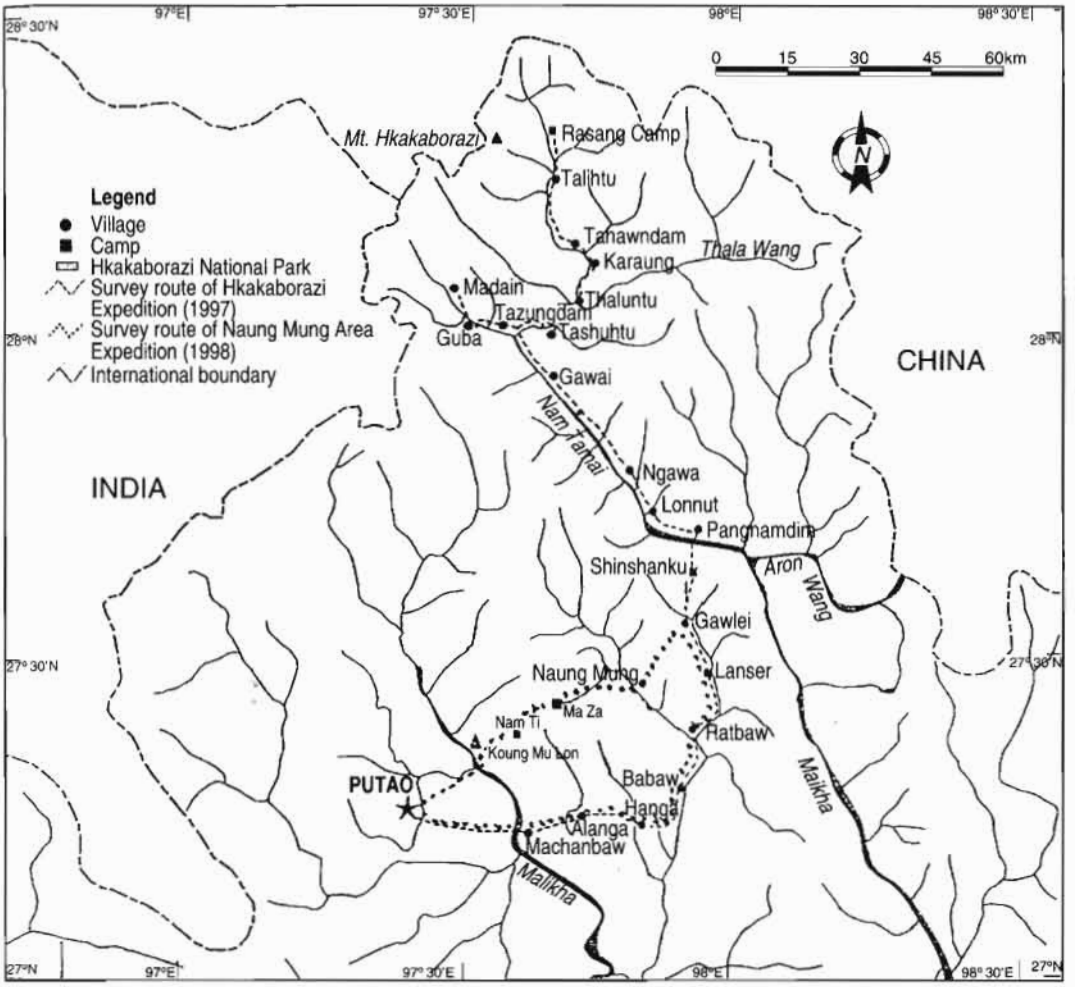
Appendix 1: **A Map of Hkakaborazi National Park**



Appendix 2: **The Survey Routes of the Hkakaborazi and Naung Mung**



Appendix 3: **Orchids Recorded on the Hkakaborazi Expedition (1997)**

Sr. No.	Scientific Name	Common Name
1	*Aerides falcata*	Sar-ka-lay-phyu
2	*Anoectochilus* spp.	Jewel orchid
3	*Arundina graminifolia*	Bamboo orchid
4	*Bulbophyllum odoratissimum*	Thazin pan
5	*Cymbidium aloifolium*	Thit-tet-lin-nay
6	*Cymbidium eburneum*	Pan-thet-shay-phyu
7	*Cymbidium lowianum*	Pan-thet-shay
8	*Cirrhopetalum* spp.	Thazin-yat-taung-thit-khwa
9	*Coelogyne* spp.	Ngwe-hnin-phyu
10	*Dendrobium hercoglossum*	-
11	*Dendrobium pulchellum*	Sin-ma-myet-kwan
12	*Dendrobium thyrsiflorum*	Ta-khaing-lone ngwe
13	*Eria pannea*	Nat-tha-mee pan
14	*Oberonia* spp.	Wyat-hla thit-khwa
15	*Paphiopedilum wardii*	Black orchid (or) khon mya hlaing
16	*Phaius tankervilliae*	Zay-ti thit khwa
17	*Pleione* spp.	Phar-la-thet thit khwa

Appendix 4: **Orchids Recorded on the Naung Mung Area Expedition (1998)**

Sr. No.	Scientific Name	Common Name
1	*Aerides falcatum*	Sar-ka-lay-phyu
2	*Anoechtochilus* spp.	Jewel orchid
3	*Acampe longifolia*	Mee-ma-long-pan
4	*Bulbophyllum odoratissimum*	Thazin pan
5	*Bulbophyllum* spp.	Thazin pan
6	*Cymbidium insigne*	Pan-thet-shay-phyu
7	*Cymbidium gigantea*	Pan-thet-shay-nyo
8	*Cymbidium aloifolium*	Thit-tet-lin-nay
9	*Cirrhopetalum* spp.	Thazin-yat-taung-thit-khwa
10	*Coelogyne hutteriana*	Ngwe-hnin-phyu
11	*Dendrobium aduncum*	-
12	*Dendrobium brymerianum*	Shwe-ka-nate
13	*Dendrobium densiflorum*	Ta-khaing-lone shwe
14	*Dendrobium nobile*	Dawn-mhee-thit-khwa
15	*Dendrobium stuposum*	-
16	*Dendrobium thyrsiflorum*	Ta-khaing-lone-ngwe
17	*Dendrobium transparens*	-
18	*Eria pulchella*	Nat-tha-mee pan
19	*Eria pannea*	Nat-tha-mee pan
20	*Eria spp.*	Nat-tha-mee pan
21	*Epipogium roseum*	-
22	*Eulophia* spp.	Ga-mone-thazin
23	*Goodyera* spp.	-
24	*Habenaria* spp	Myet-thazin
25	*Micropera rostrata*	-
26	*Oberonia* spp.	Wyat-hlathit-khwa
27	*Paphiopedilum wardii*	Black orchid (or) khon mya hlaing
28	*Phalaenopsis parishii*	Barani thit khwa
29	*Phaius tankervilliae*	Zay-ti thit khwa
30	*Phaius flavus*	Nay-myo-nwe thit khwa
31	*Pholidota chinensis*	Kwat-mhee-thit-khwa
32	*Pholidota spp.*	Kwat-mhee-thit-khwa
33	*Pleione maculata*	Phar-la-thet-thit khwa
34	*Pleione* spp	Phar-la-thet-thit khwa
35	*Rhynchostylis retusa*	Kyaung- mee-too
36	*Sarcanthus* spp.	-
37	*Thunia marshalliana*	Stone orchid
38	*Thrixspermum* spp.	-

Endemic Species and New Records of Orchids in Hkakaborazi and Surrounding Areas

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"the area is the watershed of the Maikha River with China"

Introduction

Location and topography

This study was undertaken in an area adjoining Hkakaborazi National Park (Myitkyina Division, Myanmar). Myitkyina Division is in the Putao District of Kachin State in the northernmost part of Myanmar. Within Putao District there are five townships: Naung Mung in the north, Khaung-Lam-Bhu in the east, Machanbaw in the south-east, Putao in the centre and Sumprabum in the south.

The area is the watershed of the Maikha River with China. It is very mountainous with rugged terrain and fast-flowing streams and incorporates Hkakaborazi (5,881m) which is the highest peak in south-east Asia. It is landlocked with no transportation except by footpath and by bridges made of steel cable or cane across the streams.

Previous knowledge of orchids in this region

Most of the previous expeditions to this region have not put much emphasis on orchid research.

"eminent plant collector and explorer F.K.Ward discovered the new *Paphiopedilum*"

In 1922 eminent plant collector and explorer F.K.Ward discovered the new *Paphiopedilum*, between Putao and Nam Tamai, but the flower was lost. He found it again in the same region between 1930 and 1931 and later in 1937, growing on a dry sandy bank in the pine forest just below Htawgaw about 241 km from his previous sighting.

After this find of F.K. Ward's, no more discoveries were reported for many years. This could be due to the remoteness of this region, as it is in the extreme north of Myanmar and one of the least-known parts of south-east Asia.

Some 40 years later in 1977, on an expedition that was organised by a team from Myanmar Orchid Nursery of the Ministry of Forestry to search for this long-lost species, *Paphiopedilum* was rediscovered. It took the team two months to discover the plants near Chan Kwe Pu Hill (2,827m) and Hkah Kin Village on the eastern side of Maikha River: they found a colony of about 50 plants with some in bloom.

"some 40 years later in 1977, *Paphiopedilum* was rediscovered"

The Expedition

In April 1998 I received an invitation from U. Saw Tun Khaing, the Country Programme coordinator of the Wildlife Conservation Society (Myanmar) to join an expedition to the Naung Mung area. I readily accepted.

There were 11 participants in this expedition, with 2 participants from the Myanmar Floriculture Association, including myself. We flew from Yangon to Putao on the 24 April 1998.

The expedition covered more than 201 km, incorporating 13 villages, of the area adjoining Hkakaborazi National Park. The expedition's route map is shown in Appendix 2 of the paper by Saw Lwin, in this publication.

My aim during this expedition was to study the orchids of the area, which have never been researched in detail before, placing emphasis on the distribution, habitats and populations of the species endemic to this area, and to create new records of orchid species.

Results

The orchids collected during our trip are listed below.

1. Aerides falcatum
2. *Anoectochilus* spp
3. Acampe longifolia
4. Bulbophyllum odoratissimum
5. *Bulbophyllum* spp
6. Cymbidium aloifolium
7. Cymbidium gigantea
8. Cymbidium insigne
9. *Cymbidium* spp
10. *Cirrhopetalum* spp
11. Coelogyne hutteriana
12. *Coelogyne* spp
13. Dendrobium aduncum
14. Dendrobium brymerianum
15. Dendrobium densiflorum
16. Dendrobium nobile
17. Dendrobium stuposum
18. Dendrobium thyrsiflorum
19. Dendrobium transparens
20. *Dendrobium* spp
21. Eria pannea
22. Eria pulchella
23. Epipogium roseum
24. *Eulophia* spp
25. *Goodyera* spp
26. *Habenaria* spp
27. *Oberonia* spp
28. Micropera rostrata
29. Paphiopedilum wardii
30. Phalaenopsis parishii
31. Phaius tankervilliae
32. Phaius flavus
33. Pholidota chinensis
34. Pleione maculata
35. *Pleione* spp
36. Rhynchostylis retusa
37. *Sarcanthus* spp
38. *Thrixspermum* spp
39. *Thunia* spp

Of the species collected those which are believed to be endemic to this region are discussed below.

Paphiopedilum wardii Summehayes

Distribution

During this expedition, *Paphiopedilum wardii* was found near Nam Sabum Village, between Nam Ti Camp and Babulon Hill, near Tasa Ku and Lone Seng Hill and at Gawlei Village. We also obtained about 50 specimens of *Paphiopedilum wardii* that the villagers had collected from the surrounding mountains. We did not find *Paphiopedilum wardii* any more after Gawlei, so we presume that Gawlei must be the limit of species' distribution in this area.

"colonies of 50-60 plants were found at each location"

Habitat

The plants we found grew mostly in the deep shade of the primary forest floor in deep humus and loose soil. The terrain is very steep with a gradient of 60-70%. The slopes mostly face north but that at Tasa Ku faces south. Colonies of 50-60 plants were found at each location and included young seedlings and mature plants. As it was after the flowering period (which is from December to March) we observed only seed pods on the plants.

Identification

The plant is easy to distinguish on the ground with its silvery green and dark tessellated green on the upper surface of the leaf. The lower surface of the basal part of the leaf has dense purple spots. New growth appears from both the lower leaf axil and from the creeping rhizomes.

The flowers are single with a purple, pubescent peduncle 20-25 cm long and measure 8-10 cm across. The dorsal sepals are green with white veins, the lateral petals are greenish white flushed with brownish purple and spotted all over with dark maroon and the lips are greenish yellow, finely spotted with brown.

"the plant is easy to distinguish on the ground with its silvery green and dark tessellated green on the upper surface of the leaf"

The flowers from the plants collected were uniform with very little variation in size and colour.

Dendrobium aduncum Wall ex Lindl

Distribution

This species has not been recorded in Myanmar before. It was first introduced from India and subsequently from Malaysia and south-west China (Schelpe and Stewart 1990). On this expedition it was found between Nam Sabum and Nam Ti and near Ratbaw.

Habitat

It was mostly found at elevations of between 500-1,000m, on trees along the streams, in partial sunlight.

Description

This species hangs from the branches of trees along streams, as a tangle of stems. The stems are stiff, slender branches, greenish grey in colour, with greyish white leaf sheaths. Old stems can be 40-60 cm long. The leaves are linear lanceolate and deciduous. The flower buds appear from the inter-nodes, with one or two flowers at each node. The flowers are pink and measure about 1.5 cm across. A distinctive feature of the flower is the lip, which is small and globular and the tip is like a hook at the centre of the flower. The inside surface is hairy with a bright purple anther cap. The sepals and petals are rather similar in shape and colour. The flowering season is in May and June.

"this species hangs from the branches of trees along streams, as a tangle of stems"

***Dendrobium brymerianum* Reich b.f.**

Distribution

Grant (1895) wrote that the species existed somewhere in Burma, but no specific location was mentioned. Pridgeon (1992) described it as a striking species from Burma, Thailand, and Laos. During our expedition, we found it between Nam Sabum and Nam Ti Camp.

Habitat

Plants were found on branches of large trees 50 to 60m high in the primary forest. The branches shade the plants. The plants grow at elevations greater than 1,500masl.

Description

The terete stem is slightly swollen in the middle and 12-18 inches long. The leaves are persistent, at the upper end of the stem. The golden yellow flowers appear near the top of the stem; they are 2 inches across and have a lip with a beard-like appendage. The flowering season is in the period from March to May.

***Epipogium roseum* (Don) Lindl**

Distribution

This species is found in Africa, Asia, Australia, and New Caledonia. In Malaysia, it has been found only once, in the Cameron highlands (Siedenfaden and Wood 1992).

This species has not been recorded in Myanmar before. We found the plant, in flower, between Nam Sabum and Nam Ti.

Habitat

Saprophytic rhizomes are ovoid horizontal tubers. We found the plants inside the ankle-deep grasses in the open sunlight.

Description

The stem is yellowish white and the flowers are white. Many flowers grow from the base of the rhizome. The flower is 1-2 cm long, the lip 1 cm long and the flower bract 1.5 cm long.

Conclusions

We believe that

- there are many new species unrecorded in the orchid world,
- there are some known species that have not yet been recorded in Myanmar, and
- existing known species should be properly surveyed, recorded, and preserved in the interests of biodiversity conservation in this region.

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Rhododendrons Endemic to Myanmar's Snow-capped Mountain Region

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"most of these little-explored forests are still in their natural condition"

Introduction

According to the vegetation pattern, the Myanmar section of the Sino-Himalaya Region and the upper parts of the triangular region between Main Hka, Mai Hka, and Mali Hka can be divided into

- high mountain evergreen forests,
- wet evergreen forests,
- moist deciduous forests and shrub forests,
- high mountain coniferous forests,
- high mountain alpine scrub and rhododendron forest, and
- alpine meadow.

Most of these little-explored forests are still in their natural condition.

Floral Diversity

"in 1954, 120 families of flora comprising 1,000 species of trees, shrubs, herbs, bamboos, and climbers, were listed"

The Sino-Himalayan ecosystem of Hkakaborazi and its surrounding area holds a variety of vegetation, from forest to algae and lichens. In the last botanical survey, which was done in 1954, 120 families of flora comprising 1,000 species of trees, shrubs, herbs, bamboos, and climbers, were listed. Among them, the most dominant families and the numbers of species recorded were Ericacea (8 genera and 200 species); Orchidaceae 84 species (both terrestrial and epiphytic); Musaceae (20 species); Zingiberaceae (14 species); and Areaceae (18 species). The ecosystem also harbours primitive families, such as Magnoliaceae, consisting of small numbers of rare species. At high altitude (2,438m), the occurrence of oak, chestnut, conifers, and magnolia is typical of wet, moist, evergreen forest. An extensive area of tall grasses is also found at high attitude. Orchid ovoids, bird's nest ferns (*A plenum*) and stag's horn ferns (*platyserium*) provide many examples of epiphytes.

"in the tundra climate region (3,000m and higher) stunted conifers, dwarf rhododendrons, *Betula*, juniper, and moss can be found"

In the tundra climate region (3,000m and higher) stunted conifers, dwarf rhododendrons, *Betula*, juniper, and moss can be found. Many other interesting species including those of Cyadaceae, Aquilariaceae, Juglandaceae, Cupressaceae, Cyperaceae, Primulaceae, Rosacea, and Lauraceae are indigenous to this region. The ancient families of Ginkgoaceae and Taxaceae (red pine) are also endemic.

Origin and Distribution of *Rhododendron*

Rhododendrons belong to the Ericacea family. The genus *Rhododendron* is widely distributed throughout the world, mainly in the temperate regions of the northern and southern hemispheres and in tropical regions from sea level to high elevations.

They occur naturally in Europe (Austria and the Swiss Alps), Russia, North America, Japan, Korea, New Guinea, Malaysia (Cameron Highlands), India, (Kashmir, Sikkim, Himalayas, Nilgiris, Assam, Manipura), China (Yunnan, Sezchaun, Kansu), Tibet (Province of Pemako), Myanmar (northernmost Kachin State and Chin Hill), Bhutan, Nepal, Pakistan (Swat Valley, Kaghan Valley, Lahore), and Sri Lanka.

In Myanmar, the estimated 200 species (according to F.K. Ward in 1954) can mostly be found in the areas of Mai-Hka-Thain-Lwin Division, Ngawchaung Valley, Mount Iwaw Bun, Lauk Haung, Myitkyina Plain, Putao Plain, Shangorouit Pass, Maguchi Pass, Zaklang, Adung Valley, and Seinghku Valley. A few can be found in Chin Hill and Shan State; these species occur only in China, Tibet, Nepal, Bhutan, and northern Myanmar. The centre of origin of *Rhododendron* is considered to be the Sino-Himalayan Range, including the Tibet-Myanmar Frontier Range and the China-Myanmar Frontier Range.

The Economic Importance of the Ericacea Family

This family Ericacea is economically important. It incorporates the genus *Gaultheria*; both *G. hookeri* and *G. laxiflora* produce volatile oil, which is used for producing cosmetic and perfumes. Of the *Rhododendron* spp., *R. nitens*, *R. imperator*, *R. forrestii*, *R. chryseum*, and *R. indicum* are famous, and ideal for rock garden landscaping. They are commercially cultivated for ornamental purposes. In the Himalayan ecosystem, a thick cover of this vegetation protects soil from the pelting of the rain and it plays a significant role in limiting erosion.

Some of the most beautiful Myanmar species were introduced to western countries for commercial use by plant hunters of the early twentieth century — such as George Forest and F.K. Ward. Nowadays over 300 new hybrids have been created with the help of plant hunters in the west and east Himalayas and Myanmar.

Rhododendron Species found in Abundance in the Upper Part of Mai-Hka-Mali-Hka Division and Putao Plain

The sub-tropical monsoon and mountain climate, with mean January temperatures below 17°C and occasional frost during winter months, creates luxurious vegetation in the northern mountains.

The Naung Mung area of Putao Plain is built up of highly metamorphous rock (gneiss, quartzite and marble). Precipitation is high (average of 4 to 4.5m per year) and occurs throughout the year. The warm, humid summers and cool winters encourage the following species to proliferate.

Rhododendron simsii Planch

This very common *Rhododendron*, which thrives well on rocky cliffs, can be found in the Putao Plain at an altitude of 411m and is also abundant in Naung Mung Township. It is a small tree about three metres high and its showy flowers are bright carmine red and canducous. The flowering season is from November to March.

"a crooked or gnarled trunk, wrinkled bark, and crimson flowers with short pedicles"

***Rhododendron arboreum* W.W. Smith**

This species is abundant in Naung Mung Township and in Sum-Parabum. It grows at an altitude of 2,133m. It has a crooked or gnarled trunk, wrinkled bark, and crimson flowers with short pedicles. The flowering season is from April to July.

***Rhododendron delavayi* Franch**

This species grows abundantly in Naung Mung Township and Sum-Parabum Township, at altitudes of from 411-2,377m. It is a medium-sized tree, has thick bark with a cork layer underneath, and small, aromatic, scarlet flowers.

***Rhododendron stewartianum* Diels**

This species thrives on the west flank of Malikha River and in the conifer forest beyond Naung Mung Township, at an altitude of 1,707m. It is an evergreen alpine shrub with leaves crowned at the end of the branch and aromatic flowers that are white and rosy pink. The flowering season is from May to June.

***Rhododendron pruniflorum* Hutchinson**

This species is widely distributed on metamorphous rock at an altitude of 1,829m. It can also be found in Khum Lun and in the Putao Plains. It is an alpine shrub with deep red flowers and leaves with an aciculate tip. The flowering season is from November to February.

Rhododendron Species found in the Alpine Forests of Northern and Northeastern Myanmar

"an evergreen alpine shrub with leaves crowned at the end of the branch and aromatic flowers that are white and rosy pink"

At an altitude of 914m and above, this area, which is made up of quartzite, pink-grey marble, quartz-rock, and schist, has a tundra climate with a mean temperature (during the warmest month) of 9°C or less. It is slightly warmer than the permafrost region with much more precipitation, about 203-254 cm per year. The frozen soil melts in summer allowing tree roots to penetrate more deeply and the soil to be more fully developed. Flowering species of *Rhododendron* can be found abundantly in this region.

***Rhododendron sino-grande* Balf. F.K. Ward**

This is a large tree, about 15m high, with flowers of creamy yellow with a purple splash at the bottom of the corolla tube, the shape of the corolla tubes being ventricose campanulate. The flowering season is from May to June. Early specimens were collected at Ngwe-Chaung Valley and Kang Fan.

***Rhododendron pankimense* Cowan and F.K. Ward**

"the frozen soil melts in summer allowing tree roots to penetrate more deeply"

This is a small shrub with showy and aromatic flowers of purple with a black spot at the bottom. The flowering season is from March to August. It can be found in Mai-Thanlwin Division, Ngawchaung Valley, and Adung Valley.

***Rhododendron genestierianum* (rhododendron flower) Forrest**

This evergreen shrub has deep purple, aromatic flowers with a long pedicle. The flowering period is from March to June. This species can be found only in Seinghku Valley.

***Rhododendron oxyphyllum* Franch**

This small tree has aromatic flowers of yellow with a crimson blotch in the throat of the corolla tube. The flowering period is from May to June. This species occurs widely in Nyitadi, Maguchi Pass, and Tama Bum.

***Rhododendron falcineri* Hook**

This small tree has aromatic flowers with a white or yellowish corolla with purple spores at the base within. It grows well in dense thicket on the steep rock faces, especially at Maguchi Pass.

Endangered Species of *Rhododendron* found in the Permafrost Region

The ice-peak climate of northernmost parts of Myanmar at an altitude above 4,200m with a mean temperature of 0°C during the warmest months keeps the surface soil frozen most of the year. In the summer, a few inches of topsoil can thaw. However the rest of the ground remains frozen (permafrost) but a few woody plants can survive. The area is made up of quartz-rich and coarse-grained marble and granule ferrous schist (according to observations made by F.K. Ward in 1949). The red earth is gradually replaced at higher elevations by brown mountain soil and brown mountain meadow soil. Species of *Rhododendron*, when they can be found in this area, are mostly under shrubs and are uncommon. A decrease in population is occurring, due to habitat loss. *Rhododendron* is threatened with extinction in the foothills of the Hkakaborazi Range.

***Rhododendron dendricola* Hutchinson**

This epiphytic rhododendron has showy flowers that are white to pink in colour and aromatic. The leaves are large and silvery brown underneath. The flowering period is from March to May.

***Rhododendron megacalyx* Balf. F.K. Ward**

This shrub has very large, aromatic flowers that are creamy white to pale pink in colour. The leaves are silvery brown underneath. The flowering period is from May to June.

***Rhododendron stenaulum* Balt. F. W.W. Smith**

This small tree has aromatic, deep purple flowers. The corolla tube is salverform and has black spots at the bottom. The capsule is long and narrow.

Rhododendron repens

These are dwarf, evergreen azaleas. The flowers are small, red, and aromatic. The flowering season is from June to August.

Rhododendron imperator

This creeping species clambers over rocks and has small, purple, aromatic flowers. The flowering season is from May to August.

Current Status and Threats to the Survival of Large Mammals in North Myanmar

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Introduction

"this region contains the country's most important watersheds"

Situated between the Indian subcontinent and the south-east Asian peninsula, Myanmar contains an unusual diversity of habitats and life forms. While surveys based on Landsat imagery in the early 1980s indicated a total area of closed and degraded forest at more than 40%, more current estimates put this figure closer to 20% (International Union for Conservation of Nature and Natural Resources [IUCN] 1992). Much of the remaining intact forests are in north Myanmar, a geographic region of more than 64,372 sq.km north of 25° latitude, at the eastern edge of the Himalayas. This region contains the country's most important watersheds, and serves as a key reservoir for Sino-Himalayan biodiversity (Collins et al. 1991).

"up until the 1990s, however, few biological surveys for wildlife had been conducted in the north"

North Myanmar was described as part of the Sino-Himalayan region by F.K. Ward (1944), who felt that effects of Pleistocene glaciating created a unique floral composition influenced primarily by India, the Himalayas, China, and Malaysia. Up until the 1990s, however, few biological surveys for wildlife had been conducted in the north. In 1931, while searching for the source of the Irrawaddy River (Ward 1932), Lord Cranbrook collected several hundred bird and mammal specimens north of 27° 30'. A few years later, specimen-collecting expeditions were carried out to the Upper Chindwin (Morris 1936), and along the Yunnan border (Stanford 1940). The first attempt at a systematic survey of the status of wildlife and recommendations for their protection throughout parts of Myanmar was in 1959 by Milton and Estes (1963) who got as far north as the Chaukan Pass along the border with Assam.

Recent wildlife surveys

"the first, Pidaung Wildlife Sanctuary (25° 15'-25° 35' N, 97° 04'-97° 28' E), was protected in 1913"

Since 1994, the authors have conducted seven trips to north Myanmar to survey wildlife, assess the status of protected areas, and investigate new sites for designation as parks or sanctuaries. Until 1996, only two protected areas existed north of 25° 02' latitude in Myanmar. The first, Pidaung Wildlife Sanctuary (25° 15'-25° 35' N, 97° 04'-97° 28' E), was protected in 1913 primarily for large mammals such as elephant (*Elephas maximus*), gaur (*Bos gaurus*), tiger (*Panthera tigris*), leopard (*Panthera pardus* [common leopard]), and bears (*Ursus* sp.). However, between 1939 and 1957, elephants declined more than 75%, while tigers, leopards, and bears declined 83-90% in Pidaung (Estes and Kimlai 1964). When the

authors visited the sanctuary in 1995, and again in 1997, much of the original habitat was degraded and there was no evidence of any large wildlife population remaining in the sanctuary.

The second protected area in the region, Tamanthi Wildlife Sanctuary, was established in 1974 along the Upper Chindwin River, primarily for the protection of Sumatran rhinoceros (*Dicerorhinus sumatrensis*), and other species of large wildlife (Hundley 1952). A survey by the first author there in 1994 found no evidence of rhinos surviving in the sanctuary, and other species of large mammals, such as tiger and gaur, were at unusually low densities due to poaching pressures (Rabinowitz et al. 1995). Between 1995 and 1997, three survey expeditions were conducted in the Putao and Naung Mung Townships (Putao District) above 27° latitude. The most extensive of these trips, in the vicinity of Mount Hkakaborazi, resulted in the discovery of three new large mammal species for the country — blue sheep (*Pseudois nayaur*), black muntjac (*Muntiacus crinifrons*), and stone marten (*Martes foina*), and one new species for science, the leaf muntjac (*Muntiacus putaoensis*) (Rabinowitz and Khaing 1998; Amato et al. 1999; Rabinowitz et al. in press). New range extensions were documented for the golden jackal (*Canis aureus*) and the Malayan sun bear (*Ursus malayanus*).

The discovery of the black muntjac, which had been sought by the Vernay-Cutting Expedition in 1938 but never found, established the presence of the only other sizeable population of this species outside of south-east China, more than 1,609 km away (Rabinowitz et al. 1998). In addition, the survey documented probably one of the largest remaining populations of the rare red goral (Rabinowitz 1999), a species only first described early this century (Pocock 1914). This survey, and a second one conducted a year later in the Naung Mung Township between Putao and the Nam Tamai, indicated that the region north of Putao still contained good populations of most wildlife species, and was a transition zone between the tropical Indo-Malaysian faunal communities of the south and the temperate and alpine Sino-Himalayan fauna from the colder north. The large mammal species that had been extirpated from this area included tigers, elephants, rhinos, and most gaur. The Nam Tamai River seemed to be a natural barrier restricting certain fauna, such as Hoolock's gibbon (*Hylobates hoolock*), leaf muntjac, and sambar deer (*Cervus unicolor*) to the south of the river and black muntjac and red goral (*Naemorhedus cranbrooki*) to the north of the river. Partly as a result of these surveys, the government gazetted Mount Hkakaborazi National Park in 1998; 2,369 sq.km of mountainous area bordered by the Nam Tamai branch of the Mai Hka in the south and the border with China in the north. Mount Hkakaborazi is a true Himalayan park, containing populations of musk deer (*Moschus moschiferous*), red panda (*Ailurus fulgens*), takin (*Budorcas taxicolor*), red goral, black muntjac, and blue sheep. In 1999, an expedition was carried out to the Hukaung Valley, along the old Ledo (or Stilwell) Road between Myitkyina and the border with Assam (26-27° N, 96-97° E). This area, long known for its large wildlife such as rhinos and tigers, was still unadministered and wild as late as 1933. But this changed during World War II when a supply road for the Allies was built through the Hukaung Valley. Today, the road is abandoned and large areas of the Hukaung Valley remain uninhabited, still containing most of the characteristic wildlife species for the area, except rhinos. In September 1999, a 2,500 uninhabited piece of the Hukaung Valley was formally recommended to the government as the Hukaung Valley Wildlife Sanctuary.

Hunting and trade of wildlife in north Myanmar

The loss and degradation of forest habitat has been an important factor in the decline of large mammals throughout central Myanmar (McShea et al. 1999). In north Myanmar, however, it is hunting of wildlife for sale or trade that is the overwhelming threat to the future survival of many wildlife species, particularly large mammals. In all areas visited by the authors, hunters were

"the Lisu are known as the most dedicated hunters in north Myanmar"

targeting particular species whose parts were valued by traders. In Tamanthi Wildlife Sanctuary, Lisu from Putao Township were encountered hunting otter, tiger, and gaur which they sold to traders from China, or carried across the border themselves (Rabinowitz et al. 1995). In the Hukaung Valley, Lisu were again reported to be the main hunters penetrating some of the more remote areas after tiger and gaur. While most of the different ethnic groups hunt to varying degrees, the Lisu are known as the most dedicated hunters in north Myanmar, and even across the border into China (Ma et al. 1995). Throughout the lower regions of north Myanmar, particularly in the more rugged border areas, tigers, elephants, and gaur still existed only in small pockets and at relatively low densities. Around the town of Putao, and all areas north that were visited, all three of these species were extirpated (Rabinowitz 1998). Even in the Gaoligongshan Mountain region along the Myanmar-China border recent surveys found no evidence of tigers, elephants, or rhino, and evidence of only a possible few scattered gaur in the mountains, all of which were species that had historically occurred in the area (Ma et al. 1995). Our most extensive hunting and trade data came from our expeditions to the Putao District. Table 13 lists 33 mammal species that were found being sold in the Putao markets, or were killed in villages north of Putao for sale to traders. Table 14 lists the range of prices that villagers claimed they would get for particular animal parts desired by wildlife traders. While the most valuable and sought after species were musk deer for its musk gland, bear for its gall bladder, otter for its skin and penis, and pangolin (*Manis pentadactyla* [Chinese pangolin]) for its scales, the most frequently killed species were red goral and barking deer, followed by takin, serow (*Naemorhedus sumatraensis*), and red panda. Leopards and otter were now said to be very rare in the region due to hunting pressures, although one hunter killed and sold a leopard (skin and bones) in 1995 to a trader from Putao for 12,000 kyats*.

"the most frequently killed species were red goral and barking deer"

Hunting was carried out by local people using a variety of methods, the most common being a locally made crossbow with arrows dipped in poison from a local plant. Snares were commonly used for deer, while jaw traps brought over from China, or bamboo spear traps, were sometimes used for larger species such as bears. Home-made black powder rifles were rarely seen north of Putao. Hunting was mostly carried out by Rawan and Lisu people and, to a somewhat lesser extent, Myanmar-Tibetans in the far north. However the Rawan were said to be good at trading, while the Lisu were the better hunters. Rawan and Lisu from China also reportedly crossed the border hunting in small groups of 3-6 individuals along the mountainous border areas. In the lower elevation areas between the town of Putao and the border of Hkakaborazi National Park, hunting occurred throughout the year, but the majority was from June through January. The months of February through May were occupied with plantation making, and hunting was mostly restricted around the plantation area. In the higher elevations of Hkakaborazi National Park, hunting usually took place

"hunting was carried out by local people using a variety of methods, the most common being a locally made crossbow with arrows dipped in poison from a local plant"

* There are 425 kyats to a US dollar.

Table 13: Wildlife species found for sale or killed by local people in Putao markets and in villages north of Putao

Wildlife species	Putao markets	Naung Mung area	Hkakaborazi National Park
CERVIDAE (antlers and skins)*			
Leaf muntjac		X	
Black muntjac			X
Common muntjac	X	X	
Sambar deer	X	X	
MOSCHIDAE (musk gland)*			
Musk deer			X
AILUROPODAE (skin)*			
Red panda			X
HYLOBATIDAE (bones and skin)*			
Hoolocks gibbon	X	X	
CERCOPITHECIDAE (bones and skin)*			
Phayres langur	X	X	
Assamese macaque		X	X
URSIDAE (skins)*			
Asiatic black bear		X	X
Malayan sun bear		X	
VIVERRIDAE (skins)*			
Large Indian civet		X	
Common palm civet		X	
Otter (penis)*			
BOVIDAE (skins and horns)*			
Serow	X	X	X
Red goral	X		X
Blue sheep	X		
Takin	X	X	X
MUSTELIDAE (skins)*			
Back-striped weasel		X	X
Stone marten			X
Yellow-throated marten		X	X
Ferret badger		X	
HYSTRICIDAE (skins)*			
Porcupine	X	X	X
MANIDAE (scales)*			
Pangolin	X	X	
SUIDAE (meat and tusks)*			
Wild boar	X	X	
FELIDAE (skins and bones)*			
Tiger	X		
Clouded leopard		X	
Marbled cat		X	
Golden cat		X	
Leopard cat		X	X
CANIDAE			
Wild dog (dhole)		X	
Asiatic jackal	X		
PTEROMYIDAE			
Flying squirrel			X

*Animal parts in parentheses represent those parts most desired by traders

[1]During 1997 survey US $1 = 163 kyats and during 1998 survey US $1 = 246 kyats

[2]1 lb = 27 tical; 1 viss = 100 ticals

Table 14: Trade prices for wildlife products from 1997-1998 survey expeditions to Putao and Naung Mung Townships

Species	Animal part used	Price range	Unit
Musk deer	musk gland	8,000-30,000	kyats/tical
Red goral	Skin	200-1,000	kyats
	Horn	50	kyats
Takin	Horn	3000-8,000	kyats
Red panda	Skin	150-500	kyats
Serow	Skin	1,000-2,000	Kyats
	Horn	100-300	kyats
Barking deer	Skin	200	kyats
	Horn	50-100	kyats
Himalayan black bear	gall bladder	5000-8000	kyats/tical
	Paws	50	kyats
Otter	Skin	10,000-15,000	kyats/foot of skin
Pangolin	Scales	7000-8000	kyats/vis
Sambar deer	Skin	800	kyats
	Antlers	150-200	kyats
Flying squirrel	gall bladder	500-600	Kyats

[1]During 1997 survey US $1 = 163 kyats and during 1998 survey US $1 = 246 kyats
[2]1 lb = 27 tical; 1 viss = 100 ticals

"local traders also came from Putao, Naung Mung, and Khaunglanphu Townships, from where many of the wildlife parts are sent into China"

from June-September, sometimes extending into October and November. This also corresponded with the period when most of the traders came from China, since the high mountain passes were closed from November through May. Local traders also came from Putao, Naung Mung, and Khaunglanphu Townships, from where many of the wildlife parts are sent into China. While many of the wildlife parts were valued for medicinal purposes, barking deer skins were valued as material for leather jackets, and were often sent to Mandalay.

At the height of the season, as many as 30 traders per month were reported coming through some villages. Local people usually traded wildlife, baskets, and some medicinal herbs for cooking utensils, salt, tea, soap, and clothes. The most sought-after species in the high altitudes of the far north is musk deer. The musk trade dates back centuries (Green 1978) and this animal is considered well on its way to extinction (Oza 1988). Local people have long developed sophisticated methods of trapping this deer with snares made from local materials (Wallace 1913), a practice still reported in north Myanmar. Because of the value of this species, villages in Hkakaborazi National Park claim to have traditional musk deer-hunting areas, which are known and respected among the villages. Since only the males contain the valuable musk, females are killed for their meat. Some villages still claimed an annual off-take of 15-20 musk deer, although all say that musk deer have become scarcer in recent years.

"since only the males contain the valuable musk, females are killed for their meat"

Summary

The outlook for wildlife in many parts of the Himalayas is grim (Ranjitsinh 1995). The Himalayan fur trade, despite having declined in recent years, still exists (Heinen and Leisure, 1993), while the demand for wildlife parts

used for traditional medicine practices by the Chinese has increased (Rabinowitz 1998). Even in remote regions of south-east Tibet, where there are still extensive forests and relatively low human population densities, hunting pressures have adversely affected most wildlife populations (Jiang and Bleisch 1996). Although Myanmar joined the convention on international trade in endangered species of wild fauna and flora (CITES) in 1997, the trade in wildlife parts within the country and across the border to neighbouring countries continues to thrive (Martin 1997) and is a driving force behind declining wildlife numbers. In a bear bile production centre in China visited by the second author, most of the bears were said to come from Myanmar. Myanmar is becoming increasingly faced with the empty forest syndrome (Redford 1992), where there are large areas of seemingly suitable forest habitat remaining which are devoid of most of the larger wildlife species.

The situation is becoming increasingly desperate because many of Myanmar's neighbours, which have already overexploited their own resources, are now looking to exploit the last remaining pockets of forest and wildlife resources in Myanmar. However, the fact that large areas of north Myanmar are still intact and contain their characteristic diversity of many large mammal species, albeit at lower than normal densities, still gives hope for the future.

Conclusions

North Myanmar is one of the most important and biologically diverse regions of the country. It contains the headwaters of most of the major river systems in Myanmar, and it is a transition zone between the tropical Indo-Malayan fauna and flora from the south, and the temperate and alpine Sino-Himalayan fauna and flora from the north. Much of north Myanmar is still relatively sparsely populated and contains good areas of forest and other habitats. In the newly designated Hkakaborazi National Park, Himalayan species such as takin, musk deer, red goral, and red panda still abound, although in lower numbers than in the past. Still, Hkakaborazi might have some of the best populations of black barking deer and red goral in the world. In addition to the new leaf muntjac that was discovered in the transition zone south of the park, it is likely that the geographic isolation of Hkakaborazi Park will lend itself to more biological discoveries in the future. However, the problem is that hunting is omnipresent throughout this region, particularly by certain ethnic groups like the Lisu, who target particular species and help maintain a thriving trade in wildlife parts to cities like Mandalay and across the border into China. Certain species like tiger, elephant, and gaur are already at critically low numbers in this region because of hunting.

Rhinos appear to be already extinct from the region. Himalayan species within the new Hkakaborazi Park are also being continually hunted for a thriving cross-border trade with China. Existing and proposed protected areas like Tamanthi, Hkakaborazi, and Hukaung Valley are excellent, intact habitats which can preserve much of the region's biodiversity if properly managed and protected. At least several more protected areas should be established in the north, as well as a strategy of buffer zone management for areas outside these protected sites. Above all, the illegal trade in wildlife parts must be stopped, or, at least, brought under government control. In particular, free access across the Myanmar border by Chinese traders should be stopped. The continued degradation of north Myanmar's resources not only threatens the future biological wealth of the country, but could also threaten the abundant water resources that emanate from this region.

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Birds Recently Sighted in Hkakaborazi Region, Northern Myanmar

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Introduction

Hkakaborazi region is a narrow strip of the western escarpment of Yunnan Province in China, once part of a continuous land formation comprising the Tibetan Plateau to the east (Kingdon-Ward 1944). At the most northern extremities of Myanmar is a sparsely populated, little-explored region that is generally referred to as the icy mountains —containing some lesser-known Himalayan peaks, including Mount Hkakaborazi, estimated at 5,881m high (Figure 9).

Designated as a protected area in 1996, the Ministry of Forestry declared the area north of the Nam Tami River to the Chinese border as Hkakaborazi National Park in 1998 (Figure 9) and submitted a proposal for upgrading Hkakaborazi to the status of a World Natural Heritage site to the United Nations Educational, Scientific and Cultural Organization (UNESCO).

This report is the outcome of data collected during two surveys that were carried out by biological expeditions of Myanmar Forest Department supported by the Wildlife Conservation Society, New York.

Objectives

- To assess the presence and distribution of avifauna
- To find unrecorded bird species and Sino-Himalayan bird species
- To make recommendations for the active management and protection of Hkakaborazi National Park.

Methods

The data on bird presence were obtained by observations with binoculars and telescopes, netting with mist nets, and examination of hunters' kills in villages. In March / April 1997, we travelled and observed birds on the main trail from Putao to Rasang Camp (28° 19' N, 97° 39' E) (Figure 9). A second bird survey was carried out between 25 April and 24 May 1998, and started at Putao Town. We walked and observed birds along the main trail to Gawle via Naungmon Town and back to Putao via Babaw and Machanbaw. During this survey, mist netting was carried out in the Nanhti Camp and Naungmon Town areas.

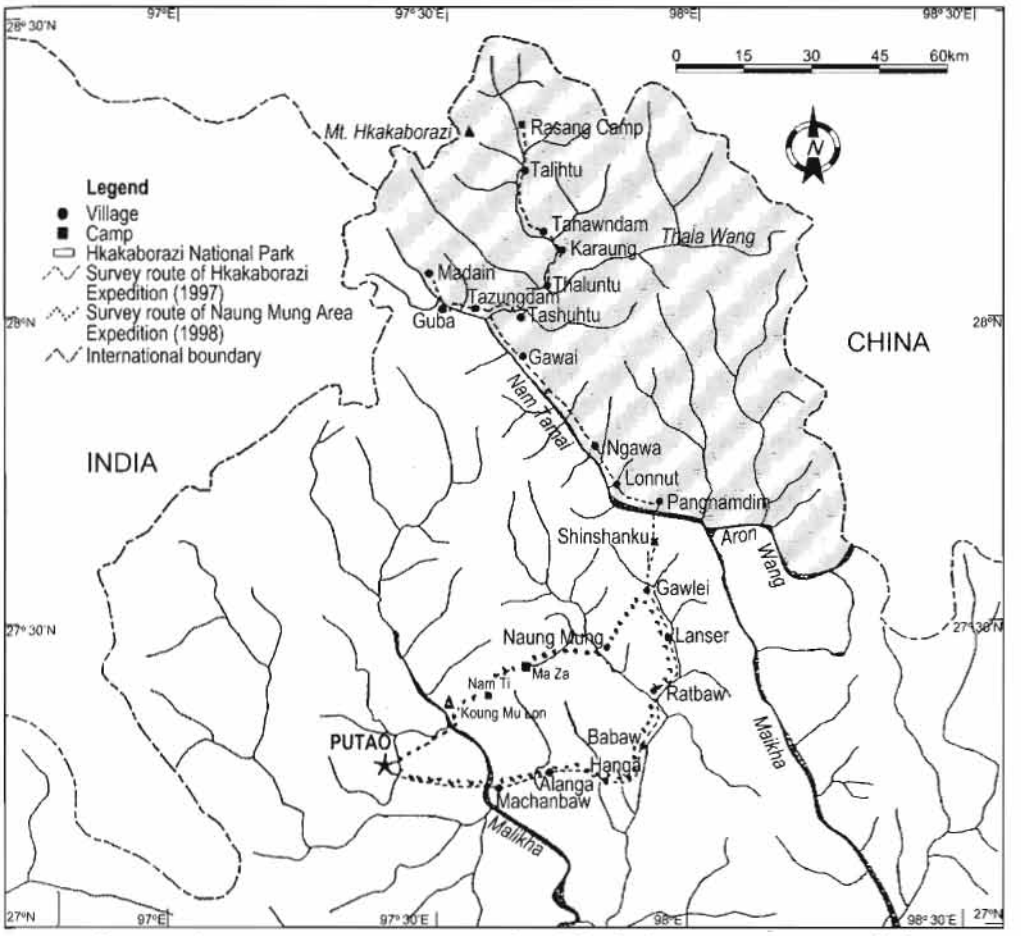

Figure 9: **North Myanmar showing the Khakaborazi Protected Area (shaded), survey route and villages visited during the 1997 and 1998 expeditions**

Survey Route

Between 2 March and 13 April 1997, the first bird survey was carried out by a biological expedition of Myanmar Forest Department into far northern Myanmar, starting at the town of Putao (27° 16' N, 97° 24' E) and reaching as far north as Rasang Camp (28° 19' N, 97° 39' E) (Figure 9). For the purpose of bird watching, nearly 290 km were covered. During the second bird survey, we travelled from Putao and observed birds on the main trail. We also set up the bird netting (for detailed identification) at two places (Nanhti and Natmgmon).

Results

A quick assessment of bird presence and distribution was made during the two bird surveys; the total bird count was 160 species and out of that 33 Himalayan species were recorded. Although the presence of many species of birds is expected in this area, a lower number than expected was recorded due to the weather conditions and time limitations. Two white georgette flycatchers, one grey-cheeked fulvetta and one golden babbler were captured in two days by mist netting in Nanhti Camp. One active nest of wreathed hornbill was seen 2.4 km away from

Nanhti Camp. One blue-rumped pitta captured in a snare was seen near the cultivated area near Nanhti Camp. Three red-vented bulbul, two oriental white-eye, four grey-cheeked Fulvetta, one common tailorbird, one red-whiskered bulbul, and one puffthroated babbler were netted in three days near Naungmon Town. One red-whiskered bulbul nest with three eggs was found near Naungmon and one greater-coucal nest with three eggs was found by the stream near Gawle. One (live) captured kalij pheasant was seen in Alanga Village. During the survey, the songs of the large hawkcuckoo, the great barbet, the golden-throated barbet, and the blue-throated barbet were heard every day. Although there are many wetland habitats including streams, rivers, and lakes, no migratory birds were found during the survey. Although their habitats are still in good shape, few birds of prey and hornbill species were seen, presumably because it was their breeding season.

Discussion

The Hkakaborazi region is the only place that contains Sino-Himalayan subtropical forests and Sino-Himalayan temperate forests, which provide habitats for Sino-Himalayan avifauna. From the two surveys in 1997 and 1998, we were able to identify 33 Himalayan species that indicated it was a transition zone between the Indo-Malayan and Sino-Himalayan region. Although few bird species were recorded during the survey, considerable numbers of threatened species were listed (Appendix 1). There was no evidence of migratory birds in the wetland habitats, which might be explained by the fact that the survey was carried out of the migratory season, which is between mid-October and late March. Although there was no illegal bird trade in the region, large species such as birds of prey and hornbill were shot by crossbow and some birds that live on the ground, such as pitta pheasant, were captured by snares for subsistence purposes.

Hkakaborazi National Park adjoins the neighbouring countries of India and China. We therefore need to cooperate with them in transboundary conservation matters.

Recommendations

- A systematic ornithological survey should be carried out to study the presence and abundance of existing bird species.
- The endangered, endemic, Himalayan bird species should be categorised and the Hkakaborazi region should be designated an 'important bird area for biodiversity conservation'.
- Detailed identification of avifauna should be conducted and the species so far unrecorded should be studied.

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Appendix 1: Birds recorded in the Hkakaborazi region

S. No.	English Name	Scientific Name	Status	Putao (1342')	Namti (2050')	Naungmon (1798')	Gawlei (2200')	Alanga (1520')	Babaw (1700')	Pangnandim (3670')	Tazungdam (4730')	Tahundam (6300')
1	Little heron	*Butorides striatus*	CR			X	X	X				
2	Black stork	*Ciconia nigra*	R				X					
3	Black kite	*Milvus migrans*	R		X	X	X		X		X	X
4	Crest serpent-eagle	*Spilornis cheela*	CR		X	X	X		X		X	X
5	Pied harrier	*Circus melanoleucos*	R			X						
6	Northern hobby	*Falco subbuteo*	F			X						
7	Rufous-throated partridge	*Arborophila rufogularis*	R							X		
8	Blood pheasant*	*Ithaginis cruentus*	R									X
9	Himalayan menal	*Lophophorus impejanus*	R									X
10	Kalij pheasant*	*Lophura leucomelanis*	R				X	X				
11	Common pheasant	*Phasianus colchicus*	R				X					
12	Red jungle fowl	*Gallus gallus*	CR			X	X	X				
13	Grey peacock-pheasant	*Polyplectron bicalcaratum*	R		X	X	X	X	X			
14	Red-wattled lapwing	*Vanellus indicus*	CR			X	X	X	X			
15	Ibisbill*	*Ibidorhyncha struthersii*	M									
16	Pintailed pigeon*	*Treron apicauda*			X	X	X	X				
17	Green imperial pigeon	*Ducula aenea*	R		X	X	X	X		X		
18	Mountain imperial pigeon*	*Ducula badia*	R		X	X	X	X				
19	Spotted dove	*Streptopelia chinensis*	CR	X	X	X	X	X	X	X		
20	Oriental turtle-dove	*Streptopelia orientalis*	R	X			X		X		X	
21	Emerald dove	*Chalcophaps indica*	R				X			X		
22	Red-breasted parakeet	*Psittacula alexandri*	R							X		
23	Large hawkcuckoo*	*Cuculus sparveriodes*	R	X	X	X	X	X				
24	Indian cuckoo	*Cuculus micropterus*	RM	X	X	X	X	X				

Appendix 1 Cont.....

25	Plaintive cuckoo	*Cacomantis merulinus*	CR	X	X	X	X	X				
26	Drongo cuckoo	*Surniculus lugubris*	R/M	X	X	X	X	X				
27	Greater coucal	*Centropus sinensis*	CR	X		X	X	X				X
28	Chestnut-winged cuckoo	*Clamator coromandus*	R/M				X	X	X			
29	Mountain scopsowl *	*Otus spilocephalus*	CR			X	X	X				
30	Himalayan swiftlet *	*Collocalia brevirostris*	R			X	X					
31	Asian palm-swift	*Cypsiurus balasiensis*	CR	X	X	X	X	X				
32	Red-headed trogon	*Harpactes erythrocephalus*	R				X	X				
33	Common kingfisher	*Alcedo atthis*	CR			X	X			X		
34	White-throated kingfisher	*Halcyon smyrnensis*	CR				X	X	X			
35	Black-capped kingfisher	*Halcyon pileata*	R				X					
36	Common hoopoe	*Upupa epops*	R	X	X			X	X		X	X
37	Rufous-necked hornbill	*Aceros nipalensis*	R	X	X	X	X					
38	Wreathed hornbill	*Aceros undulatus*	R		X		X					
39	Oriental pied hornbill	*Anthracoceros albirostris*	R	X					X			
40	Great hornbill	*Buceros bicornis*	R		X	X	X	X			X	
41	Great barbet	*Megalaima virens*	R		X	X	X	X	X			
42	Golden-throated barbet	*Megalaima franklinii*	R		X	X	X	X	X			
43	Blue-throated barbet	*Megalaima asiatica*	CR	X	X	X	X	X	X			
44	Greater yellownape *	*Picus flavinucha*	R				X	X				
45	Himalayan goldenback *	*Dinoplum shorii*	R						X			
46	Common goldenback	*Dinopium javanense*	CR		X		X					
47	Grey-capped woodpecker	*Picoides canicapillus*	R				X					
48	Long-tailed broadbill*	*Psarisomus dalhousiae*	R				X					

Appendix 1 Cont.....

49	Rusty-naped pitta	*Pitta oatesi*	R		X							
50	Blue-rumped pitta	*Pitta soror*	R		X							
51	Barn swallow	*Hirundo rustica*	M	X								
52	Nepal housemartin	*Delichon nipalensis*	F				X					
53	Large woodshrike	*Tephrodornis gularis*	CR			X	X	X				
54	Rosy minivet	*Pericrocotus roseus*	R		X		X	X				
55	Long-tailed minivet	*Pericrocotus ethologus*	R	X	X	X	X	X			X	
56	Scarlet minivet	*Pericrocotus flammeus*	CR	X	X	X	X	X	X			
57	Common iora	*Aegithina tiphia*	CR									X
58	Orange-bellied leafbird*	*Chloropsis hardwickii*	R				X	X	X			
59	Black-crested bulbul	*Pycnonotus melanicterus*	CR				X					
60	Red-whiskered bulbul	*Pycnonotus jocosus*	CR	X	X	X	X	X	X	X		
61	Red-vented bulbul	*Pycnonotus cafer*	R	X	X	X	X	X	X			
62	Black bulbul	*Hypsipetes leucocephalus*	R		X	X	X	X	X			
63	White-throated bulbul*	*Alophoixus flaveolus*	R				X	X	X			
64	Mountain bulbul	*Hypsipetes mcclellandii*	CR		X		X					
65	Black drongo	*Dicrurus macrocercus*	CR	X	X	X	X	X	X			
66	Ashy drongo	*Dicrurus leucophaeus*	CR	X	X	X	X	X			X	
67	Bronzed drongo	*Dicrurus aeneus*	CR		X	X	X	X	X			
68	Spangled drongo	*Dicrurus hottentottus*	CR				X	X	X			
69	Greater racket-tailed drongo	*Dicrurus paradiseus*	CR		X		X	X		X		
70	Maroon oriole*	*Oriolus traillii*	R		X	X	X	X	X			
71	Asian fairy bluebird	*Irena puella*	CR		X							
72	Green magpie*	*Cissa chinensis*	R	X								

Appendix 1 Cont.....

73	Rufous treepie	*Dendrocitta vagabunda*	R			X		X	X			
74	Grey treepie	*Dendrocitta formosae*	R	X	X	X	X	X	. X			
75	Collared treepie*	*Dendrocitta frontalis*	R			X	X	X	X			
76	House crow	*Corvus splendens*	R			X						
77	Large-billed crow	*Corvus macrorhynchos*	CR		X		X	X	X			
78	Collared crow	*Corvus torquatus*	R								X	
79	Sultan tit*	*Melanochlora sultanea*	R		X			X	X			
80	Great tit	*Parus major*	R								X	X
81	Yellow-cheeked tit*	*Parus spilonotus*	R								X	
82	Chestnut-vented nuthatch*	*Sitta nagaensis*	R				X					
83	Chestnut-bellied nuthatch	*Sitta castanea*	R					X				
84	Velvet-fronted nuthatch	*Sitta frontalis*	R					X	X			
85	Brown dipper*	*Cinclus pallasii*	R		X		X					
86	Puff-throated babbler	*Pellorneum ruficeps*	CR			X		X				
87	White-browed scimitar-babbler*	*Pomatorhinus schisticeps*	CR					XX				
88	Golden babbler	*Stachyris chrysaea*	R		X		X		X		X	
89	Grey-throated babbler	*Stachyris nigriceps*	R		X							
90	White-necked babbler	*Stachyris leucotis*	R		X			X				
91	White-crested laughing thrush	*Garrulax leucolophus*	CR		X	X	X	X	X			
92	Red-tailed laughing thrush	*Garrulax milnei*	R									X
93	Greater necklaced laughing thrush	*Garrulax pectoralis*	R		X	X		X	X			
94	Chestnut-backed laughing thrush	*Garrulax nuchalis*	R			X						
95	Silver-eared mesia*	*Leiothrix argentauris*	R		X	X	X	X	X			
96	Cutia*	*Cutia nipalensis*	R		X		X	X				

Appendix 1 Cont.....

97	Grey-cheeked fulvetta	*Alcippe mornisonia*	CR		X							
98	Nepal fulvetta	*Alcippe nipalensis*	CR		X							
99	Long-tailed sibia	*Heterophasia picaoides*	R		X	X	X	X	X			
100	Rufous-vented yuhinia	*Yuhina occipitalis*	R		X							
101	Black-chinned yuhinia*	*Yuhina nigrimenta*	R		X							
102	Orange-flanked bush-robin	*Tarsiger cyanarus*	F								X	X
103	Oriental magpie robin	*Copsychus soularis*	CR	X	X	X	X	X	X			
104	White-rumped shama	*Copsychus malabaricus*	CR		X						X	
105	Daurian redstart	*Phoenicurus auroreus*	-			X						X
106	Plumbeous water redstart	*Rhyacornis fuliginosus*	R				X			X	X	
107	Slaty-backed forktail	*Enicurus schistaceus*	R				X					
108	White-crowned forktail	*Enicurus leschenaulti*	R		X			X				
109	Stonechat	*Saxicola torquata*	R							X	X	X
110	Grey bushchat	*Saxicola ferrea*	R									X
111	River chat	*Thamnolaea leucocephala*	R					X				
112	Blue rock thrush	*Monticola solitarius*	-	X								
113	Blue whistling thrush	*Myophonus caeruleus*	CR&M				X					
114	Chestnut thrush	*Turdus rubrocanus*	M				X		X			
115	Dusky warbler	*Phylloscopus fuscatus*	CM					X	X			
116	Greenish warbler	*Phylloscopus trochiloides*	M							X	X	X
117	Striated grassbird	*Megalurus palustris*	R					X	X		X	X
118	Hill prinia	*Prinia atrogularis*	R								X	X

Appendix 1 Cont.....

119	Common tailorbird	*Orthotomus sutorius*	CR			X		X				
120	Dark-necked tailorbird	*Orthotomus atrogularis*	CR	X		X		X	X			
121	Mountain tailorbird	*Orthotomus cuculatus*	R					X			X	
122	Slaty-bellied tesia	*Tesia olivea*	R		X							
123	Chinese bush warbler	*Bradypterus tacsanowskius*	M			X						
124	Asian brown flycatcher*	*Muscicapa dauurica*	CM				X					
125	Rufous-gorgetted flycatcher	*Ficedula strophiata*	R		X							
126	White-gorgetted flycatcher*	*Ficedula monileger*	R		X	X						
127	Little pied flycatcher	*Ficedula westermanni*	F					X				
128	Blue-throated flycatcher	*Cyornis rubeculoides*	R		X	X		X	X			
129	Hill blue flycatcher	*Cyornis banyumas*	F		X							
130	Grey-headed canary flycatcher	*Culicicapa ceylonensis*	CR		X	X	X					
131	Rufous-bellied niltava*	*Niltava sundara*	R									X
132	Yellowbellied fantail	*Rhipidura hypoxantha*	R								X	
133	White-throated fantail	*Rhipidura albicollis*	CR		X	X						
134	Black-naped monarch	*Hypothymis azurea*	CR		X							
135	Asian paradise flycatcher	*Tersiphone paradisi*	R		X			X				
136	White wagtail	*Motacilla alba*	CM	X	X	X	X	X	X	X	X	X
137	Grey wagtail	*Motacilla cinerea*	M	X						X		X
138	Yellow wagtail	*Motacilla flava*	M	X			X					
139	Yellowhooded wagtail or citrine wagtail	*Motacilla citreola*	M				X					
140	Richard's pipit	*Anthus richardi*	CR	X				X	X			

Appendix 1 Cont....

141	Ashy woodswallow	*Artamus fuscus*	CR	X								
142	Brown shrike	*Lanius cristatus*	M			X	X	X				
143	Burmese shrike	*Lanius collurioides*	R	X		X	X					
144	Grey-backed shrike*	*Lanius tephronotus*	M	X				X				
145	Long-tailed shrike	*Lanius schach*	R	X	X		X					
146	Chestnut-tailed starling	*Sturnus malabaricus*	R	X	X							
147	Common myna	*Acridotheres tristis*	CR	X		X	X	X	X			
148	Collared myna	*Acridotheres albocinctus*	R	X								
149	Purple sunbird	*Nectarinia asiatica*	R					X	X			
150	Green-tailed sunbird*	*Aethopyga nipalensis*	R			X						X
151	Black-throated sunbird*	*Aethopyga saturata*	R					X			X	
152	Crimson sunbird	*Aethopyga siparaja*	R	X				X				
153	Streaked spiderhunter*	*Arachnothera magna*	R		X		X		X			
154	Plain flowerpecker	*Dicaeum concolor*	R				X	X				
155	Oriental white-eye	*Zosterops palpebrosus*	R	X	X			X				
156	Eurasian tree sparrow	*Passer montanus*	CR	X		X		X	X			
157	House sparrow	*Passer domesticus*	R			X	X		X			
158	White-rumped munia	*Lonchura striata*	R	X				X	X			
159	Scaly-breasted munia	*Lonchura punctulata*	R			X						
160	Crested bunting	*Melophus lathami*	R									X

* = Himalayan species; R = resident; CR = common resident; F = found, M = migrant

Note: 38 Himalayan species out of 160 recorded during 2 survey trips (Hkakaborazi Expedition 1997 and Naungmung Expedition 1998)

Socioeconomic and Cultural Conditions of Ethnic Communities in Hkakaborazi National Park

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Introduction

Hkakaborazi region is recognised as one of the richest areas in the world in terms of biological resources. For this reason, a biological expedition was sent to this region to carry out a detailed survey on different aspects. The expedition team included four foresters, three zoologists, two botanists, two surveyors, one hiker, and one geographer. This paper resulted from a very adventurous and risky journey to the northernmost part of Myanmar.

Geographical Background of the Study Area

Location

Hkakaborazi National Park is situated in the northernmost part of Myanmar, which is a mountainous region of northern Kachin State (see map in Appendix 1 of 'An Introduction to Myanmar Native Orchids of The Hkakaborazi Area' by Saw Lwin, this volume). It lies between north latitudes 27° 35' and 28° 29', and between east longitudes 97° 18' and 98° 15'. Hkakaborazi National Park is included in the Naung Mung Township of Putao District, Kachin State. It is bounded by India in the west and by China in the north and east. The southern boundary is demarcated along the Nam Tamai River and Taron River.

Geology

The northern part of Kachin State includes the largest tectonic unit in Myanmar. This region is underlain by consolidated, partially low-grade metamorphic, Paleozoic, and Mesozoic sediments and its substratum consists of Pre-Cambrian crystalline rocks. Cretaceous sediments occur chiefly in the western part of this tectonic region, while Late Tertiary and Quaternary sequences surround its western marginal area and form the filling of intermontane basins.

Geomorphology

A mountainous region of Hkakaborazi National Park is situated in the northern part of Myanmar. It partially belongs to the Tibetan Plateau of China. In the extreme north-west regions, it is made up of ranges that flank the Himalayan mountain system, with very high altitudes and steep slopes. The north-eastern fringe of Myanmar consists of valleys and ridges trending from north to south owing to compression forces in between the high ridges. The mountain ranges that run along the Chinese and Indian borders have high altitudes of over 3,048masl. The highest peaks of Myanmar are all in this northernmost mountainous region and they are all covered by snow, as the snow line in the area is about 4,724m. The highest peak is the well-known Hkakaborazi (28° 18' N, 97° 25' E) (5,881m). Other notable high peaks in the area are Ta Hta Razi (28° 18' N, 97° 25' E) (5,203m), Sheankala Razi (28° 22' N, 97° 44' E) (5,463m), and Dindaw Razi (28° 22' N, 97° 44' E) (5,463m). All these mountain peaks are

"there are many tributaries of mountain streams that flow into the Seinghku Wang and Adung Wan. The most prominent have a dendritic pattern reflecting the geologic structure"

covered with perpetual snow and ice. So they are known as the 'icy mountains'.

The mountains in Hkakaborazi National Park are composed of several branches rather than a single range. The average altitude of these ranges is about 3,048m and they have steep slopes and escarpments. Some escarpments have a dip of nearly 90°. Extensive fluvial plains are almost absent, with only narrow plains alongside the mountain streams. The mountains trend from north to south, and get gradually lower southwards. The slopes of the mountains are steeper in the north than in the south.

Hydrology

Hkakaborazi National Park has many rivers and streams, due to its abundant rainfall. The largest river system of this area is Nam Tamai River system; it is formed by the confluence of two mountain streams, Seinghku Wang and Adung Wan. There are many tributaries of mountain streams that flow into the Seinghku Wang and Adung Wan. The most prominent have a dendritic pattern reflecting the geologic structure. The Nam Tamai, having steep slopes and a narrow valley, flows swiftly. Mountain streams carry big boulders along the watercourse. They are all perennial streams since they are fed with melting snows in the summer. Numerous small glaciers are found along the slopes of the high icy mountains. The streams at the source of the Nam Tamai begin their drainage system in the mountains lying across the Sino-Myanmar border. They join together to form the Nam Tamai, which later joins up with the Taron River. The Taron and Nam Tamai join together to form the Maihka, which continues to flow southward.

"in general, it has a cool, temperate climate. Some of the higher mountains have permanent snow cover"

Climate

The climate of the extreme north of Myanmar is influenced by both latitude and altitude. Hkakaborazi National Park is mainly situated in the Naung Mung area, and has a northernmost location. Therefore, in general, it has a cool, temperate climate. Some of the higher mountains have permanent snow cover. The climate of the northernmost part of Myanmar is influenced by both monsoon winds and also by disturbances from westerlies.

Due to the lack of meteorological stations in the Naung Mung area the data from the nearest meteorological station at Putao were used for this study. It experiences the highest temperatures at summer solstices, when it receives maximum insolation (Table 15). The average annual temperature is above 25°C in June, July, and August. The highest mean daily maximum temperatures also occur during these months. In June, the daily highest maximum temperature recorded is 37.8°C. The lowest minimum daily temperature goes down to nearly freezing point in January (see Figure 10).

"it experiences the highest temperatures at summer solstices"

Mean daily relative humidity of Putao is always high (about 90%) especially in the morning (Table 16). In the evening, relative humidity tends

Table 15: Temperatures (° C) in Putao (1981-1990)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean	14.0	16.0	18.5	20.4	24.6	26.0	25.6	26.4	25.4	23.4	18.7	15.0
Mean daily maximum	20.8	22.3	24.1	25.0	29.8	29.4	28.4	30.1	28.8	28.3	25.6	21.4
Mean daily minimum	7.2	9.8	12.9	15.7	19.5	22.5	22.8	22.8	21.9	18.6	11.8	8.5
Highest maximum	26.3	28.3	32.6	33.1	37.0	37.8	36.0	36.0	36.0	33.2	33.2	27.5
Lowest minimum	0.6	2.0	7.0	10.2	13.0	19.0	19.0	17.6	17.6	11.0	4.7	3.0

Table 16: Mean Daily Relative Humidity (%) in Putao (1981-1990)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
0930h (MST)	97	92	88	87	80	91	96	93	92	87	91	96
1830h (MST)	85	83	81	82	77	86	88	86	89	86	85	87

to be high as well (more than 90%) (see Figure 11). Mean monthly precipitation is 3,873 mm with higher rainfall in the summer months (Table 17). The highest rainfall occurs in the months of June, July, and August. The summer monsoon winds penetrate the area following the topographic trend of the mountains and valleys and the mountainous terrain brings about more orographic rains within this area.

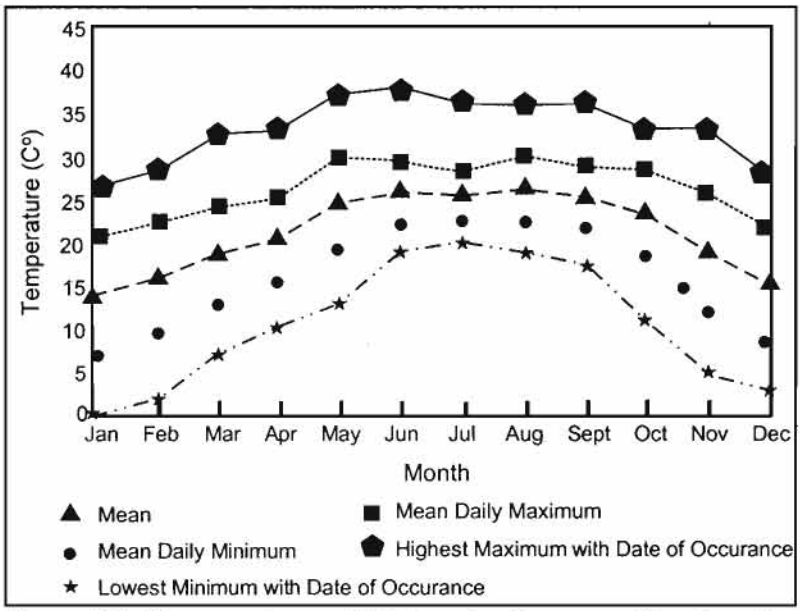

Figure 10: **Temperature of Putao in Degrees Centigrade (1981-1990)**

Naturally, there is no such rainfall in the summer months of April and May or in the winter months of November, December, and January. However, the extreme north of Myanmar receives rainfall all the year round. This can be explained by its location and the effect of the air circulation of westerlies of temperate climate. The number of average monthly rainy days accounts for 165.5 days with most rain occurring in the summer (see Figure 12).

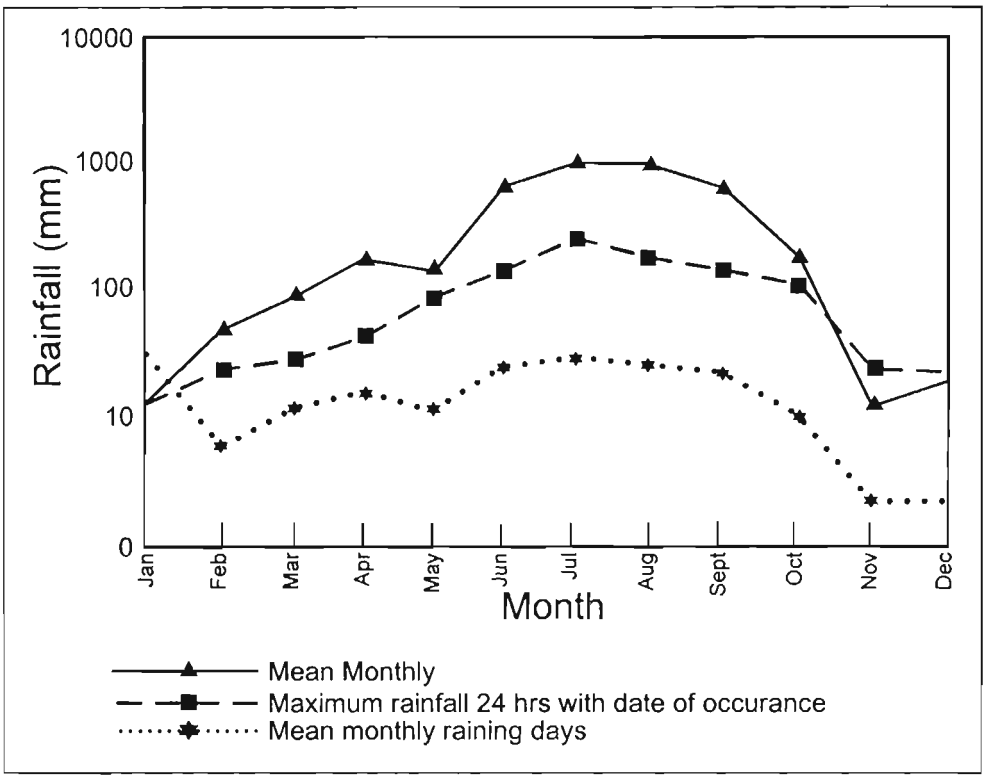

Figure 11: **Rainfall in (mm) for the year (1981-1990) at Putao**

Table 17: Rainfall (mm) in Putao (1981-1990)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Mean monthly rainfall	13	46	84	170	138	625	996	951	633	184	13	20	3873
Maximum rainfall within 24h	13	23	27	43	83	141	243	180	143	109	25	24	-
Mean monthly days with rain	2.7	5.8	11.5	15.7	11.6	24.5	29.1	26.2	23.1	10.7	2.3	2.3	165.5

Source: Hydrology and Meteorology Department

Pedology and Biogeography

"fertile fluvisols and gleysols are found in the river valley plains and are used as agricultural land"

There are lithosols on the steeper slopes of the high mountains and cambisols are found on the rest of the hilly tracts. Fertile fluvisols and gleysols are found in the river valley plains and are used as agricultural land.

With heavy rainfall, poor accessibility and low human occupancy, the region has a dense, natural vegetative cover. The southern part of Hkakaborazi National Park has temperate, semi-deciduous, broad-leaved rainforest owing to the cool, temperate, humid climate and an altitude

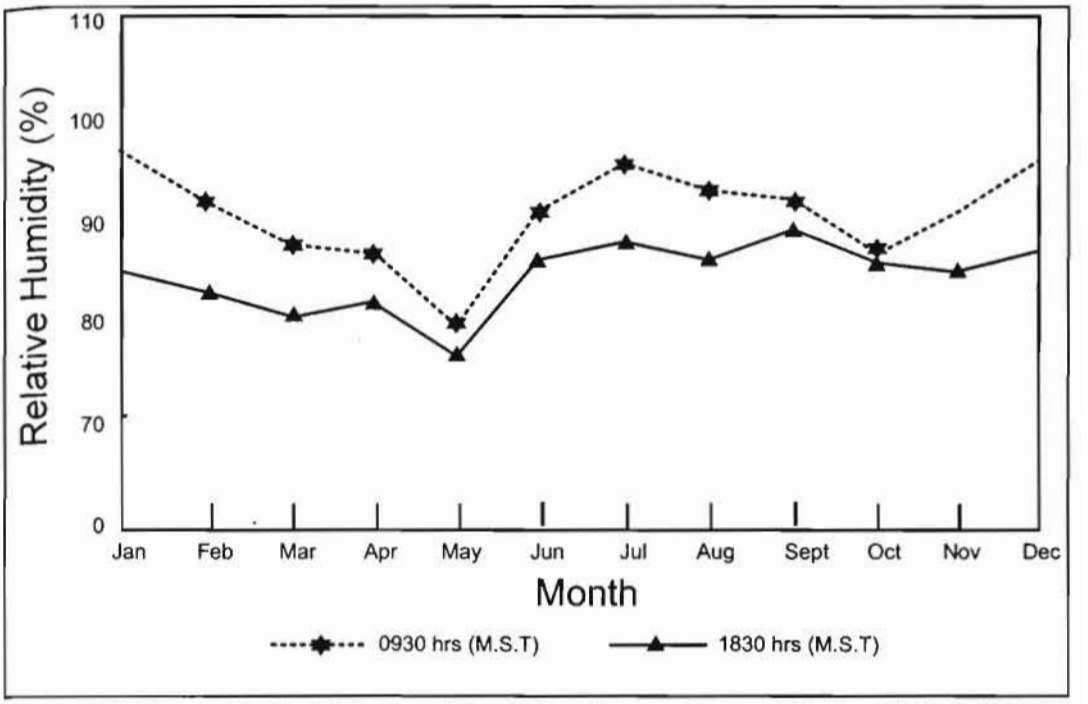

Figure 12: **Mean Daily Relative Humidity Percentage of Putao (1981-1990)**

between 1,829 and 2,743m. Evergreen, coniferous forests are dominant between 2,743 and 3,352m. At the very high summits, snow forests prevail. Alpine vegetation and scrub occur above 3,352m. In the river valleys and gently sloping areas, subtropical, evergreen, broad-leaved forests occur, and there is very thick undergrowth especially in the rainy season. Bamboo, ferns, climbers, epiphytes, magnolias, maples, cherries, and birch are common.

Hkakaborazi and its environs are rich in biodiversity, and they are little-explored regions. The wild animals living in the national park include barking deer, monkey, bear, wild boar, sambhur, serrow, goral, otter, takin, musk deer, blue sheep, red panda, many bird species, and fish. The existence of some of these animals is under threat. Otter and musk deer are rare species and they are endangered in this area due to their high trade value.

Social Geography of the Study Area

General Characteristics of the Human Population

The biological expedition team observed 11 villages within the park along the route leading to Hkakaborazi. Altogether there are 138 residential houses with 160 households in these villages. The average density of the population in Naung Mung Township is 1.3/km^2 and it is one of the most sparsely populated areas in Myanmar. Along the trail, the density is even less than 1.3/km^2. In 1997, the total population was 838 people (439 males and 399 females) (Table 18). Among these villages Arundam Village is the most populous with a population of 160. Arundam is situated on the bank of Nam Tamai River. The least populous village is Ngalaindam, which has only 15 residents. This village lies on the northern part of the expedition trail standing on the head-stream areas of Tashu Wan Creek. Most of these villages stand either in the river valleys or at the confluence of the streams.

"the chief reasons for the location of nucleated settlements on the riverain area could be easy access to drinking water, better communications, and availability of flat lands for cultivation"

There is no human occupancy or settlement on steep slopes, ridges of high altitudes, and in dense forest areas. It was observed from the field study that the pattern of human settlement is mainly influenced by topography. Some villages are also located on the alluvial fans between piedmonts and streams. It was observed that plains have to be given priority for human settlement rather than for farm land. In some instances human settlements are found together with cultivated lands, but the majority of villages are agglomerations of separate residential units. The chief reasons for the location of nucleated settlements on the riverain area could be easy access to drinking water, better communications, and availability of flat lands for cultivation. The compact settlements are usually found on the marginal strips of streams. The shape of the village, therefore, depends absolutely on the nature of those lands. Thus, the development of villages is controlled by the extent of level lands as well as by agricultural production.

Ethnic Groups

The majority of ethnic groups belong to Kachin races as the study area is situated in Kachin State. The majority of the population is Rawan. The minority groups comprise a few other Tibeto-Myanmar races (Dalong) and Taron (Table 18). They are all descendants from an early Tibeto-Burman race who migrated to Myanmar from Tibet. The indigenous Kachin races of Lisu and Rawan and Tibetans are found in the Sino-Myanmar border region. There is close communication across the border. The Tibetans settled in China first and unintentionally became settlers in Myanmar.

Table 18: Population and Educational Status of Hkakaborazi National Park

Village	No. of houses	No. of house-holds	Ethnic group	Population		Religion	School	No of teachers	No of students	Building type	Condition of school buildings
				M	F						
Pangnandim	6	8	Rawan	18	14	Christian	Primary school	3	12	Grass and timber	Normal
Ngawa	16	24	Rawan	83	56	Christian	Primary school	2	18	Zinc sheets and timber	Normal
Gawai	18	18	Rawan	60	48	Christian	Primary school	3	38	Zinc sheets and timber	Normal
Tazundam	12	16	Rawan	46	50	Christian	Primary school	2	12	Zinc sheets and timber	Poor No desks
Guba	6	7	Tibetan	15	22	Buddhist	Primary school	1	10	Grass and timber	Normal Lack of stationery
Madain	15	12	Tibetan	35	43	Buddhist	Primary school	2	12	Grass and timber	Normal Lack of stationery
Tazuhtu	18	22	Rawan	68	88	Christian	Primary school	3	15	Grass and timber	Normal Lack of stationery
Ngalaindam	3	3	Tibetan	5	10	Buddhist	None	-	-	-	-
Talarhtu	8	11	Rawan (70%)	35	25	Christian	Primary school	3	15	Grass and timber	Normal
Arundam (Crown)	25	30	Rawan (65%) Taron (35%)	71	89	Christian	Primary school	3	57	Grass and timber	Normal Lack of stationery
Tahundam	11	9	Tibetan	38	29	Buddhist	Primary school	2	6	Grass and timber	Normal Lack of stationery

Tibetans and Tarons were the last people to migrate to Myanmar. They settled in the northernmost part of Myanmar where the climate is generally cool. (Table 19). The majority of Taron groups are found in Karoung Village, which is also known as Arundan or Adonlong Village (Table 20). Tibeto-Myanmars are found in places near icy mountains very close to the border areas with China—in two villages, Tahawadam and Ngalaindam. Tibeto-Myanmars are also found in the Guba and Madain villages situated close to the Indian border. All these races living in Hkakaborazi National Park are famous for being great hunters.

Ways of Living

Many of the above-mentioned ethnic races wear Myanmar clothes of longies and engies (underwear and shirt) like most Bamars. One exception is the Tibeto-Myanmars, the men wear trousers and the women long skirts. They also wear long, woollen coats at social and religious ceremonies. Rawan men wear traditional suits for social and religious ceremonies, with bamboo hats that have fangs of wild boars attached. Tarons wear long trousers with blankets wrapped around as their traditional costume. Their traditional way of life is not strictly forbidden and they are more liberal within their close society.

Houses with long-footed posts and split bamboo matting walls are commonly found in villages along the trail. These residential houses are constructed of timber and bamboo with thatched roofing. The floor is made of bamboo tied together. Houses built entirely with logs are found on the northern part of the trail where the climate is cool, in places such as in Tashuhtu, Arundam, Guba, Madain, and Tahawadam. The roofing of these houses is made of thin sheets of pine. In these rural houses, windows are almost absent (two main entrances, one at the front and the other at the rear). The fireplace is located within the house itself, there is no separate kitchen. Thus the houses are full of smoke. As the region receives relatively low insolation and direct sunlight, it has a cool climate so clothing and meat are dried by the heat of the fire.

Languages

Rawans and Tibeto-Myanmars have their own dialects and speech is dissimilar. But there are more Rawans, so most of the other races speak Rawan as a common language. Moreover, Rawans and Tibeto-Myanmars have native written languages, but Tarons do not. They have only a spoken native language. All races are able to understand and speak the Myanmar language except for Tibeto-Myanmars and some Tarons. Only 20 Tibeto-Myanmars are able to understand and speak the Myanmar language. The majority of Rawans can speak the Myanmar language fluently.

Religion and Beliefs

Formerly animists, the vast majority of Rawans and Tarons have converted to Christianity. There are different branches of Christianity, but the church of Christ is the dominant branch. Every Rawan village has a pastor and a church of its own. Tibeto-Myanmars are mostly Theravada Buddhists. In Tahawadam Village there is a Buddhist shrine and a Buddhist monastery. Tibetans, originally Hrinayana Buddhists, were later converted to Theravada after their migration into Myanmar.

Health and Hygiene

Current health-care programmes are unsatisfactory. There are no health-care centres in any of the 11 villages. Indigenous medical care, based on medicinal plants such as herbs, tubers and bulbs is practised throughout the region. In acute cases, patients are sent to the township headquarters hospital at Naung Mung. The most common diseases include malaria, influenza, pneumonia, and intestinal infectious diseases (Table 21).

Table 19: Population of Tahawndam Village (Tibetan)

Sr. No.		Name	Age	Sex	Household leader and relationship
1	1	U Gana	58	Male	Household leader
	2	Mg Htein Sein	25	Male	Son
	3	Mg Kunbatawgyi	15	Male	Son
	4	Mg Da Nga	12	Male	Son
	5	Mg Sri Kunta	8	Male	Son
	6	Ma Sarin Aung New	20	Female	Daughter
	7	Ma Khin Saw Dayma	10	Female	Daughter
2	1	U Pe Ma Yaung Htu	37	Male	Household leader
	2	Daw Sonekardayma	32	Female	Wife
	3	Ma Hsahtindayma	13	Female	Daughter
	4	Daw Ahkyaydayma	60	Female	Mother
	5	Mg Tawgyisarin	9	Male	Son
	6	Ma Rashichodae	7	Female	Daughter
	7	Mg Tet Lu	4	Male	Son
	8	Mg Khama Cho Phi	1	Male	Son
3	1	U Htaung Sha	59	Male	Household leader
	2	Daw Ahmo	43	Female	Wife
	3	Mg Pe Magonba	19	Male	Son
	4	Ma Pe Malarmo	15	Female	Daughter
	5	Mg Htet Shae	3	Male	Son
	6	Maung Zunphi	1	Male	Son
4	1	U Aung Chout	39	Male	Household leader
	2	Daw Lu Saung	32	Female	Wife
	3	Mg Sarin Tawgyi	7	Male	Son
	4	Mg Sarin Aung Htwa	3	Male	Son
	5	Ma HtashiYaungtaung	1	Female	Daughter
	6	Daw Kya Mo	68	Female	Mother
5	1	U Lwon Dam Min	33	Male	Household leader
	2	Daw Hsaung Dayma	36	Female	Wife
	3	Mg Sarin Chon Phi	9	Male	Son
	4	Ma Yin Sein Aungmo	5	Female	Daughter
	5	Mg Pe Ma Chon Phi	1	Male	Son
6	1	U Htin Htu	61	Male	Household leader
	2	Daw Ma Yin	61	Female	Wife
	3	U Yin Sein Chon Phi	33	Male	Son
	4	Mg Dagyi	26	Male	Son
	5	Ma Sana Yaungtaung	20	Female	Daughter
	6	Ma Yin Chay Hsamo	25	Female	Daughter
	7	Ma Sarin Chode	16	Female	Daughter
	8	Ma Htashi Nsamo	8	Female	Daughter
	9	Mg Pe Ma Nabo	3	Male	Son
	10	Ma Hsana Aungmo	4	Female	Daughter
	11	Mg Htashi Tawgyi	1	Male	Son
7	1	U Htin Sein	30	Male	Household leader
	2	Daw Chan Chaw Thwema	27	Female	Wife
	3	Ma Hsana Thwema	11	Female	Daughter

Table 19 Cont.....

7	4	Ma Pe Moe	7	Female	Daughter
	5	Mg Sarain Kyaung Hsu	4	Male	Son
	6	Mg Hsana Naung Hsu	1	Male	Son
8	1	U Kyaung Hsu	37	Male	Household leader
	2	Daw Htay	38	Female	Wife
	3	Mg Chawayi Dawgyi	13	Male	Son
	4	Mg Htin Sein Naung Hsu	10	Male	Son
	5	Mg Saya Dawgyi	8	Male	Son
	6	Ma Sari Yaung Saung	5	Female	Daughter
	7	Ma Kyan Hsu Thwema	1	Female	Daughter
	8	U Namar Johnson	23	Male	Younger brother
9	1	Daw Sari Dawma	73	Female	Household leader
	2	Ma Ah Htu	40	Female	Daughter
	3	Mg Ah Bon	26	Male	Son
	4	Daw Sanjay Larmoe	28	Female	Daughter
	5	Ma Sitha	5	Female	Granddaughter
	6	Ma Hsana Larmoe	3	Female	Granddaughter
	7	Mg Karu	18	Male	Grandson
	8	Ma Lan Hsu	16	Female	Granddaughter
	9	Mg Kaw Yaw	14	Male	Grandson
	10	Mg Hsana Htashi	13	Male	Grandson

The staple diet is mainly composed of rice, maize, pulses, beans, sweet potatoes, yams, and potatoes. Rice is grown and consumed in villages where there is enough level land for cultivation, but production is not sufficient to meet consumption of the people in the area for the whole year. Maize is commonly used as a staple food, but production is still too low to meet demand and it has to be supplemented by root crops, yams, and bulbs, which grow wild in the jungle. There is no evidence of malnutrition, but gathering enough food for a day is a hard task.

Educational Status

Most villages have a State Primary School but the majority of them are in need of qualified teachers and some general school workers have to teach without any professional skills. The township educational officer at Naung Mung cannot effectively supervise the teaching activities due to poor communications. In all schools visited by the team, it was found that the teacher-pupil ratio is 1:10. Such a ratio could provide an effective education programme if facilities were good (Table 18).

Some primary school buildings are very old, tilted to one side, and nearing collapse; some of them are life threatening. There are not enough desks in the primary school in Karaung Village and no desks in the schools in Tazundam and Tahawadam Villages. In Talarhtu village, there is no State Primary School; a church is used instead. The primary schools of Tazundam, Tashuhtu, Karaung, and Tahwandam face shortages of stationery and textbooks, which imposes difficulties on teaching activities. All the Tibeto-Myanmars have the opportunity to receive elementary education but they have no opportunity to complete primary education. Nobody attains an educational status higher than the fourth standard, that is, primary school level.

Table 20: Population of Karaung Village (Rawan & Taron)						
Sr. No.		Name	Age	Sex	Race	Household leader & relationship
1	1	U Yonepali Min	80	Male	Rawan	Household leader
	2	Daw Hsone Dam Nan	75	Female	Taron & Rawan	Wife
	3	Mg Yonepali Hsin	28	Male	Taron & Rawan	Son
	4	Mg Yonepali Min	15	Male	Taron & Rawan	Son
	5	Ma Yonepali Nin Yam	25	Female	Taron & Rawan	Daughter
2	1	U Yonepali Phon	40	Male	Taron & Rawan	Household leader
	2	Daw Hsin Chan Chan	35	Female	Rawan	Wife
	3	Mg Yonepali Phon	13	Male	Rawan	Son
	4	Mg Yonepali Khin	11	Male	Rawan	Son
	5	Mg Yonepali Hsin	8	Male	Rawan	Son
	6	Mg Yonepali Min	6	Male	Rawan	Son
	7	Ma Yonepali Nan	4	Female	Rawan	Daughter
	8	Mg Yonepali Phi	2	Male	Rawan	Son
3	1	U Yonepali Derum	34	Male	Rawan & Taron	Household leader
	2	Daw Hsone Dum Nin	30	Female	Taron & Rawan	Wife
	3	Mg Yonepali Phon	12	Male	Rawan & Taron	Son
	4	Mg Yonepali De	8	Male	Rawan & Taron	Son
	5	Ma Yonepali Nan	5	Female	Taron & Rawan	Daughter
	6	Ma Yonepali Nin	2	Female	Taron & Rawan	Daughter
	7	Mg Yonepali Khin	1	Male	Rawan & Taron	Son
4	1	U Yonepali Joseph	30	Male	Rawan & Taron	Household leader
	2	Daw Tahson Nin Yam	26	Female	Rawan & Rawan	Wife
	3	Ma Yonepali Nan	2	Female	Rawan & Taron	Daughter
	4	Mg Yonepali Myo Rum	2 mnth	Male	Rawan & Taron	Son
5	1	U Chein Rein Hsin	65	Male	Rawan	Household leader
	2	Daw Hsondamnan	55	Female	Taron & Rawan	Wife
	3	U Chein Rein Phon	30	Male	Rawan & Taron	Son
	4	Mg Chein Rein Khin	26	Male	Rawan & Taron	Son
	5	Mg Chein Rein Hsin	23	Male	Rawan & Taron	Son
	6	Daw Hsondamnin	35	Female	Taron & Rawan	Daughter-in-law
	7	Ma Chein Rein Chan	5 mnth	Female	Rawan & Taron	Grand Daughter
6	1	U Hsonedamphon	35	Male	Taron & Rawan	Household leader
	2	Daw Htala Nanhtein	33	Female	Rawan & Taron	Wife
	3	Ma Hsonedamnan	12	Female	Rawan & Taron	Daughter
	4	Mg Hsonedamphon	10	Male	Rawan & Taron	Son
	5	Ma Hsonedamnin	3	Female	Rawan & Taron	Daughter
	6	MaHsonedamchan	1	Female	Rawan & Taron	Daughter
	7	Daw Htala Nanhsin	70	Female	Rawan & Taron	Grandmother
7	1	U Wan Sein Phon	60	Male	Rawan	Household leader
	2	Daw Chan Rein San	65	Female	Rawan	Wife
8	1	U Hsonedam Phee	85	Male	Rawan	Household leader
	2	Daw Htala Nan Chan	60	Female	Rawan	Wife
	3	Mg Hsonedam Khin	30	Male	Taron*	Son
	4	Mg Hsonedam Yon	24	Male	Rawan	Son
	5	Ma Hsonedam Chan	18	Female	Taron & Rawan	Daughter
	6	Mg Hsonedam Htinrun	12	Male	Taron & Rawan	Son
	7	Mg Hsonedam Khin	8	Male	Taron & Rawan	Son
	8	Ma Hsonedam Nan	6	Female	Taron & Rawan	Daughter

Table 20 Cont.....

9	1	U Ahromdam Saymi	34	Male	Rawan	Household leader
	2	Daw Hsonedam Nam	30	Female	Taron & Rawan	Wife
	3	Ma Ahrondam Nam	12	Female	Rawan & Taron	Daughter
	4	Mg Ahrondam Phon	8	Male	Rawan & Taron	Son
	5	Ma Ahrondam Nin	6	Female	Rawan & Taron	Daughter
	6	Ma Ahrondam Chan	2	Female	Rawan & Taron	Daughter
10	1	Daw Yonpali Nan	36	Female	Taron & Rawan	Household leader
	2	Mg Lyondam Hsin	18	Male	Rawan	Son
	3	Ma Lyondam Nan	14	Female	Rawan	Daughter
	4	Ma Lyondam Nin	10	Female	Rawan	Daughter
	5.	Mg Lyondam Phee	8	Male	Rawan	Son
11	1	U Yonepali Htawma	87	Male	Rawan	Household leader
	2	Daw Hsonedam Nan	78	Female	Taron*	Wife
	3	Mg Lyondam Deson	28	Male	Rawan & Taron	Grandson
12	1	U Hsinchan Khin	29	Male	Rawan	Household leader
	2	U Htala Nan Hsin	34	Male	Rawan	Uncle
	3	Mg Lyondam Phon	10	Male	Rawan	Nephew
	4	Daw Htala Nan	45	Female	Rawan	Mother
	5	Daw Tahsunam Nan	40	Female	Rawan	Aunt
	6	Ma Lyondam Nan	18	Female	Rawan	Niece
13	1	U Lyondam Phi	78	Male	Taron*	Household leader
	2	Ma Lyondam Doo	27	Female	Taron & Rawan	Daughter
	3	Ma Lyondam Zin	24	Female	Taron & Rawan	Daughter
	4	U Lyondam Hsin	35	Male	Taron & Rawan	Son
	5	Daw Tazan Nan	29	Female	Taron & Rawan	Daughter-in-law
	6	Mg Lyon Ang Phon	10	Male	Taron & Rawan	Grandson
	7	Ma Lyon Ang Htin	8	Male	Taron & Rawan	Grandson
	8	Ma Lyon Ang Nin	6	Female	Taron & Rawan	Granddaughter
	9	Ma Lyon Ang Chan	3	Female	Taron & Rawan	Granddaughter
14	1	U Hsondam Detan	29	Male	Taron & Rawan	Household leader
	2	Daw Lyondam Chan	34	Female	Rawan & Taron	Wife
	3	Ma Hsondam Nan	10	Female	Rawan & Taron	Daughter
	4	Ma Hsondam Nin	8	Female	Rawan & Taron	Daughter
	5	Mg Hsondam Htin	5	Male	Rawan & Taron	Son
	6	Ma Hsondam Chan	2	Female	Rawan & Taron	Son
15	1	U Lyondam Phee	30	Male	Taron & Rawan	Household leader
	2	Daw Hsin Chan Nin	26	Female	Rawan & Taron	Wife
	3	Mg Lyondam De	4	Male	Rawan & Taron	Son
	4	Ma Lyondam Nan	2	Female	Rawan & Taron	Daughter
16	1	U Lyondam Min	33	Male	Taron*	Household leader
	2	Daw Htala Nan Naing	30	Female	Rawan	Wife
	3	Ma Lyondam Nan	6	Female	Rawan & Taron	Daughter
	4	Ma Lyondam Nin	4	Female	Rawan & Taron	Daughter
	5	Ma Lyondam Chan	3	Female	Rawan & Taron	Daughter
	6	Mg Lyondam Phon	1	Male	Rawan & Taron	Son

Table 20 Cont.....

17	1	U Lyondam Derum	36	Male	Taron & Rawan	Household leader
	2	Daw Hsompali Chan	30	Female	Taron & Rawan	Wife
	3	Ma Lyondam Nan	12	Female	Rawan & Taron	Daughter
	4	Mg Lyondam Phon	9	Male	Rawan & Taron	Son
	5	Mg Lyondam Htin	6	Male	Rawan & Taron	Son
	6	Ma Lyondam Chan	3	Female	Rawan & Taron	Daughter
	7	Ma Lyondam Doo	1	Female	Rawan & Taron	Daughter
18	1	U Lyondam Hteinpa	89	Male	Taron & Rawan	Household leader
	2	Daw Htala Nan Chan	78	Female	Rawan	Wife
	3	Mg Lyondam Yon	30	Male	Rawan & Taron	Son
	4	Ma Lyondam Yon	29	Female	Rawan & Taron	Daughter
	5	U Lyondam Htin	38	Male	Rawan & Taron	Son
	6	Daw Yonepali Nin	29	Female	Taron & Rawan	Daughter-in-law
	7	Mg Lyondam Phon	18	Male	Rawan & Taron	Grandson
	8	Ma Lyondam Nan	15	Female	Rawan & Taron	Granddaughter
	9	Ma Lyondam Chan	10	Female	Rawan & Taron	Granddaughter
	10	Mg Lyondam Khin	17	Male	Rawan & Taron	Grandson
	11	Mg Lyondam Hsin	12	Male	Rawan & Taron	Grandson
	12	Ma Lyondam Doo	6	Female	Rawan & Taron	Granddaughter
	13	Ma Lyondam Zin	1	Female	Rawan & Taron	Granddaughter
	14	Mg Lyondam Phi	2	Male	Rawan & Taron	Grandson
19	1	U Lyondam Khin	45	Male	Taron & Rawan	Household leader
	2	Daw Htala Nam Nan	47	Female	Tawan	Wife
	3	Ma Hsondam Chan	30	Female	Taron & Rawan	Daughter
	4	Ma Hsondam Doo	28	Female	Taron & Rawan	Daughter
	5	Ma Hsondam Nan	10	Female	Taron & Rawan	Daughter
20	1	U Lyondam Dawi	45	Male	Taron*	Household leader
	2	Ma Lyondam Non	35	Female	Taron*	Sister
	3	Ma Lyongdam Chan	37	Female	Taron*	Sister
	4	Ma Lyondam Nan	39	Female	Taron*	Sister
	5	Ma Lyondam Nin	4	Female	Rawan & Taron	Niece
21	1	U Hta Hsu Nan Hsin	55	Male	Rawan	Household leader
	2	Daw Tazan Non	45	Female	Rawan	Wife
	3	Mg Hta Hsu Nan Pon	35	Male	Rawan	Son
	4	Mg Hta Hsu Nan Htin	28	Male	Rawan	Son
	5	Mg Hta Hsu Nan Khin	15	Male	Rawan	Son
	6	Ma Hta Hsu Nan Ban	24	Female	Rawan	Daughter
	7	Ma Hta Hsu Nan Nan	30	Female	Rawan	Daughter
	8	Ma Hta Hsu Nan Nin	27	Female	Rawan	Daughter
	9	Ma Nan	3	Female	Rawan	Granddaughter
	10	Ma Nan	2	Female	Rawan	Granddaughter
22	1	U Tazan Phon	50	Male	Rawan	Household leader
	2	Daw Ahrondam Nan	45	Female	Taron & Rawan	Wife
	3	Mg Dazan Di	30	Male	Rawan	Son
	4	Ma Dazan Chan	24	Female	Rawan	Daughter
	5	Ma Dazan Nan	17	Female	Rawan	Daughter
	6	Ma Dazan Nin	10	Female	Rawan	Daughter
	7	Ma Dazan Htan	8	Female	Rawan	Daughter

Table 20 Cont.....

22	8	U Dazan Phon	33	Male	Rawan	Son
	9	Daw Ahrondam Nam	30	Female	Rawan	Daughter-in-law
	10	Mg Tet Phon	2	Male	Rawan	Grandson
	11	U Dazan Khin	28	Male	Rawan	Son
	12	Daw Yonepali Non	30	Female	Taron & Rawan	Daughter-in-law
	13	Ma Dazan Nan	4	Female	Rawan	Granddaughter
	14	Ma Dazan Nin	2 mnth	Female	Rawan	Granddaughter
23	1	Daw Yonepali Nin Hson	40	Female	Rawan	Household leader
	2	Ma Ahrondam Nan	29	Female	Rawan	Daughter
	3	Ma Ahrondam Nin	25	Female	Rawan	Daughter
	4.	Ma Nan	4	Female	Rawan	Granddaughter
	5	Ma Nin	1	Female	Rawan	Granddaughter
	6	Mg Ahrondam Khin	13	Male	Rawan	Grandson
	7	Mg Ahrondam Hsin	10	Male	Rawan	Grandson

Economic Geography of the Study Area

Primary Activities

There are four types of primary economic activities: cultivation, hunting, gathering of medicinal plants, and others (Table 22).

Cultivation

Two kinds of farming methods are practised in the National Park, shifting cultivation and wet cultivation.

Shifting cultivation: The most extensive occupation is hill-agriculture, which is a subsistence type of economic activity. Taungya (hill farming) is carried out on the gentle slopes of hills. Bamboo and tall trees are cleared by the slash-and-burn method, and crops are grown in the early monsoon period. Some taungya is even found on steep slopes with an angle of 45°. The chief crops of hill agriculture are glutinous rice, maize, beans and pulses, mustard, potatoes, yams, and millet. Only what is needed is grown. The rice yield per ha is usually less than 20 baskets (one basket is equivalent to 42 kg of unhusked paddy). This yield is not enough to support a farming family, so maize, beans, potatoes, yams, and wheat have to supplement the daily diet. There is a very small amount of terrace-like cultivation in a few areas.

Wet cultivation:

'Le' or wet cultivation is mainly for growing paddy. Ngawa and Tazundam villages, which have a small area of flat land, are the main rice-producing areas. Although paddy-growing lands are found as far north as Tazundam Village, in the north, the shortages of level land and the cool climate do not permit the successful growing of paddy. The yield is low due to lack of modern farming methods, sparse application of fertilisers, and destruction by wild animals. The average yield per ha is less than ten baskets, which is much less than annual family consumption.

Hunting

The second most important economic activity is hunting, which in this case is the indiscriminate killing of wild animals for food. There are two reasons for hunting: to get meat for the family's

Table 21: Health Conditions in Hkakaborazi National Park

Village	Food	Health centre	Major diseases	Drinking water	Toilet system	Remarks
Pangnandim	Millet, maize, yam	Nil	Malaria, diarrhoea, worm infection, pneumonia	Stream	Pit type and bush type	Very rare physical cleaning and washing Live together with domestic dogs and chickens
Ngawa	Rice, maize, potatoes	Nil	Malaria, diarrhoea, worm infection, pneumonia	Stream	Pit type and bush type	Very rare physical cleaning and washing Live together with domestic dogs and chickens
Gawai	Rice, maize, potatoes, pith of minbaw palm	Nil	Malaria, diarrhoea, worm infection, pneumonia	Stream	Pit type and bush type	Very rare physical cleaning and washing Live together with domestic dogs and chickens
Tazundam	Millet, maize, pith of minbaw palm	Nil	Malaria, diarrhoea, worm infection, pneumonia	Stream	Pit type and bush type	Very rare physical cleaning and washing Live together with domestic dogs and chickens
Guba	Wheat, millet, maize, milk, cheese, potatoes	Nil	Malaria, diarrhoea, worm infection, pneumonia	Stream	Pit type and bush type	Very rare physical cleaning and washing Live together with domestic dogs and chickens
Madain	Wheat, millet, maize, milk, cheese, potatoes	Nil	Malaria, diarrhoea, worm infection, pneumonia	Stream	Pit type and bush type	Very rare physical cleaning and washing Live together with domestic dogs and chickens
Tazuhtu	Millet, maize, yam, potatoes, pith of minbaw, palm	Nil	Malaria, diarrhoea, worm infection, pneumonia	Stream	Pit type and bush type	Very rare physical cleaning and washing Live together with domestic dogs and chickens
Ngalaindam	Millet, maize, yam, potatoes, pith of minbaw, palm	Nil	Malaria, diarrhoea, worm infection, pneumonia	Stream	Pit type and bush type	Very rare physical cleaning and washing Live together with domestic dogs and chickens
Arundam (Crown)	Millet, maize, yam, potatoes	Nil	Malaria, diarrhoea, worm infection, pneumonia	Stream	Pit type and bush type	Very rare physical cleaning and washing Live together with domestic dogs and chickens
Talarhtu	Millet, maize, yam, potatoes	Nil	Malaria, diarrhoea, worm infection, pneumonia	Stream	Pit type and bush type	Very rare physical cleaning and washing Live together with domestic dogs and chickens
Tahundam	Wheat, maize, millet, milk, cheese, potatoes	Nil	Malaria, diarrhoea, worm infection, pneumonia	Stream	Pit type and bush type	Normal physical cleaning and washing Live together with domestic dogs and chickens

Table 22: Economic Conditions of Hkakabo Razi National Park

Village	Main profession	Crops	Other professions	Wild animals	Transpor-tation	Road condition	Nearest town	Remarks
Pangnandim	Shifting cultivation	Millet, maize, sweet potatoes	Hunting, collecting machit oo, gusha, and other medicinal plants	Barking deer (black), wild boar, monkey, bear, Serow	On foot	Footpath	Naung Mung (48 km)	Primitive farming methods, subsistence agriculture, small-scale domestic breeding
Ngawa	Wet cultivation, shifting cultivation	Rice, maize, mustard, yam, potatoes	Hunting, collecting machit oo, gusha, and other medicinal plants	Barking deer (black), wild boar, monkey, serow	On foot	Footpath	Naung Mung (72 km)	Primitive farming methods, subsistence agriculture, small-scale domestic breeding
Gawai	Shifting cultivation	Rice, maize, yam, millet	Hunting, collecting machit oo, gusha, and other medicinal plants	Barking deer (black), bear, monkey, wild boar, serow, red goral	On foot	Footpath	Naung Mung (104 km)	Primitive farming methods, subsistence agriculture, small-scale domestic breeding
Tazundam	Shifting cultivation	Millet, maize, yam, potatoes, beans	Hunting, collecting machit o gusha, and other medicinal plants	Barking deer (black), serow, red goral, wild boar, bear, monkey	On foot	Footpath	Naung Mung (120 km)	Primitive farming methods, subsistence agriculture, small-scale domestic breeding
Guba	Shifting cultivation	Wheat, maize, millet, potatoes, yam, beans, mustard		Musk deer, serow, red goral, takin, barking deer (black), bear, monkey	On foot	Footpath	Naung Mung (128 km)	Primitive farming methods, subsistence agriculture, small-scale domestic breeding, breeding of hybrid cattle
Madain	Shifting cultivation	Wheat, maize, millet, potatoes, yam, beans, mustard	Hunting, collecting machit oo, gusha, and other medicinal plants	Musk deer, serow, red Goral, takin, barking deer (black), bear, monkey	On foot	Footpath	Naung Mung (133 km)	
Tazuhtu	Shifting cultivation	Wheat, maize, millet, potatoes, yam, beans, mustard	Hunting, collecting machit oo, gusha, and other medicinal plants	Barking deer (black), monkey, serow, red goral, bear	On foot	Footpath	Naung Mung (137 km)	
Ngalaindam	Shifting cultivation	Wheat, maize, millet, potatoes, yam, beans, mustard	Hunting, collecting machit oo, gusha, and other medicinal plants	Barking deer (black), monkey, serow, red goral, bear	On foot	Footpath	Naung Mung (143 km)	
Talarhtu	Shifting cultivation	Wheat, maize, millet, potatoes, yam, beans, mustard	Hunting, collecting machit o gusha, and other medicinal plants	Barking deer (black), monkey, serow, red goral, bear	On foot	Footpath	Naung Mung (145 km)	
Arundam (Crown)	Shifting cultivation	Wheat, maize, millet, potatoes, yam, beans, mustard	Hunting, collecting machit oo, gusha, and other medicinal plants	Barking deer (black), monkey, serow, red goral, bear	On foot	Footpath	Naung Mung (151 km)	
Tahundam	Shifting cultivation	Wheat, maize, beans, millet, yam, mustard	Hunting, collecting machit oo, gusha, and other medicinal plants	Barking deer (black), monkey, serow, red goral, bear	On foot	Footpath	Naung Mung (160 km)	

"the use of jaw traps is the most destructive device for local fauna because none of the animals, old or young, can escape"

needs and to gather horns, leather, fur, and other parts of animals to be sold for some income. All mature men hunt, using various devices such as crossbows and poison-tipped arrows, snares, traps, strings and spears, hunting dogs, jaw traps, and locally-made guns. The use of jaw traps is the most destructive device for local fauna because none of the animals, old or young, can escape (Table 22).

Hunting is carried out both near and away from the villages. Hunting around the village area is done in combination with taungya farming. Hunting away from the village takes place in the snow-capped mountains. The hunting season begins in June, July, or August when the snow has melted and grasses begin to sprout from the ground. The animals hunted commonly include monkey, bear, barking deer, wild boar, sambhur, serow, goral, takin, musk deer, and blue sheep. Monkey, bear, and wild boar usually destroy the taungya crops. Monkeys, barking deer, wild boars, gorals, and serows are more numerous than other animals. The skin of the otter is a valuable commodity; thus the demand for its skin threatens to cause the extinction of these animals by over-hunting.

Horns, leather, and other animal products from hunting are sold to Rawans and Lisus who live on the other side of border, in China. Rawans in Myanmar also visit fellow Rawans on the Chinese side to sell these animal products. There are no immigration checkpoints to hinder such cross-border migrations.

"monkeys, barking deer, wild boars, gorals, and serows are more numerous than other animals. The skin of the otter is a valuable commodity"

Traders from Putao also purchase these animal products, but less frequently than those from China. The products are sent to markets of east Asian countries via Naung Mung, Putao, Myitkyina, Mandalay, and Tachileik or to China via Panandin and Makhongan Villages. In return, textiles, salt, and some basic domestic requirements are purchased or exchanged through a 'barter system'. The price of horn and leather is less than 10,000 kyats per piece (1997), but a kind of powder from musk deer costs more than 10,000 kyats per tical (one tical is equivalent to 16g).

The gathering of medicinal plants

Some income is generated from the gathering of medicinal plants. Their collection begins soon after the taungya harvest, at the time of snowmelt, during the months of July, August, and September. These indigenous medicinal products are also very useful in the health care of the local people. The main medicinal plants include majt oo, hkantauk root, gusha oo, and shipadi root. Majit oo and gusha oo are obtained from beneath the snow cover of icy mountain slopes and they are highly priced commodities, worth 2000 kyats per viss (1 viss is equivalent to 1.6 kg). Hkantauk roots are gathered in Gawai Village and nearby downstream areas.

"a kind of powder from musk deer costs more than 10,000 kyats per tical (one tical is equivalent to 16g)"

Other Primary Economic Activities

Fishing in icy waters from the melting snow is also practised occasionally. Domestic breeding of poultry and pigs is done on a family basis in every

house for domestic consumption. Beekeeping is also practised in hollow trees in Tazundam Village and in other upstream villages. Honey is gathered for bartering and domestic use.

Secondary Economic activities

Traditional handicrafts include the production of baskets or containers from bamboo and cane available locally, and these activities can be observed along the route to Hkakaborazi. In Tahawadam Village woollen clothing for domestic use is produced using handlooms.

Tertiary Economic activities

Tertiary economic activities comprise seasonal occupations such as road maintenance and guiding and portering for visitors.

Transportation and Communication

Roads and other means of communication are essential for the movement of commodities and goods as well as for promoting all-round regional development by movement of people, new ideologies and modem technologies. However, in the northernmost remote area, such innovations are almost completely lacking.

The footpath leading to Hkakaborazi is one of the most difficult trails ever to be found. The metalled road between Putao and Machanbaw is 22.5 km long and it is an all-season road. The 98 km long gravelled road connecting Machanbaw and Naung Mung was built with readily available rocks from nearby streambeds and is motorable but the surface of the road is very rough. From Naung Mung to Tahawadam Village (156 km), footpaths are constructed along the steep escarpments. But the footpaths are very slippery, and can be dangerous for travellers. Sometimes communication is cut off by landslides and mudslides that occur in the wet season. Transportation of goods by mule is possible up to 13 km from Naung Mung, to Gawle Village. But further away from Gawle, goods are transported by human porters (Table 22).

There are 22 suspension bridges, some of which have been built by the local people. These suspension bridges are small and narrow so that only a single person can go across at a time. Local bridges are not strong enough, since they are constructed with local cane and bamboo. The Ministry of Construction maintains some sections of the footpaths and some are maintained by local people. The swift-flowing, boulder-carrying streams are not used at all for transportation, but they could be used for sports if ecotourism were to thrive here; some of them have 'gushing white waters' with noisy, rushing currents.

Problems of the Study Area

Physical problems

Hkakaborazi National Park is located in the northernmost part of a mountainous region and has rugged terrain; the remote location of this park results in poor accessibility. It also limits agriculture to shifting cultivation (taungya farming) which results in deforestation and land degradation.

Environmental damage caused by deforestation includes soil erosion, landslides, and the destruction of wildlife habitats (causing a reduction in biodiversity). As soil erosion increases at the sources of the streams, excessive deposition downstream can block the waterways. There is an increasing danger of landslides in the area especially on the steeper slopes in the northern village areas. Firm evidence of such landslides was observed on the way from Gawine Village to Tahawadam in the north. The lack of vegetation cover caused by burning of the forest loosens

"deforestation will also lead to the destruction of taungya farming plots"

the soil and increases the tendency for swift surface flow. The consequently weak structure of the surface layers leads them to slide down slopes, especially during the rainy season.

The danger of landslides is especially deadly on the slopes with more than a 45° tilt. A landslide that occurred in 1994 caused three deaths and the destruction of three houses at Tahawadam Village. In July 1995 a landslide near Ngawa Village caused the death of four people. There may be similar instances that are not recorded. Deforestation will also lead to the destruction of taungya farming plots and a reduction in hunting, which are the main occupations for the indigenous races. As a result, they will face hunger and starvation and eventually absolute poverty.

Social Problems

The villages included in the field study are situated in the most remote areas of the least-developed regions of Myanmar Naing-Ngan and so they face all sorts of problems. The first requirement for survival is to have sufficient agricultural land. Being a mountainous region, there is little level land that can be tilled easily. The shortage of medicine and insufficient medical care are also a problem. Searching for food for survival is always a top priority, and so education is neglected in the face of poverty. Men prefer to hunt while women and children work tirelessly at taungya farming.

"the shortage of medicine and insufficient medical care are also a problem. Searching for food for survival is always a top priority"

Intermarriages among close relatives within the Taron race have resulted in genetic degradation, producing mentally retarded or physically handicapped people. However, marriages between Rawans and Tarons have created new and healthier generations. At the time of writing, there are only eight typical Taron people. The Tibeto-Myanmars are quite possibly the last to migrate into Myanmar so they are less likely to mix with other races. There are only two households who are a mixture of Tibeto-Myanmar and Rawan. Currently Tibeto-Myanmars form a small minority group with intermarriages among close relatives. If this continues, they, like Tarons, will also face genetic degradation.

As the region has a cold climate and lacks health education, personal hygiene is poor. Most people are dirty and untidy and in most villages farm animals and pets are kept within the family house. Firewood is used to keep the house warm, there is not enough warm clothing to protect from cold weather. As it is a hilly area, salt is a necessity, and it is very expensive. It is bought from Naung Mung market and some Tibeto-Myanmars have to go up to China to purchase the necessary salt.

The hills and mountains along both sides of Adongwan Valley are almost naked from taungya practices. Firewood collection and logging for houses in the area between Tashubtu and Tahawadam villages have increased.

"there is not enough warm clothing to protect from cold weather"

Economic Problems

The two main occupations of taungya (or shifting agriculture) and hunting cause deforestation, soil erosion, and the extinction of existing wildlife and

ecosystems. Due to the coincidence of the hunting season and breeding season many wild species now have low populations.

Some of the native people in the area would be willing to migrate into Naung Murg and Putao towns because of their difficulties, but they cannot afford the travelling expenses or the charges for a new place to live that would be required.

Taungya farming is carried out for two successive years on a plot. The plot is then abandoned and the farming shifts to another plot. In this type of agriculture there are more inputs than outputs, and it can lead to harmful deforestation and soil erosion. It is an old farming method and seed quality is poor. Also, the more food is produced the more forests are destroyed. However it is the only means of livelihood for a hill family.

Feasible solutions to the existing problems

Based on the findings of our socioeconomic study, feasible solutions to the existing problems will now be presented.

Naung Mung Township in the northernmost part of Myanmar, which is also the hilliest area, needs all-round development. The people living there have yet to be provided with the basic requirements of food, clothing, and shelter. Government officials and non-government organisations (NGOs) should be made available to help meet social needs and to supply financial aid.

Deforestation and land degradation is the most pressing problem in this area. Problems originating from land degradation can cause various types of devastating consequences in this mountainous environment. Therefore, land management should be considered the top priority, with terrain evaluation, continuous deforestation, and land use being the most important factors to address. To prevent continued degradation, a well-organised, long-term national park system could be introduced.

Awareness of environmental conservation should be taught in our education system starting from elementary school level. Public education through literature, talks, and television programmes should also be established

A change from shifting cultivation to terrace cultivation is also essential to improve land quality. In the transformation of the cultivation system, officials should discourage taungya farming by highlighting the demerits of shifting cultivation and supplying farm implements for terrace cultivation.

Future Prospects and Recommendations

kakaborazi National Park has a naturally rich biodiversity. It is rare to find such natural stands of forests and wild animals in the world. Thus, Hkakaborazi National Park should be recognised as a world heritage site in the future.

The following recommendations for the development of the Hkakaborazi area are based on existing problems and needs.

The area is affected by soil erosion and places where there is no vegetative cover, such as steep slopes, partially snow-covered areas, and abandoned taungya lands, should be afforested with suitable plant species.

Food, clothing, medicines, and medical care should be provided to local people by the state until they can afford to buy these necessities themselves.

Terraced cultivation should be introduced on selected sites on sloping hillsides.

Suitable crops and high-quality seeds should be distributed free of charge on the chosen farming sites.

A better variety of young domesticated animals should be supplied on a family basis and the basic techniques of raising them should be taught.

"food, clothing, medicines, and medical care should be provided to local people by the state until they can afford to buy these necessities themselves"

Through training and workshops in elementary schools and for family members living in the area, education on forest conservation, wildlife conservation, protection of soil erosion, and understanding the fundamentals of the natural environment should be provided.

Local ethnic groups that wish to do so could be helped to migrate, through a formal arrangement, and new agricultural lands could be created in the newly occupied areas.

The crossing of the international boundary around Hkakaborazi National Park should be controlled by security officials and immigration department officials.

"new agricultural lands could be created in the newly occupied areas"

Footpaths connecting Naung Mung town and Tahawadam Village in the extreme north should be upgraded, at least to mule roads, to enable easier transportation of goods and other necessities.

Systematic research on the conservation of wildlife including birds, rare species of plants, and medicinal plants should be carried out together with conservation and restoration of the natural environment of areas within the National Park.

Limited parts of the National Park should be used for ecotourism and the income generated used for conservation of forest.

Conclusion

"limited parts of the National Park should be used for ecotourism"

Hkakaborazi National Park, rich in biodiversity, is suffering from land degradation and deforestation due to human interference. Feeding areas for wildlife are gradually decreasing and the existence of some species is threatened. Multidisciplinary systematic research and detailed surveys are required in order to protect against further damage to this area.

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Ecotourism Prospects and Management:
Issues in Hkakaborazi National Park

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"the expedition found new species of barking deer (called the leaf deer by local hunters)"

Introduction

On 2 March 1997, a biological expedition, which was led jointly by the Wildlife Conservation Society (WCS) and Myanmar Forest Department, set out to find new species of plants and animals and to investigate their related habitats and the situation regarding disturbed and undisturbed ecosystems.

The expedition found new species of barking deer (called the leaf deer by local hunters) which was tentatively named *Muntiacus pataoensis*. They also observed very rare orchids, including the slipper orchid, *Paphiopedelium wardii*, which was discovered by F.K. Ward in 1920. They collected 500 species of plants and listed 26 species of animals and 125 species of birds as a result of the expedition.

"disturbance of the environment seems to be diminished because of its remote location in the highlands in the far north"

Hkakaborazi, which attracts botanists, zoologists, and ecotourists with both technical and personal interests, faces threats to some of its rare species, for example, very rare and popular butterflies. Disturbance of the environment seems to be diminished because of its remote location in the highlands in the far north.

This paper suggests administrative and departmental procedures from a management perspective that would be beneficial to the park.

Hkakaborazi protected area has been put into the first priority protected area system, 'National Park' and there are still some requirements in order to meet its obligations as a national park. These are as follow.

- Paper boundary demarcation
- Implementation of settlement procedures for the inhabitants according to the 'Forest Rules and Regulations, 1995'
- Implementation of procedures regarding restrictions on and permission for visitors

The Ethnic Groups in the Hkakaborazi Area

"Hkakaborazi protected area has been put into the first priority protected area system"

Considering the area extends over 2,369 sq.km, the population of 1627 seems very small. Eighteen villages were recorded in the census of February 1999. The different ethnic groups are Yawan, Lisu, Htarone, Jimphaw,

and Myanmar-Tibetans. The majority are Christian but some Myanmar-Tibetans are Buddhist. The largest ethnic group is the Yawan.

Information from the census regarding population, religion, households, schools, cultivated land, and crops is given in Table 23.

Culture

Traditionally the inhabitants, who live on the high mountains in small groups, survive by hunting and taungya cultivation. They are honest and fond of the surrounding forests and streams. They lack advanced education, knowledge of modern agriculture, and awareness about the importance of the environment. Nowadays, they have a chance of being educated in these matters by explorers.

Traditional land use and Hunting practices

Shifting cultivation is practised, and wheat, hill rice, corn, and vegetables are grown. Wild animals are hunted and animal skins sold or exchanged to help meet family needs.

Boundary Demarcation

The area of the national park (2,369 sq.km) that was initially marked on the map comprised the upland areas of the northern boundary, including Hkakaborazi Peak (5,881m).

The boundary demarcation of the park, which borders China and India and has a perimeter roughly estimated at 273.5m will be a big task requiring a special project to accomplish it.

The demarcation process will follow Forest Department procedures and will include the following

- Surveying the boundary (its perimeter)
- Setting up boundary pillars, marking blazes, and recording compass bearings
- Marking prominent trees along the boundary (for example, National Park NP/19973)

Putting up signboards reading 'National Park' on trees at a height of 3.65m

- Inspecting paths
- Detailed Records and Traverse Map of the Park

The process will require a survey team and a working schedule of a year. The survey and demarcation work should take place from November to March, which is the dry season. The survey will take about three years.

The cost, the members of the task force, and the field equipment, survey tools, and instruments required will have to be worked out in detail.

The parts of the park boundary bordering China and India are the most important; they are dealt with through international law and mutual agreements.

Weather

Putao Region is 420m above sea level and rainfall is very high – 3.9m per year, on average. Rainfall occurs all year round; the monthly rainfall pattern from 1996 to 1999 is shown in Table 24.

Table 23: Socioeconomic survey in Hkakaborazi National Park (February 1999)

Village	Ethnic group	Population			Religion	No. of households	No. of schools	Cultivated land (ha)	Crops grown
		Male	Female	Total					
Ali Aung	Yawan	62	69	131	Christianity	21	1	16	Rice, corn, wheat, rye
Tasulaung	Yawan	30	33	63	Christianity	10	1	8	Rice, corn, wheat, rye
Cushion (1)	Yawan	25	31	56	Christianity	8	1	7	Rice, corn, wheat, rye
Cushion (2) (MaKkan tract)	Yawan	18	32	50	Christianity	6	1	6	Rice, corn, wheat, rye
YanHtang (MaHkan tract)	Yawan	23	24	47	Christianity	6	1	6	Rice, corn, wheat, rye
MaKhan (MaKhan tract)	Yawan	106	78	184	Christianity	28	1	22	Rice, corn, wheat, rye
Dahon dun (Tsutu tract)	Tibetan	36	32	68	Buddhist	11	1	8	Rice, corn, wheat, rye
Khayoung (Tsutu tract)	Yawan Htarone	71	88	159	Christianity	28	1	19	Rice, corn, wheat, rye
Talar ku (Tasutu tract)	Yawan	43	31	74	Christianity	12	1	9	Rice, corn, wheat, rye
Tasutu (Tsutu tract)	Yawan	94	89	183	Christianity	27	1	22	Rice, corn, wheat, rye
Nga war (Ngawar tract)	Yawan	60	52	112	Christianity	17	1	14	Rice, corn, wheat, rye
Kawaing (Ngawar tract)	Yawan	55	58	113	Christianity	18	1	14	Rice, corn, wheat, rye
Dagon (Dagondan tract)	Yawan	50	55	105	Christianity	11	1	13	Rice, corn, wheat, rye
MaDain (Dagondan tract)	Tibetan	35	40	75	Buddhism	11	1	9	Rice, corn, wheat, rye
Sandan (Dagondan tract)	Yawan	18	20	38	Christianity	5	1	4	Rice, corn, wheat, rye
Taon dan (Dagondan tract)	Yawan	15	12	27	Christianity	3	0	3	Rice, corn, wheat, rye
Pan Nandin (Pan Nandin tract)	Yawan	25	27	52	Christianity	6	1	6	Rice, corn, wheat, rye
Man Ton (Pan Nandin tract)	Yawan	43	48	91	Christianity	10	1	11	Rice, corn, wheat, rye
Total		809	819	1628		238	17	197	

Table 24: Normal and Monthly Rainfall (mm) from 1996 to 1999 in Putao Division, Kachin State					
Month	Normal rainfall	1996	1997	1998	1999
January	13	15	16.3	43.9	5.1
February	35.05	44.4	37.6	30.2	--
March	72.90	20.6	163.3	151.9	24.9
April	146.05	104.4	73.9	124.2	40.9
May	169.93	82.3	105.9	243.6	426.2
June	720.60	462	459.2	720.9	1086.1
July	955.04	923	1085.9	1082.5	980.2
August	905	1066.8	1046.7	1023.9	1020.1
September	629.92	306.6	746.5	449.8	1137.4
October	208.03	216.2	20.3	220.5	95.2
November	4.83	61.2	9.1	39.1	--
December	19.05	--	41.1	22.6	--
Total	3896.11	3835.9	3806.4	4147.8	4816.1

Settlement Procedures for the inhabitants according to the 'Forest Rules and Regulations, 1995'

The Forest Settlement Officer has the following authorised responsibilities relating to the inhabitants and villages in a forest reserve or protected area.

- The Settlement Officer is responsible for announcing to the local community the intentions for the area to be legally protected and to ask the people rights and privileges they want to claim.
- The Settlement Officer is responsible for interviewing the applicants who are claiming rights and privileges and granting some rights or privileges with the permission of the Director General and the Minister from the Ministry of Forestry.

There are very sensitive issues to take into account, related to cultural, social, economic, and religious matters. There should be specific instructions and mutual agreements between the Forest Department and the inhabitants that will favour environmental conservation, and some surrounding areas of the villages will be excluded from the national park for cultivation.

A community development plan and programmes for future integrated assessment have to be considered in order to prevent the cutting down of forests and traditional hunting practices.

It is inevitable that the Nature and Wildlife Conservation Section of the Forest Department will have to be acquainted with the local community so that they can provide education about environmental conservation and scientific agriculture.

The degree of fully protected and systematic management of a national park depends on the reflection and reaction of the local community in a protected area.

Recommendations for ecotourism

Putao (Hkakaborazi Peak and its environment), which has a reputation for snow-capped mountains and undisturbed forests, attract visitors (tourists and ecotourists) from different parts of the world.

"the peak season for tourism is from January through to March"

The numbers of tourists from 17 different countries are shown in Table 25. The peak season for tourism is from January through to March. The highest recorded monthly inflow of tourists is 26 in January 1998 (Table 26) and February 1999 (Table 27). In 1998 and 1999 a total of 145 tourists visited Putao.

Table 25: Numbers of tourists from different countries (1998-1999)

Country of origin	Male	Female	Total
Russia	2	0	2
Japan	24	1	25
Germany	5	1	6
Spain	5	4	9
Taiwan	3	0	3
Italy	14	23	37
Australia	8	0	8
France	7	0	7
Canada	4	3	7
USA	6	3	9
Korea	5	0	5
Singapore	3	4	7
Thailand	7	6	13
Ireland	1	0	1
UK	4	0	4
Denmark	0	1	1
Sweden	1	0	1
Total	99	46	145

Table 26: Monthly Inflow of Tourists in 1998

Month	Number of Tourists		
	Male	Female	Total
January	16	10	26
February	9	3	12
March	7	5	12
April	6	0	6
May	4	1	5
June	7	0	7
July	2	1	3
August	1	0	1
September	0	0	0
October	0	0	0
November	0	0	0
December	6	2	8
Total	58	22	80

"the tourists came with different aims"

The tourists came with different aims, which include hiking, mountaineering, undertaking research on animals and plants, camping, bird watching, and cultural study. Ecotourists have many different specialities such as botany, zoology, mountaineering, hiking, and an interest in butterflies and orchids.

Table 27: Monthly Inflow of Tourists in 1999

Month	Number of Tourists		
	Male	Female	Total
January	15	6	21
February	11	15	26
March	5	3	8
April	5	0	5
May	3	0	3
June	1	0	1
July	0	0	0
August	1	0	1
September	0	0	0
Total	41	24	65

Anybody who wants to visit the Putao area should have knowledge of the proper communication channels (see suggestions in Figure 13) so that difficulties in obtaining legal permission to visit are not experienced.

"anybody who wants to visit the Putao area should have knowledge of the proper communication channels"

Details of visits and itineraries should be given to all authorities concerned in advance. Problems occurred in early 1999 because some visitors could not prove they had the appropriate permission or were unaware of certain restrictions.

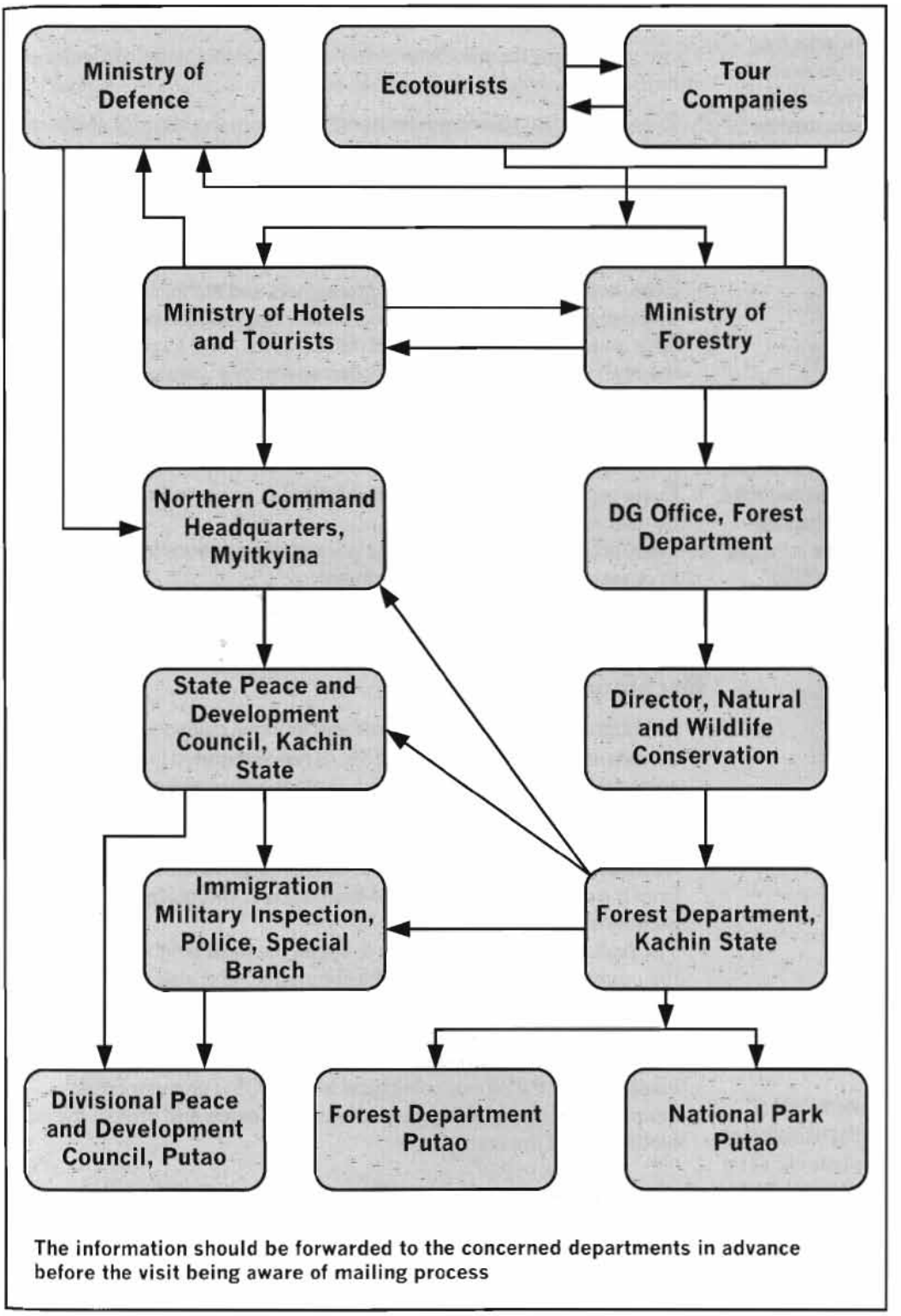

Figure 13: **Suggested Communication Channels for Ecotourism**

"every ecotourist (including both researchers and technicians) should understand the departmental procedures regarding the protection of flora and fauna"

Permission to visitors

It is suggested that the principles below should be adopted in order for visits to go smoothly.

- Every ecotourist should ask for permission from the Ministry of Forestry to undertake their research or fulfil their intended purposes.
- Every ecotourist should report to the local administration as soon as they arrive in the locality.
- Every ecotourist should have copies of their personal papers that they can show to the authorities concerned.
- Every ecotourist (including both researchers and technicians) should understand the departmental procedures regarding the protection of flora and fauna, conservation of natural areas, and forest law so that they can undertake research or collect specimens without breaking the law.

"every ecotourist should contact local administration so that they are informed about prohibitions and permissions in the zone to be visited"

Restrictions for visitors

- Every ecotourist should find out which areas are restricted from access by visitors.
- Every ecotourist should know the rules and regulations for the National Park set out by the Forest Department.
- Every ecotourist should contact local administration so that they are informed about prohibitions and permissions in the zone to be visited.

Recommendations

- Although the extent of settlements and taungya cultivation seems small considering the park area (381,259.78 ha), integrated land use by the community should be encouraged. Further cutting down of forests should be restricted. The local community should be educated about the importance of endangered species.
- Because the park is located in a remote area, protection of rare species from the danger of inevitable law-breakers and smugglers should be addressed.
- The park staff should learn how to speak the local language so that they can become familiar with the community and able to help change their traditions.
- With the aim of upgrading Hkakaborazi, with its peak of 5,881m and attractions for both professionals and amateurs, to the status of 'World Heritage Site' the pioneer biological team WCS is giving special attention and undertaking great efforts to research and protect the rich biodiversity of the area.

"with the aim of upgrading Hkakaborazi, with its peak of 5,881m to the status of 'World Heritage Site'"

Conclusion

The Ministry of Forestry is responsible for encouraging ecotourism, to help fulfil the national plan objectives of welcoming international travellers to our land and promoting the tourist industry. This paper gives general suggestions, which, although not technical, do highlight the management issues.

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Integration of Community-based Conservation Approaches to Wildlife and Forest Laws

Emerging Legislation and Policies in Neighbouring Countries

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"some countries have formulated new policies and amended their laws in the wildlife and forestry sector"

Introduction

We are all aware of the emerging concepts in conservation. These concepts are not merely developing on paper but have taken root at ground level. I am referring to the community approach to conservation. We are all familiar with the successes this concept has gained in some countries of south and south-east Asia. India, Nepal, and Thailand are some of the countries that have seen the inception and strengthening of the community approach.

Some countries have formulated new policies and amended their laws in the wildlife and forestry sector, which reaffirms the strengths and advantages of this approach to conservation. Until recently conservation-related laws and policies had ignored the fact that wildlife areas, besides serving as habitats for wild animals and plants, also harbour a large human population of forest dwellers, especially in developing countries. These local people have lived in the forest and survived on forest produce for centuries. Such peoples' existence, knowledge, practices, rights, and sense of responsibilities, which have often governed the management of their environs, have usually been completely ignored by the authorities.

"these local people have lived in the forest and survived on forest produce for centuries"

In this paper I refer to some of the relevant concepts that are gaining popularity in Asian countries.

Concepts in the forestry sector include community forestry (CF) and joint forest management (JFM) and in the protected area sector they include conservation areas, buffer zones, biosphere reserves, ecodevelopment programmes in the buffer zone of protected areas, community reserves, and conservation reserves.

Historical backdrop

Although community-based conservation seems like a novel concept to many, it is not a new one. Only the recognition it has started receiving in official circles in recent times is new. In most of these concepts we see that there is not a major shift from an earlier system of management, that is, from the system that prevailed prior to the nationalisation of forests in south Asian countries; the change has taken place in the attitudes of those who were considered to be the guardians of the resources of the

"although community-based conservation seems like a novel concept to many, it is not a new one"

nationalised forests — the Forest Department officials. The acceptance by foresters of the role of the community in conservation of resources is new. This acceptance of the vital role of people in conservation has given impetus to community-based conservation.

Instances of community initiatives in conservation have been documented and studied and reveal initiatives in the following different circumstances.

- In areas where peoples' rights to forests were curtailed as a result of the declaration of reserved forests and protected areas, such as national parks, sanctuaries, and nature reserves, which affected the livelihood of the people.
- In forests that were declared reserved or protected but could not be actually protected by the authorities concerned due to paucity of manpower and inaccessibility of such areas.
- In areas where forests were not nationalised and remained under the control of the people.

In areas that remained under the control of people de facto, natural resources continued to be managed by people as per their rules and regulations despite the nationalisation of forests. But areas that came under government control and began to be governed as per state laws started to witness conflicts. Attempts were made to alienate people from the resources by fencing them off from the forests, but in the absence of alternatives, people have continued to live in and around these areas, sharing their habitat with the other inhabitants of the forest. Although in earlier times man and animal have coexisted in the forest, these days the shrinking habitats of wild animals together with an increase in human population have led to what are often termed 'people versus park' problems. To find a solution to these problems, and especially after having realised the inadequacies in state action, governments in some countries have accepted the strengths of the community for protecting the resources in their vicinity. The reason for the strength of the community-based approach is simple — the dependence of these people on the resources. This makes it different from the conventional approach to conservation.

Concepts Emerging Related to Forestry

Community Forestry (CF)

The growing consciousness amongst the forest bureaucracy in many countries regarding their inadequacies in meeting the objectives of forest-resource management — and success stories of community initiatives in conservation which have come to light from several countries have led foresters to take the role of the community more seriously. Nepal was the first country in the Hindu Kush-Himalayan region to amend its forest law (in 1993) to include the concept of CF.

In CF, national or government forests can be handed over to the community after they have formed forest user groups (FUGs) and have made an official request for part of the national forest to be handed over. These groups are entitled to develop, conserve, use, and manage the forest and to sell and distribute forest products independently, by fixing their prices according to the workplan prepared for this purpose with the assistance of the District Forest Officer (DFO). The FUGs are registered with the District Forest Office (DFO), which gives them a legal identity and autonomy in action. The Forest User Groups (FUGs) can generate funds from grants and donations received from the government and non-government or private sources and from collection of fines and fees. The law in Nepal gives priority to CF. The decision of His Majesty's Government of Nepal has been welcomed for its progressive attitude, as it is for the first time ever that forest authorities have handed over forests completely. There is no condition of sharing of resources by the community with the department. Thus with an increased sense of ownership of resources, there is a higher incentive to conserve.

"community forestry has been described as community development with a special emphasis on forestry"

A group of foresters strongly favoured the involvement of people in the management of forests, a form of forestry that later came to be known as CF. By the mid-1970s policy-makers realised that participation of local people was crucial in the management of the forests on which they were dependent. Government, with financial assistance from the World Bank and other donor agencies, introduced a programme to restore the formal control of forest resources to the local communities.

So far almost 10,000 community FUGs have been formed and approximately 750,000 hectares of forest land has been brought under CF (about 17% of the total forest area of Nepal).

Community forestry has been described as community development with a special emphasis on forestry. While the master plan of the forestry sector made it obligatory for users to spend income derived from the forests on forest improvement, the Forest Act of 1993 deviated from this guideline stating that surplus income of the FUGs can be used for development activities other than forestry.

There is an implicit understanding that forest personnel should act as mediators only in major conflicts and that conflicts of a minor nature should be resolved at community level. This provision is a bit weak and has led to several conflicts being left unresolved leading to further problems.

"there is an implicit understanding that forest personnel should act as mediators only in major conflicts"

Joint Forest Management (JFM) in India

The concept of JFM in India differs only slightly from that of CF. Whereas in the CF practised in Nepal the management of the forest is handed over entirely to the community with all the benefits accruing to the community, in the case of JFM, the management of forest land is undertaken jointly by villagers and forest department employees and the benefits are shared between the two parties in a predetermined ratio. Ownership of the land is not transferred in either of the cases.

Joint forest management is a process of reforestation/regeneration of degraded forests through a partnership between foresters and forest communities, by establishing ecological and economic benefits for the community and greater society. This programme was a result of a successful experiment undertaken in a village called Arabari in south-west Bengal in 1971-1972, in which forest protection committees (FPCs) were formed by an enterprising Divisional Forest Officer, who realised that the protection of Arabari Forest was not possible without the cooperation of the local inhabitants because of their dependency on the forest's resources. It was in 1990 that the then Secretary of the Ministry of Environment and Forests issued a circular to all the forest secretaries of all states and UTs laying down guidelines on 'involving village communities and voluntary agencies in the regeneration of degraded forest lands'. Following this, most of the states and UTs of India have passed resolutions to initiate JFM in their areas. All these guidelines are in the form of executive or administrative orders with very little legal enforcement. This has been

"joint forest management is a process of reforestation/ regeneration of degraded forests through a partnership between foresters and forest communities"

found to be a limitation by many forest protection committees (FPCs). Although JFM is being hailed as a positive step in forest conservation, it has not been accorded a legal status so far. But in the meantime, the Ministry of Environment and Forests has brought forth a new set of guidelines to overcome earlier weaknesses in the JFM order.

Some of the provisions as per the new guidelines are as follow.

- Registration of FPCs under the Societies Registration Act, 1860
- Committees have different nomenclatures in different states, hence it is being suggested that all such committees be called joint forest management committees (JFMCs)
- Reservation for women members in the General Body and Executive Committee
- The preparation of a micro-plan after detailed participatory rural appraisals (PRAs) reflecting the livelihood needs and provisions for meeting them
- The extension of JFM to good forest areas in a phased manner
- Creating a working group for conflict resolution at divisional and state level with representatives of stakeholders including non-government organisations (NGOs),
- The recognition of existing self-initiated groups
- Part of the revenue earned by the JFMCs should go to the village development fund.

At the time of writing, all states were expected to revise their state resolutions on JFM soon.

Concepts Emerging Related to Protected Areas in Wildlife Management

Conservation Areas

This concept of shifting from the conventional approach to protected area management to the community approach first took formal shape in Nepal. The third amendment, in 1989, to Nepal's National Park and Wildlife Conservation (NPWC) Act of 1973, heralded a new era in the field of protection of flora and fauna in Nepal. This legislation for the first time formally acknowledged the role of communities in resource conservation, thus replacing the notion of strict protection with that of conservation entailing sustainable use of resources by the community.

The third amendment to the NPWC Act allowed His Majesty's Government, by way of notification in the Nepal Gazette, to declare 'conservation areas' and to entrust the management of any conservation area for the period prescribed in the notification to any institution (including NGOs) established with the objective of conservation of nature and natural wealth.

The first conservation area to be officially declared was the Annapurna Conservation Area (ACA) in mid-western Nepal in 1992. But the actual management of this conservation area was assigned to the King Mahendra Trust for Nature Conservation (KMTNC), a national-level NGO, much earlier, in 1986, to initiate conservation work. The Annapurnas are one of the most popular trekking destinations in the world and visited by over 25,000 trekkers every year. This tourism pressure had taken its toll on the trekking trails and Ghandruk, being the first halting town, was most severely affected by natural resource degradation. Thus KMTNC set up their first office in Ghandruk and began their work from there. Annapurna Conservation Area covers 7,629 sq.km. A small office would not have been able to manage this area. Hence decentralised institutions in the form of Conservation Area Management Committees (CAMCs) were formed

"the management is based on a model of multiple-use zones relying to a great degree on local participation in management and development"

at the level of village development councils (elected administrative units in Nepal). The management of ACA was placed in the hands of 55 CAMCs that formed their own rules and regulations guided by the operational plan (OP). The work under the CAMCs was further divided into different subcommittees: the forest management committee; the lodge management committee; the hydropower management committee; the trail management committee; and mothers' groups.

An operational plan (OP) was drafted by the Worldwide Fund for Nature for the management of the ACA in 1986 and for almost 10 years the provisions of the OP guided the management of ACA. The management is based on a model of multiple-use zones relying to a great degree on local participation in management and development. The management zones indicated in the OP are the wilderness zone, the special-management zone, the protected-forest/seasonal-grazing zone, the intensive-use zone, and the biotic/anthropological zone. The OP regulated activities including hunting, collection of dry wood, fodder, leaf litter, bamboo, timber, medicinal plants, grazing, trekking, reforestation, and maintenance of hot springs; traditional rights were not to be restricted.

In 1993, His Majesty's Government formulated the Conservation Area Management Regulations with the intent of having formal and uniform rules for the management of conservation areas.

"the success of the Annapurna Conservation Area Project (ACAP) has been acclaimed at international level"

The success of the Annapurna Conservation Area Project (ACAP) has been acclaimed at international level. One of the main reasons for its success is the legal status accorded to the concept, which makes it stable and secure. Declaration of four more conservation areas in Nepal has occurred more recently.

Buffer Zones

A buffer zone is the peripheral zone of a national park or reserve which, when formally designated, allows local inhabitants to use forest produce. Although this concept has been talked about for many years now, Nepal is the first Himalayan country to have incorporated it into law. Nepal amended its wildlife law in 1993 to give legal recognition to the concept of the buffer zone. Provision has been made to spend 30-50% of the income of parks or reserves on development activities in the buffer zone, in coordination with local bodies. His Majesty's Government of Nepal promulgated Buffer Zone Management Regulations in 1996.

This amendment and the new Regulations for the Management of Buffer Zones are being looked upon as a measure for improving the people-parks conflict situation in protected areas. The successes of this model of conservation in Nepal are yet to be observed, as this is a relatively new experiment in Nepal. The responsibility for the management of this area rests with the Warden.

"although this concept has been talked about for many years now, Nepal is the first Himalayan country to have incorporated it into law"

The new regulations provide for the formation of user committees in coordination with local authorities to assist in community development

and balanced use of forest resources, and the conservation of other elements including wildlife, the natural environment and natural resources, biodiversity and forests.

Some lacunae have been observed in the regulations, which are likely to hamper their intent. The regulations provide for the preparation of the Buffer Zone Management Plan by the Warden; the plan is then sent to the Director General of the Department of National Parks and Wildlife Conservation and then to the Ministry for approval. Preparation of the Buffer Zone Management Plan does not include any involvement of the local people. Their role comes much later, in the preparation of the microplan, which is based on the Buffer Zone Management Plan.

Biosphere Reserves

The United Nations Educational, Scientific and Cultural Organization (UNESCO) introduced the idea of biosphere reserves in 1973-1974 as part of its Man and Biosphere Programme. Biosphere reserves are designated to reconcile the conservation of biodiversity, the quest for economic and social development, and maintenance of associated cultural values. Biosphere reserves are protected areas of land and/or coastal/marine environments wherein people are an integral component of the system.

The basic intention behind the declaration of biosphere reserves is to fulfil the following three functions:

- the conservation function — to ensure the conservation of landscapes, ecosystems, species, and genetic variation;
- the development function — to promote, at local level, economic development which is culturally, socially, and ecologically sustainable;
- the logistic function — to provide support for research, monitoring, education, and information exchange related to local, national, and global issues of conservation and development.

This category of protected area has received wide attention internationally. By December 1998, 356 biosphere reserves in 90 countries had been created.

India has declared seven biosphere reserves. These reserves have been established within the existing legal framework through administrative orders. Hence the legal protection afforded to these areas is limited to the extent that the boundaries coincide with those of a sanctuary or a national park. No law affording legal status to the concept of biosphere reserves has been made so far and there seems to be no attempt on the part of the Forest Department to push for any.

The central government in India has constituted a National Man and Biosphere Committee to advise on policy and programme formulation for biosphere reserves in the country, to lay guidelines for the preparation and approval of Management Action Plans, to oversee implementation and monitoring, and to evaluate and approve new biosphere reserves.

The management of biosphere reserves is guided by Management Action Plans and is based on a multiple-use, zonal principle. Biosphere reserves include a core area, a buffer zone, and a transition area. Ownership pattern varies in accordance with the zones: the core areas are under government ownership and the buffer and transition areas are usually under private and community ownership. Although the concept of biosphere reserves has yet to show signs of success in India, it has acclaimed success in many countries.

"ecodevelopment measures were recommended to divert pressures from protected areas"

The concept of conservation areas, as promoted initially in Nepal with the declaration of its first conservation area — Annapurna Conservation Area – in 1986, is very close to the concept of biosphere reserves.

Ecodevelopment

The World Conservation Strategy proposed by the International Union for Conservation of Nature and Natural Resources (IUCN), the United Nations Environment Programme (UNEP), and the Worldwide Fund for Nature (WWF) in 1980, emphasised the importance of alleviating rural poverty as a component of conservation planning. Ecodevelopment measures were recommended to divert pressures from protected areas. This is being done in India by creation of ecodevelopment committees in fringe villages, comprising the stakeholders.

This has not been too successful, probably because it too has been based on the premise that people are a burden on forest resources and that they have to be weaned from the forest by giving them alternatives.

"this has not been too successful, probably because it too has been based on the premise that people are a burden on forest resources"

The concept of ecodevelopment is based on the perception of providing benefits and concessions to local people to reduce their dependence on the forests. It still excludes these people from the process of planning the management of the protected area. There are also other flaws in the implementation of the programme. Proper resource use and need assessment is not done prior to deciding on the benefit to be provided and the process of identifying the beneficiary is usually erroneous. As long as money is poured in, there will be temporary relief (maybe) but conservation will not be ensured. In many places, these committees exist only on paper.

Community Reserves

Community reserves are a new form of protected area being proposed in India. They are being proposed to ensure greater participation and decision-making by the local people.

In 1997, an amendment was proposed to the existing Wildlife (Protection) Act of India, 1972, to incorporate this new category of protected area in order to give legal recognition to the efforts of those communities who have been managing forest areas in different parts of the country for many years; for example, areas such as the north-eastern states of India, where the majority of forests are managed by the community. There are also some communities, such as the Bishnois, who are well known for traditionally conserving their forest resources.

"there are also some communities, such as the Bishnois, who are well known for traditionally conserving their forest resources"

The amendment bill proposes to declare this new category of protected area in areas other than those that are within a national park; a sanctuary for protecting the flora, fauna, and traditional or cultural conservation values and practices, where the community or an individual has volunteered to conserve wildlife and its habitats.

The authority to oversee the management of this protected area would rest with a committee comprising five village representatives and representatives of the state forest or wildlife department. The committee would prepare and implement the Management Plan for the community reserve and take steps to ensure the protection of wildlife and its habitats in the reserve.

The committee has been given the authority to regulate its own procedures. However the amendment bill is silent on the rules and regulations that will govern the new set of protected areas, that is, community reserves and conservation reserves.

Conservation Reserves

This is yet another category of protected area that is being proposed to act as a buffer to national parks and sanctuaries. This kind of protection is intended for areas lying adjacent to protected areas inhabited by a considerable human population and for areas serving as corridors between two protected areas. The government intends to conserve these areas by implementing ecodevelopment programmes and seeking the participation of local people in the conservation of the resources.

It is proposed that a Conservation Reserve Management Committee be set up to advise the Chief Wildlife Warden on conservation, management, and maintenance of the reserve. The committee will comprise officials from the forest department, local village representatives, and NGOs. In this case too the committee will have the authority to regulate its own procedures.

Conclusion

The enactment of legislation empowering the community in natural resource management has certainly been a revolutionary move in Nepal, and conservation had benefited greatly. But it would be unfair and unjust if the role of agencies such as NGOs (both national and international) was not given due credit for the process. It is the unstinted conviction and constant involvement of such NGOs at different levels that has contributed to the evolution and success of community-based conservation, not only in Nepal but in India too. In India, the credit goes largely to local and community-based NGOs. We also cannot overlook the fact that the passing of amendments to the law in Nepal also reflects the political will of the country. And, in Nepal, it is not merely the political will that is visible but the bureaucratic will has also been found to be strong enough, which is evident from the enforcement of the laws there. All this together has contributed to the success of CF and conservation area management in Nepal.

Before finally concluding, I would like to outline a few points that I feel are important for Transboundary Conservation.

- If we look at the Himalayan belt, we find that there are several sets of protected areas transcending political boundaries of countries. A policy gap analysis of these protected areas that fall in different countries shows that these areas, which are rich in biodiversity, may not have the same degree of legal protection in adjacent countries. One example is Kanchenjunga protected area, which is a national park in India and has conservation area status in Nepal. Another example is Namdapha National Park in Arunachal Pradesh in India, which has the most stringent of legal protections; but on the other side of the international boundary, in Myanmar, the same area does not have protected area status. To overcome these lacunae, it is at least necessary that protected transborder areas are governed by uniform legislation. Contradictory and conflicting laws with respect to wildlife harvests, penalties, trade, customs,

"people living in such bio-rich areas on either side of international borders belong to the same ethnic groups"

immigration, and extradition are often impediments in cooperative law enforcement.

- Very often it has been observed that people living in such bio-rich areas on either side of international borders belong to the same ethnic groups and also often have marital relationships with people in adjacent areas. Communities residing in such areas normally have their own rules and norms for the management of natural resources (including wildlife) within the area. Hence it would also be appropriate to understand these customary laws and practices, which may have some inherent conservation value. Quite often the enforcement of statutory laws in both countries is inadequate due to the remote and inaccessible terrain in the mountains and hence the laws can become quite ineffective.
- Instances have come to light where endangered species found in transfrontier areas are found to be listed in different schedules in the wildlife legislation of neighbouring countries, which implies different provisions relating to the degree of protection accorded to these animals. This could result in increased poaching in countries with a lower degree of legal protection.

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'Sub-Regional Consultation on Conservation of Hkakaborazi Mountain Ecosystems in Eastern Himalayas', Putao of Kachin State, Myanmar

October 25-29, 1999

Background

Sub-regional consultation on the conservation of the Hkakaborazi mountain ecosystem is a key activity as defined by the International Centre for Integrated Mountain Development (ICIMOD) together with the Government of Myanmar and it is also an important component of the Eastern Himalayan Programme for Collaboration in Biodiversity 1998-2000, supported by the MacArthur Foundation.

The biodiversity of the eastern Himalayan region located towards the southeastern end of the Himalayas is unique. The eastern Himalayas are a meeting point of the Indo-Chinese and Indo-Malayan tropical lowland flora, the Sino-Himalayan/east Asiatic flora and the western and central Himalayan flora. Towards the east elements of the alpine flora of western China are also evident. The significance of the Hkakaborazi region lies in the fact that it is considered an Asiatic centre of endemism and centre of origin for angiosperm flora.

Hkakaborazi is a snow-capped mountain and the highest peak in Myanmar (5,881m). It is situated in the far northern part of Myanmar, in Kachin State. In 1996, 3,812 sq.km of mountain area had been reserved for nature conservation under the Wildlife Protection Law of Myanmar.

The Hkakaborazi mountain system is shared by Zayu Nature Reserve in Tibet, an autonomous region of China, which is situated in Zayu County and was established in 1985. Zayu Nature Reserve has an area of 1,014 sq.km. Forest types typical in the reserve are subtropical, evergreen, broadleaf forests and pine forests. Another natural protection area in China that falls into the Hkakaborazi region is the Gaoligong Shan Nature Reserve, covering an area of 1,233 sq.km. This reserve was established in 1983 and has been recently extended into the Dulong Jiang area that is actually in the Hkakaborazi mountains. Forest types found in the reserve are subtropical, evergreen, broadleaf forests, alpine forests and coniferous forests. Rare and endangered flora and fauna inhabit the reserve and represent a rich biodiversity.

Aspects of interest when considering conservation of the Hkakaborazi mountain ecosystem are

- Hkakaborazi is the highest mountain peak in Myanmar and the far eastern Himalayas,
- of the eastern Himalayan natural ecosystem forests it is one of those that has been least affected by modern development intervention,
- it is still a very inaccessible area, covering about 80% of Kachin State, with closed forests in Myanmar and good forest cover in parts of China,
- there is scope for transboundary collaboration and this needs to be addressed as soon as possible,

"ethnic minorities still have low population densities and practise traditional shifting agriculture"

- only limited research has been undertaken in this area and there is considerable scope for joint research initiatives,
- ethnic minorities found in the area include Kachin (Jinpo), Tayon, Dalaung (Dulong), Lisu, Tibetan, Phun, Ya-wan, and Shan-ta-yok, and
- these ethnic minorities still have low population densities and practise traditional shifting agriculture. They have their own traditional cultures and beliefs, and hence cultural diversity is also very high.

Objectives of the Workshop

The long-term objective of the workshop is to contribute to the conservation of the rich natural biodiversity of the Hkakaborazi mountain ecosystem.

Immediate objectives are

- to exchange and share information on the Hkakaborazi region between Myanmar and China,
- to create spatial and ecological databases for the future management plan of the park,
- to discuss and recommend strategies and approaches for conservation, including transboundary collaboration, and
- to identify potential sources for providing support to conservation in the region.

"twenty-nine participants from government and research institutions in Myanmar and China"

Participants

Twenty-nine participants from government and research institutions in Myanmar and China, and representatives of the Wildlife Conservation Society (WCS) (an international non-government organisation) and ICIMOD participated (see Appendix 1).

The Workshop Venue

The workshop took place in Hkakaborazi Guest House in Putao, Kachin State, which is situated in the northernmost part of Myanmar and borders with Yunnan Province and Tibet, an autonomous region of China, in the north and east, and with Arunachal Pradesh State of India in the west. Putao Town is the capital of Putao District. The people living in this region still keep their traditional life customs.

The Workshop Programme

The workshop agenda included the following.

- An inauguration session
- Session I — An Introduction to the Hkakaborazi ecosystem
- Session II — Biodiversity conservation in the eastern Himalayas
- Session III — Institutional profiles and their related activities
- Session IV — Priorities for biodiversity conservation in the Hkakaborazi mountain ecosystem
- A field trip to Mular-Shi-Di Village and Ma-chan-baw
- A plenary discussion and closing ceremony

The detailed programme is shown in Appendix 2

Inaugural Session

An inaugural address by U. Shwe Kyaw, Deputy Director General of the Forest Department, gave a warm welcome to the participants and introduced the general conditions and history of expeditions to the Hkakaborazi mountain area.

An opening speech was made by Mr Maung Myo, the Chairman of the Peace and Development Council, Putao District, Kachin State.

An opening address, given by Professor Chen Guangwei, Division Head of Mountain Natural Resources, ICIMOD, introduced the mandate of ICIMOD and its efforts in biodiversity conservation.

The background and objectives of the project were defined by Mr Ajay Rastogi, a biodiversity specialist from ICIMOD.

The schedule and key activities of the workshop were outlined by U. Htun Paw Oo, Deputy Director of the Forest Department, Myanmar.

Summary of Thematic Papers Presented at the Workshop

The 15 thematic papers presented at the workshop covered a wide range of topics related to biodiversity conservation in the eastern Himalayas and many of them introduced important information about this region to the outside world. Selected papers are included in Part II of this book. Titles have been modified in Part II in compliance with good English usage.

The non-government organisation (NGO) collaboration for the development of Hkakaborazi National Park in Myanmar presented by U. Saw Htun Khine introduced the the biogeography of and biological expeditions to this region, with detailed data and histories of related activities. An interesting paper on socioeconomic and cultural conditions of ethnic communities in Hkakaborazi National Park presented very detailed, first-hand information obtained through an expedition. One paper described the vegetation and key floristic features of the region, two papers presented information about orchids, and one paper introduced the rhododendrons endemic to the Myanmar snow-capped mountain region. One paper introduced the current status of and threats to the survival of large mammals in north Myanmar and one paper presented recently recorded birds of the Hkakaborazi region. The other topics presented included ecotourism, policy and management issues, and institutional profiles. All of these data are valuable for furthering understanding of this inaccessible region and for future collaborative cooperation.

Session I – An Introduction to the Hkakaborazi Ecosystem

"NGO collaboration for the development of Hkakaborazi National Park in North Myanmar" addressed WCS activities in Myanmar. This organisation has been providing support for field surveys (on tigers and tortoises, for example), basic training on wildlife conservation, and small research grants. "Vegetation and key floristic features of Hkakaborazi National Park" presented information on the history of botany and the vegetation and flora in northern Myanmar, as well as study methodology, field activities, and results. Special papers covered "Rhododendrons endemic to the Myanmar snow-capped mountain region", "An introduction to Myanmar native orchids of the Hkakaborazi Area", "Some endemic species and new records of orchids of Hkakaborazi and surrounding areas", and "Birds Recently Sighted in Hkakaborazi Region, Northern Myanmar". A paper on "Socioeconomic and Cultural Conditions of Ethnic

"interesting data, some at family level. Data on physical conditions and ethnic groups (their ways of living, their languages, their religion and beliefs, shifting cultivation, and hunting) were presented"

Communities in Hkakaborazi National Park" presented interesting data, some at family level. Data on physical conditions and ethnic groups (their ways of living, their languages, their religion and beliefs, shifting cultivation, and hunting) were presented. In this section "Hkakaborazi National Park and its related management issues" and "Pidaung Wildlife Sanctury" (the oldest protected area in Myanmar, established in 1913) were also addressed.

Session II — Biodiversity Conservation in the Eastern Himalayas

A study on existing and potential areas for transboundary conservation in India along the Sino-Indian border of the eastern Himalayas was described, briefing the vegetation, natural reserves, and related issues of Arunachal Pradesh and Sikkim. Remote sensing and geographic information systems (GIS) were used for analysis of land cover and use and the characteristics of protected areas. The presentation on "Emerging policy and legislation regime for biodiversity conservation in protected areas" assessed new concepts in conservation, including community forestry and ecodevelopment buffer zones.

Session III — Institutional Profiles and Their Related activities

"Current status and threats to the survival of large mammals in north Myanmar" reviewed the expedition and survey of nature and history of nature conservation in Myanmar. The illegal trade of wildlife is a key driving force threatening the survival of wild animals. Based on field survey, hunting activities and the prices of animal parts were summarised. A set of recommendations for the protection of wildlife was also suggested. A presentation was given on ICIMOD as an important international organisation working in the Hindu Kush-Himalayan eco-region and undertaking a wide range of activities related to mountain farming systems, watershed management, management of mountain commons, mountain enterprises, and infrastructure, information systems, and data dissemination. China's experiences of nature conservation in Yunnan and the Tibetan Plateau were discussed. The biodiversity characteristics of the Grand Canyon of the Yarlung Zangbo River in the eastern Himalayas were discussed in a special presentation by the expedition team leader Professor Li Bosheng, Chinese Academy of Sciences (CAS)

"the illegal trade of wildlife is a key driving force threatening the survival of wild animals"

Session IV — Priorities for Biodiversity Conservation in the Hkakaborazi Mountain Ecosystem

Two groups were formed to discuss the 'hot' issues of Hkakaborazi National Park. Group I focused on 'Management and socialeconomic issues: policy regulation, incentives for community participation, institutional mechanisms, etc.' and Group II on 'Scientific surveys and conservation planning: gaps in information and knowledge'. These were followed up with group presentations and deliberations on the scope of regional collaboration.

The outcomes of the discussion on 'Scientific survey and conservation planning: gaps in information and knowledge' are

- The geographic limits of the 'Greater Hkakaborazi' ecosystem within the countries of India, Myanmar, and China should be identified. ICIMOD will play a key role in coordinating efforts by the respective countries in the delineation of the geographic limits.
- Standardised land-use, land-cover, and vegetation maps for the ecosystem should be generated. Technical assistance from ICIMOD (GIS analysis, Land Observation Satellite (Landsat) images) is required.
- Biodiversity surveys need to be initiated with the aim of collecting baseline data on plants, animals, reptiles, amphibians, birds, and insects. Species' inventories need to be developed.
- Preliminary identification of rare, threatened, and endangered species (based on categories of the International Union for Conservation of Nature and Natural Resources (IUCN) should be refined with the accumulation of additional information.
- Biodiversity mapping requires the training of taxonomists and para-taxonomists.
- There is a need for the exchange of scientific data, personnel, and relevant literature among the three countries. ICIMOD could play a key role in facilitating this exchange.
- Scientific research projects need to be initiated within the area. Training in research methods is an important requirement. These activities could be supported by ICIMOD and other NGOs (such as WCS).
- Scientific studies on wildlife trade, medicinal plant use, traditional resource use, density and distribution of threatened plants and animals (habitats), and anthropogenic dependence on natural resources should be initiated.
- Permanent plots in representative habitats for purposes of research, vegetation sampling, and monitoring should be established.
- Shifting cultivation and hunting for the wildlife trade are perceived as serious threats to biodiversity in the area. The management plan needs to identify and test sustainable alternatives to these activities.
- The establishment of research stations will help in surveying, monitoring, and data collection in the long term.
- It is important to share information on migratory and threatened bird and mammal species.
- Environmental education and awareness are significant issues that need to be addressed. Local language posters on endangered species, the value of wildlife, sustainable use of natural resources (over harvesting of wildlife and medicinal plants), and wildlife laws need to be designed and disseminated. Environmental education activities could be undertaken through mobile workshops and the introduction of environmental curricula in schools. Awareness of conservation issues should occur at all levels: from administrative authorities at district level to the local people.
- Past successes of collaborative, interdisciplinary expeditions indicate that future surveys and expeditions should also be collaborative – and should include representatives from neighbouring countries.
- It is critically important to clearly identify and quantify the threats to the area and to design appropriate solutions. Conservation solutions should be directly linked to threats and should be site specific.
- Ecotourism has unintentionally resulted in the illegal collection of butterflies, insects, birds, and orchids. Appropriate steps need to be taken to ensure that illegal collection activities are stopped and all research activities in the country are conducted in collaboration with the Forest Department.

"participants studied land cover, land use, the forest, infrastructure, and the way of life of local people"

Field Trip to Mular Shidi Village and Machanbaw Township

A one-day field trip to Mular Shi Di Village and Ma-chan-baw was organised. On the way participants studied land cover, land use, the forest, infrastructure, and the way of life of local people. The villagers of Lisu and Rawan danced, sang, and served a variety of local food to present their warm welcome to the delegetion in Mular Shi Di Village. Delegates visited local markets and observed people's activities in the Machanbaw Township: ethnic housing, family gardens, suspension bridges, and shifting agriculture (taungya) scattered among the hills provided a picturesque view. A more detailed study would allow species of plants to be identified and discussion with the local people to learn more about their daily life and income.

Plenary Discussion and Closing Ceremony

A plenary discussion was held on 29 October 1999 to finalise the recommendations for the following (see Appendix 3): (1) The Greater Hkakaborazi mountain ecosystem; (2) a southern extension to Hkakaborazi National Park; (3) wildlife trade; (4) scientific studies; (5) management of Hkakaborazi National Park; (6) an education and awareness programme; (7) world heritage site status. This was followed by the closing ceremony. Participants were pleased to have had the opportunity to visit Putao District, a remote area of Myanmar.

Appendix 1: **Participants List and Addresses**

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Appendix 2: **Workshop Programme**

26th October 1999

08:20-08:30	:	Opening Ceremony
08:30-08:45	:	Welcome Address by U. Shwe Kyaw (Deputy Director General, Forest Department, Myanmar)
08:45-08:55	:	Welcome Address by Lt Col. Maung Myoe (Chairman of the Putao District Peace and Development Council)
08:55-09:05	:	Opening Remarks by Prof. Chen Guangwei (Division Head, Mountain Natural Resources Division, ICIMOD)
09:05-09:15	:	Background and Objectives of the Project by Mr Ajay Rastogi (Biodiversity Specialist, ICIMOD)
09:15-09:25	:	Schedule and Key Activities by U. Htun Paw Oo (Deputy Director, Forest Department, Myanmar)
09:25-10:00	:	Group Photo and Tea
Session I	:	**An Introduction to the Hkakaborazi Ecosystem** (Chairperson — U. Shwe Kyaw)
10:00-10:25	:	Presentation on the 'NGO Collaboration for the Development of Hkakaborazi N.P. in Northern Myanmar' by U. Saw Htun Khine, Country Coordinator of WCS, Myanmar
10:25-10:50	:	Presentation on the 'Vegetation and Key Floristic Features of Hkakaborazi N.P' by U. Myo Khin, Lecturer, Botany Department, Yangon University
10:50-11:15	:	Presentation on 'Rhododendrons Endemic to Myanmar Snow-capped Mountain Region' by Daw Kalyar Lu, Tutor, Botany Department, Myitkyina University
11:15-12:00	:	Discussion
12:00-13:00	:	Lunch

Session II : **Afternoon** (Chairperson – U. Aung Than)

13:00-13:25 : Presentation on 'Some Endemic Species and New Records of Orchids of Hkakaborazi and Surrounding Areas' by U. Kyaw Nyunt, CEC Member, Myanmar Floriculturists' Association

13:25-13:50 : Presentation on 'An Introduction to Myanmar Native Orchids of Hkakaborazi Area' by U. Saw Lwin, CEC Member, Myanmar Floriculturists' Association

13:50-14:15 : Presentation on 'Social Economic and Development Context of Hkakaborazi N.P' by U. Atmg Win, Lecturer, Geography Department, Yangon University

14:15-15:00 : Discussion

15:00-15:30 : Tea

15:30-15:55 : Presentation on 'Pidaung Wildlife Sanctuary' by U Zin Oo, Park Warden, Pidaung Wildlife Sanctuary, FD

15:55-16:20 : Presentation on 'Hkakaborazi National Park and its Related management Issues' by U. Tun Nyo, Deputy Director, FD, Kachin State

16:20-16:45 : Presentation on 'Birds Recently Sighted in Hkakaborazi Region, Northern Myanmar' by U. Thein Aung, Park Warden, Hkakaborazi National Park

16:45-17:30 : Discussion

Film on 'Hkakaborazi N.P' at Dinner

Session II : **Biodiversity Conservation in the Eastern Himalayas** (Chairperson — U. Saw Htun Khaing)

27th October 1999

08:30-09:00 : Presentation on the Eastern Himalayas by Mr Ajay Rastogi, Biodiversity Specialist, ICIMOD

09:00-09:30 : Presentation on 'Emerging Policy and Legislation Regime for Biodiversity Conservation in Protected Areas' by Ms. Ruchi Pant, Policy Analyst and Director, Eastern Himalayas Programme Ashoka Trust for Ecology and the Environment — ATREE

09:30-10:00 : Tea

Session III : **Institutional Profiles and their Related Activities** (Chairperson – Prof. Chen Guangwei)

10:00-10:30 : 'Current Status and Threats to the Survival of Large Mammals in North Myanmar' by Dr Madhu Rao, Science Director of the International Programme, WCS

10:30-11:20 : Presentation on ICIMOD by Prof. Chen Guangwei

11:20-11:50 : Presentation on Ecotourism by Prof. Li Bosheng, Senior Staff, Department of Forestry, Yunnan Province, PRC

11:50-12:00 : Brief on National Commission on Environmental Affairs by U. Saing Than Maung, Staff Officer, NCEA

12:00-13:00 : Lunch

Session IV	: **Priorities for Biodiversity Conservation in the Hkakaborazi Mountain Ecosystem**	
13:00-16:00	: **Group I:**	Management and Social-Economic Issues: Policy Regulation, Incentives for Community Participation, Institutional Mechanisms, etc.
	Group II:	Scientific Surveys and Conservation Planning: Gaps in Information and Knowledge
16:00-17:00	: Group Presentations and Deliberations on the Scope of Regional Collaboration in Hkakaborazi Mountain Ecosystem for Biodiversity Conservation	
17:00-17:30	: Orientation and Information on Field Trip	

28th October 1999

Field Trip to Mular Shi Di Village and Machanbaw

29th October 1999

08:30-10:00	: Plenary Discussion
12:00	: Check Out and Departure for Yangon

Appendix 3 : **Recommendations of Workshop**

Hkakaborazi mountain ecosystem lies in the globally important biodiversity 'hotspot' region of the eastern Himalayas encompassing tropical, subtropical, temperate, and alpine zones. This unique area is a reservoir of biodiversity representing a transition zone between the temperate and alpine flora and fauna of the Sino-Himalayas and that of tropical Indo-Malaysia. This workshop was jointly organised by the Forest Department of the Government of the Union of Myanmar and the International Centre for Integrated Mountain Development, Kathmandu, at the headquarters of Hkakaborazi National Park, Putao, from 25-29 October 1999. The deliberations and presentations on the Hkakaborazi mountain ecosystem encompassed scientific, managerial, and socioeconomic aspects. The participants came from diverse disciplines representing government departments, universities, and local administration from the Union of Myanmar, the Chinese Academy of Sciences, an Indian NGO (ATREE), an international NGO (WCS), and regional institutions such as ICIMOD. The exchanges of views, information, and ideas were focused on identifying key issues related to the conservation of the Hkakaborazi National Park. At the outset, all participants applauded the Government of the Union of Myanmar for their sustained efforts to upgrade the conservation status of the Hkakaborazi region within a short period to that of a national park, with active involvement and support of WCS. This important decision ensures long-term commitment to the conservation of the region. At the same time, it poses an enormous challenge of ensuring conservation in an extensive and remote mountainous region. The workshop participants made the following recommendations.

The Greater Hkakaborazi Mountain Ecosystem

Historically, the ethnic communities inhabiting this region have shared similar biophysical resources, cultural background, and some extent of interdependence for barter and trade across the political borders of the Union of Myanmar, India, and China. By virtue of the rich wealth of flora and fauna, the majority of trade from Myanmar to China has been in natural products. This trade has gone on unabated to date, despite the fact that both countries are parties to international conventions such as the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) and are thus obliged to stop these transactions. The communities living here have never faced regulations restricting their use of natural resources and at the same time are living in a very remote region devoid of many alternative opportunities for income generation. The challenge that lies in this task of conserving Hkakaborazi National Park and the much-needed international cooperation to facilitate this important endeavour are widely recognised. Therefore, the workshop recommends the constitution of a Greater Hkakaborazi mountain ecosystem to conserve more effectively the natural resources of the region. In this context it becomes imperative to identify the geographic limits of this ecosystem within the countries of India, Myanmar, and China. It is necessary to generate standardised land-use, land-cover, and vegetation maps for the ecosystem, with technical assistance from in-country and

"in Hkakaborazi Park, the trade in hunting for illegal wildlife constitutes the most serious threat"

international organisations. ICIMOD, as a regional institution, is also suited to play a key role in coordinating the required efforts.

A Southern Extension to Hkakaborazi National Park

The current extent of the park in Myanmar begins at an average elevation of 914m. The tropical forest belt (below 914m) is biologically significant yet not included in the current coverage of the park. On the south-western boundary of the park, there are relatively undisturbed tracts of tropical forest remaining. It is therefore advisable to undertake a feasibility assessment to explore the possibility of extending the southern border of the park with a suitable buffer zone in order to ensure a more complete representation of vegetation and habitat types.

Wildlife Trade

In Hkakoborazi Park, although factors such as habitat loss and fragmentation are causes for concern, the trade in hunting for illegal wildlife constitutes the most serious threat. Of relevance is the fact that the market for wildlife products originating from within the park lies outside the country, mainly in China. In order to address this issue, a three-tier strategy is envisioned.

- At local level, the Government of the Union of Myanmar prohibits hunting for trade, by law. There is a need to enhance enforcement of wildlife laws to curb this activity locally, within and outside the park.
- At national level, there is a need to strengthen enforcement measures exercised by other departments, such as the Immigration and Manpower Department, to help curb these activities by monitoring the traders crossing over the border from India and China.
- At regional level, while all three countries are signatories to the CITES convention, adequate steps to enforce the provisions are lacking in all three countries in this region. It is therefore imperative that a regional institution such as ICIMOD initiates a process of regional discussions on the wildlife trade issue in consultation with government and non-government organisations such as TRAFFIC

"imperative that a regional institution such as ICIMOD initiates a process of regional discussions on the wildlife trade issue in consultation with government and non-government organisations such as TRAFFIC"

Scientific Studies

Scientific studies on wildlife trade, medicinal plant use, traditional resource use, density and distribution of threatened plants and animals, and anthropogenic dependence on natural resources should be initiated. ATREE, WCS, CAS, and ICIMOD can provide key assistance for the exchange of scientific and socioeconomic data, technical and legal literature, and expertise.

Management of Hkakaborazi National Park

- A management committee comprising of representatives from the Nature and Wildlife Conservation Division (Forest Department, Union of Myanmar), local departments (general administration, education, and health), International NGOs (WCS), and members of the local community needs to be set up.

- The committee will oversee the development of a conservation strategy to enhance protection, capacity building, and community welfare measures for Hkakaborazi National Park.

An Education and Awareness Programme

Environmental education and conservation awareness are significant issues that need to be addressed. The Nature and Wildlife Conservation Division (Forest Department) with assistance from WCS is in the process of establishing an education and information centre at Putao, the headquarters of Hkakaborazi National Park. Organisations such as ICIMOD, the Chinese Academy of Sciences, and ATREE, who are interested in contributing to the greater Hkakaborazi system, should forge linkages with this centre; it should be treated as a focal point for sharing resources.

World Heritage Site Status

The uniqueness and relatively pristine nature of the Hkakaborazi ecosystem warrants its consideration as a World Heritage Site. The Government of the Union of Myanmar, in its commitment for the long-term conservation of the area, is in the process of developing a proposal to the United Nations Educational, Scientific and Cultural Organization (UNESCO) for consideration of the park as a World Heritage Site. With knowledge of the significance of the area, neighbouring countries, and regional and international organisations working on issues of biodiversity conservation and sustainable development in mountain areas should support the recommendation. This would help focus greater international attention on the region and may result in generating much-needed financial and technical resources to help conserve the ecosystem.

Hkakaborazi: the highest mountain in South East Asia (5,881m) northern Myanmar
— *U Shwe Kyaw*

Putao Basin – fertile land with a sub-tropical climate
— *Chen Guangwei*

A village in Putao basin, well planned by Christian missionaries with road, clinic, church and houses matched with garden
— *Chen Guangwei*

Local market in Putao - farmers sell their products in the morning — *Chen Guangwei*

Children dressed in local style, Putao — *Chen Guangwei*

Sub-Regional Consultation on Conservation of Hkakaborazi Mountain Ecosystem, Putao, Myitkina — *U Shwe Kyaw*

Dr. Madhu Rao , Science Director, International Programme, WCS, making a presentation — *Chen Guangwei*

Workshop Display

Plant exhibition at the workshop in Putao — *Chen Guangwei*

Field work organised by the workshop on local land use in Putao — *U Shwe Kyaw*?

Participants are warmly welcomed by local villagers (Kachin, Lisu) — *U Shwe Kyaw*

General Meeting at the workshop — *Chen Guangwei*

INTRODUCTION TO PART 3

Management Model Plan for Pidaung Wildlife Sanctuary, Myitkyina of Myanmar

This part of the book examines biodiversity conservation in Pidaung Wildlife Sanctuary and focuses on the preparation of a management plan for the sanctuary, which can also be used as a model for other similar areas. Issues covered include evaluation of the sanctuary's current conservation value, detailed information about important species of flora and fauna, problems being faced in conserving the area and recommendations for addressing these, and how to approach creating a model management plan. A report for a workshop 'Preparing a Model Management Plan for Pidaung Wildlife Sanctuary' is also included.

Location

Pidaung Wildlife Sanctuary is located in Myitkina Township, Kachin State, Myanmar. Myanmar lies in between the diverse countries of India and China to the north-west, west, and north-east. Kachin State is situated between 24°-28° 30' N and 97°- 99° E.

Biodiversity in Myanmar

Due to its geographical position, Myanmar contains flora and fauna belonging to the Indo-Malaysian realm, and possesses an ecological spectrum ranging from snow-capped peaks to tropical rainforests as well as coastal and marine ecosystems. Thus the flora and fauna in Myanmar are unusually diverse, a reservoir of invaluable biodiversity, comprising many rare, endemic, vulnerable, and endangered species. This biodiversity, which is a natural heritage of the country, deserves to be conserved for the benefit of present and future generations. It is the richness of natural resources (for example, its biodiversity, forests, and ecosystems) and their sustainability that are the mainstay of the country's long-term integrated economic and social development.

Pidaung Wildlife Sanctuary

Designated as a reserve in 1913 and then a game sanctuary in 1918, Pidaung Wildlife Sanctuary is one of the oldest sanctuaries in Myanmar. The area consists of low-lying areas surrounded by high mountain ranges, with a plain on the southern side of the sanctuary, together with a hilly

"it is hoped that with an integrated approach, good foresight, and full participation of the local authority, the sanctuary will be returned to its former state"

and rolling configuration in the north that connects with the Kumaon and Himalayan ranges. This setting gives Pidaung a unique, rich biodiversity.

The area originally designated for the sanctuary was 450 sq.km. However, due to encroachment, the area has reduced to 434 sq.km. Because of the impact of this and other human disturbances the environment is gradually deteriorating. When its conservation value was evaluated by WCS in 1996 it gave a poor result. However the Forest Department of the Ministry of Forests, Myanmar, and the International Centre for Integrated Mountain Development (ICIMOD) are now committed to protecting this valuable area and it is hoped that with an integrated approach, good foresight, and full participation of the local authority, the sanctuary will be returned to its former state.

In addition to requiring conservation in its own right, Pidaung Wildlife Sanctuary can also be used as a case study for other similar protected areas that are in the same situation, with biodiversity declining and population pressure increasing.

A Model Management Plan

A training workshop 'Preparing a Model Management Plan for Pidaung Wildlife Sanctuary' was held in Myitkyina, Kachin State, from 12-14 December 2000, with the aim of assessing the current status of conservation in the sanctuary, to provide recommendations for a new management plan, and to provide an example for other areas facing similar problems. The workshop was a joint venture of ICIMOD and the Forest Department. It forms part of a larger ICIMOD project that has an overall goal of improving biodiversity conservation in the eastern Himalayan region.

The Assessment and Evaluation of Conservation Value for Pidaung Wildlife Sanctuary

U Saw Tun Khaing
(Country Program Coordinator Wildlife Conservation Society,
Myanmar Program)
December, 2000

Introduction

Wildlife conservation has been addressed with a modern approach in Myanmar since 1981, when the Nature and Wildlife Conservation Division was established and a Nature Conservation and National Park Project was initiated with the support of the United Nations Development Programme (UNDP) and the Food and Agriculture Organization (FAO). The Division ran its activities with a total staff of 2,250. Currently, there are 31 existing protected areas representing 2.26% of the total land area of Myanmar. Out of these, 19, including Pidaung Wildlife Sanctuary, are under the intensive management of the Nature and Wildlife Conservation Division. The rest are still not well staffed and remain under Forest Department administration.

Involvement of the Wildlife Conservation Society

The Wildlife Conservation Society (WCS) is a non-profit-making non-government organisation (NGO) that has been involved in the wildlife conservation activities of Myanmar since 1994. With the collaboration of the Forest Department, WCS has laid down some guidelines for its activities that are beneficial to the Nature and Wildlife Conservation Division of the Forest Department. One of the activities outlined is that all the existing protected areas of Myanmar will be evaluated to highlight those with the best potential for further development of conservation.

This activity has been carried out by U. Saw Tun Khaing, Country Programme Coordinator of the WCS Myanmar Programme, and has been completed in 21 areas, including Pidaung Wildlife Sanctuary, out of 31. Evaluation in Pidaung was completed in November 1996. A list of the existing protected areas of Myanmar is given in Table 28 of the paper 'NGO Collaboration for the Development of Hkakaborazi National Park in Northern Myanmar' (see Section 2).

Methodology used in the assessment

For the assessment, a uniform grading system for measuring conservation value was constructed in such a way that all areas could be judged by a standardised matrix. In the matrix, four main aspects for each area were first considered: natural resources, infrastructure development, management, and threats, where the former three aspects are positive and the last one negative attributes of the area. For each aspect, 10 possible measuring parameters were outlined. For example, area, flora, fauna, avifauna, aesthetic, cultural, research/education, climatic control, and tourism potential (local and foreign) are the measuring parameters for natural resources. Similarly, the other aspects have their own respective parameters (see Appendix 1).

For grading each parameter, the marking system is set with a range of 0-10. After grading each parameter, the sum total for each aspect can be obtained. The conservation value of the area

can be calculated simply by subtracting the value for threats from the value derived from the sum of the values for natural resources, infrastructure development, and management. Then, the status of the assessed protected area can be defined qualitatively as critical, poor, fair, and so on, up to excellent, depending on the percentage value calculated. For instance, if the value falls between 0 and 10, the result would be 'critical' and if it falls between 81 and 100, it would be 'excellent'. So, the final conservation value for each site is judged not only on the richness of natural flora and fauna and the inputs of infrastructure development and management of the respective site but also on the reduction in threats occurring in that area.

"the final conservation value for each site is judged not only on the richness of natural flora and fauna and the inputs of infrastructure development and management of the respective site but also on the reduction in threats occurring in that area"

When the areas were visited for data collection, the Country Programme Coordinator brought along local guides or hunters who can provide information about wildlife, the situation of habitats, encroachment, and the collection of minor forest products from the park. In most cases, the park warden and his staff accompanied the team and, after the trip, the general situation of the park was discussed. With full participation of the warden and his staff, the data were recorded in the prescribed matrix. In this way, the conservation values for the areas have been quantified. The conservation values for the 21 protected areas completely evaluated are shown in Appendix 2.

The assessment of Pidaung Wildlife Sanctuary

As mentioned above, a trip took place in October-November 1996 to assess Pidaung Wildlife Sanctuary. The result came out at 13%, which can be interpreted as 'poor' in terms of conservation value. The detailed grading for Pidaung Wildlife Sanctuary is shown in Appendix 3.

The past and current status of Pidaung Wildlife Sanctuary

Because of its unique status in terms of flora and fauna, Pidaung Wildlife Sanctuary was established in 1918 to protect key species such as tiger, elephant, leopard, guar, banteng, sambar, and bear. However the wildlife population declined, and habitats were lost, mainly due to serious human disturbances during the Second World War and aftermath. When Oliver Milton and Richard D. Estes surveyed the area in 1958-1959, they found the wildlife population was greatly decreased (see Table 28).

"wildlife population declined, and habitats were lost, mainly due to serious human disturbances during the Second World War and aftermath"

Further detrimental impacts on the wildlife and habitats of Pidaung Wildlife Sanctuary are given below.

- In 1962, due to the expansion of sugar cane plantations, 2,052 ha of Pidaung Reserved Forest and Pidaung Extension Reserved Forest in the south-western portion of the sanctuary were cut down.
- In 1972, 345 Gatshanyan households and 15 Laphan households were settled inside the sanctuary and along the side of the Ledo road, for security reasons.

- In 1980, forest vegetation extending for 1.6 km on both sides of the railway line for a total distance of 25 km was cut down for the same security reasons.
- For security reasons, Malikha Village (143 households) and Pidaung Village (95 households) were established on the side of the railway line inside the sanctuary.
- In 1993, 397 ha of Pidaung South Extension Reserve were deforested for 2 military settlements.

Table 28: Some past survey results of Pidaung Wildlife Sanctuary

Species	Year	
	1937	1958-59
Elephant (*Elephas maximus*)	200	49
Gaur or Bison (*Bos gaurus*)	300	61
Banteng or Saing (*Bos banteng*)	200	13
Hog deer (*Cervus porcinus*)	500	17
Sambhur (*Cervus unicolor*)	250	45
Barking deer (*Muntiacus muntjac*)	150	18
Wild boar *(Sus scrofa)*	-	18
Tiger *(Panthera tigris)*	12	2
Leopard *(Panthera pardus)*	10	2
Bear (*Selenarctos thibetanus*)	20	2
Wild dog *(Cuon alpinus)*	40	2

As a result of these human disturbances, when the country programme coordinator and Dr Alan Rabinowitz visited the sanctuary in March and November 1996, information on wildlife was very scanty and the area on the south of the railway line was found to be very much fragmented and degraded. Although the northern hilly area of the sanctuary seems to be intact, it was not possible to visit these areas for security reasons.

Issues

Due to population pressure and the expansion of agriculture, the present-day protected areas in Myanmar are bound to face problems and issues of one type or another. However, Pidaung Wildlife Sanctuary is said to be facing the most complex challenges for its conservation.

- *Taungya cutting.* This is driven by tradition, economic necessity, and lack of alternatives. It is a countrywide problem that needs to be solved with a long-term national economic plan.
- *Railway and road construction.* Although this is detrimental to some extent, if undertaken properly it can be positive for conservation. However, clearing vegetation for a stretch of 1.6 km on both flanks of the railway and expansion of 305m on both sides of the road have created great damage to the sanctuary.
- *Fuelwood collection and charcoal burning.* This problem is also associated with taungya cutting. Although Malikha and Pidaung Villages were established primarily for security reasons, nowadays these villages have become sources of fuelwood and charcoal to be sold for use in cities like Myitkyina and Mandalay.
- *Timber, bamboo, and rattan extraction.* These activities are common in the northern part of the sanctuary where there are still good habitats for wildlife. These products are mainly extracted for Myitkyina.
- *Grazing.* There are cattle breeding farms inside the sanctuary for milk production. Gurakha people run these farms; the free grazing of cattle causes a negative impact on wildlife and its habitats.
- *Settlement of military complexes and villages.* These settlements cause wildlife to abandon their habitats and possibly migrate to other undisturbed areas outside the sanctuary that are also linked to the Kumaon range, towards the Indian border.

Conclusion

As mentioned earlier, Pidaung is unique from a conservation perspective. With hilly regions in the north and lowland plain with grassland in the south, it has aptly been compared to the famous Kruger National Park of South Africa.

Nowadays, it is a pathetic scene to see such an area gradually losing its beauty. However, it is heartening to learn that ICIMOD is committed to stem the tide of degradation with an agroforestry approach. Saving this valuable area will be a very tough challenge for those involved, including the Forest Department and ICIMOD. It is hoped that with an integrated approach, good foresight, and the backup of strong political-will, the future survival of Pidaung Wildlife Sanctuary will be ensured.

"it is a pathetic scene to see such an area gradually losing its beauty"

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Appendix 1 : Grading System for measuring the parameters of conservation value in the Protected Area of Myanmar

Status	Measuring Parameters									
Natural resources	Area	Flora	Fauna	Avifauna	Aesthetic	Cultural	Research/ Education	Climatic control	Tourism potential	
									Local	Foreign
Infrastructure development	Accessibility	Staffing	Building	Office facilities	Social services	Visitor facilities	Communication (telephone)	Electricity	Transport facilities	Education/ training facilities
Management	Legality	Boundary demarcation	Management plan	Law enforcement	Habitat improvement	Buffer zone development	Community development	Support	Training of staff	Funding
Threats	Human settlement	Shifting cultivation	Poaching wildlife for Food	Poaching wildlife for Trade	Resource collection	Illegal timber extraction	Mining/ Exploration for oil	Dam construction	Highway-construction	Tourism (impact of pollution)

Notes:
Grading for individual parameter: 0 to 10 in ascending order
Conservation value: (1) + (2) + (3) - (4)
Range of result: 0 - 10 critical, 11-20 poor, 21 - 40 fair, 41 - 60 good, 61 - 80 very satisfactory, 81 - 100 excellent

Appendix 2: Conservation values for the 21 protected areas completely evaluated

Protected Area	Status					
	Natural resources	Infrastructure	Management	Threats	Conservation value	
					Percentage	Grade
Natmataung National Park	75	24	27	21	35	Fair
Moyingyi Wetland Bird Sanctuary	55	25	29	13	32	Fair
Pidaung Wildlife Sanctuary	43	8	19	32	13	Poor
Lampi Marine National Park	49	3	15	21	15	Poor
Hkakaborazi National Park	72	7	16	19	25	Fair
Htamanthi Wildlife Sanctuary	51	15	23	17	24	Fair
Shwe-U-Daung Wildlife Sanctuary	58	10	13	33	16	Poor
Hlawga Wildlife Park	64	69	49	15	56	Good
Alaungdawkathapa National Park	68	58	51	20	52	Good
Meinmahla Kyun Wildlife Sanctuary	65	27	47	17	41	Good
Taunggyi Bird Sanctuary	29	10	11	14	12	Poor
Parsar Protected Area		8	15	13	14	Poor
Loimwe Protected Area	22	5	15	24	6	Critical
Inlay Wetland Bird Sanctuary	64	49	37	25	42	Good
Wetthikan Wetland Bird Sanctuary	40	17	24	26	18	Poor
Shwesettaw Wildlife Sanctuary	77	74	59	28	61	Very Satisfactory
Popa Mountain Park	76	75	61	13	66	Very Satisfactory
Lawkananda Park	38	36	41	3	37	Fair
Minzontaung Wildlife Sanctuary	55	17	41	5	36	Fair
Minwuntaung Wildlife Sanctuary	36	15	8	16	14	Poor
Pyin-Oo-Lwin Bird Sanctuary	24	12	8	22	7	Critical

Appendix 3: Detailed grading for Pidaung Wildlife Sanctuary

Status	Measuring Parameters										
Natural resources	Area	Flora	Fauna	Avifauna	Aesthetic	Cultural	Research/education	Climatic control	Tourism potential		Total
									Local	Foreign	
	7	5	4	3	4	-	8	4	3	5	43
Infrastructure development	Accessibility	Staffing	Building	Office facilities	Social services	Visitor facilities	Communication (telephone)	Electricity	Transport facilities	Education/ training facilities	
	7	1	0	0	0	0	0	0	0	0	8
Management	Legality	Boundary demarcation	Management plan	Law enforcement	Habitat improvement	Buffer zone development	Community development	Support	Training of staff	Funding	
	4	3	0	2	3	0	0	3	0	4	19
Threats	Human settlement	Shifting cultivation	Poaching wildlife for		Resource collection	Illegal timber extraction	Mining/exploration for oil	Dam construction	Highway construction	Tourism/ (impact of pollution)	
			Food	Trade							
	6	6	6	1	8	2	0	0	3	0	32

Notes:

Grading for individual parameter: 0 to 10 in ascending order

Conservation value: (1) + (2) + (3) - (4) = 38

Range of result: 0 - 10 critical, 11-20 poor (13%), 21 - 40 fair, 41 - 60 good, 61 - 80 very satisfactory, 81 – 100 excellent

Period of assessment: 21 October 1996 to 27 October 1996

The Technical Approach to Model Management for Pidaung Wildlife Sanctuary

Htun Nyo
(Deputy Director, Nature and Wildlife Conservation Division
Sein Htoon Linn
Assistant Director, Planning and Statistics Department)

Introduction

"Myanmar is also endowed with about 7,000 plant species"

The various forest types of Myanmar are home to nearly 300 known mammal species, 360 reptile species, 68 species of swallowed-tailed butterflies, and about 1,000 bird species (about 12% of the total bird species of the world). Some 45 species of mammal, 39 species of birds, and 36 species of reptiles have been listed as endangered species. Myanmar is also endowed with about 7,000 plant species. Out of these wildlife species, quite a number of them are in 'red data categories' as defined by the International Union for Conservation of Nature and Natural Resources (IUCN). It is likely that there are also many wild flora and fauna species not yet recorded in Myanmar.

By energetic cooperation with the United Nations Convention on Biological Diversity (UNCBD) and the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), Myanmar, like other member countries, gives much attention to the protection of biodiversity and the prevention of illegal trade in wildlife, wild plants, and their parts.

Policy and legislation on biodiversity conservation

Protection of biodiversity is one of the major imperatives of the National Forest Policy, 1995. This policy seeks to extend the protected area system (PAS) by 5% of the total land of the country, from 2.2% at present, with a goal of 10% in the long run. The National Forest Policy also introduces a system of environment pricing based on the 'polluter pays' principle to compensate for environmental and ecological degradation.

"the National Forest Policy also introduces a system of environment pricing based on the 'polluter pays' principle"

Highlighting environmental and biodiversity conservation, forest law encourages community forestry and people's participation in environmental and forest management.

In 1879, the Elephant Preservation Act was promulgated and it was amended in 1883. In 1902, the Burma Forest Act was promulgated in which wild animals and their parts were declared 'forest produce'. Under this act, the Forest Department was responsible for wildlife protection and provided regulations to control hunting and fishing in the reserved forests. Specific legislation to protect wildlife was enacted in 1912 under the Wild

Birds and Animal Protection Act and further regulations with the same aim, covering both forest reserves and public forests, were made in 1917. In 1936, to consolidate and amend the laws relating to the protection of wildlife, the first comprehensive Wildlife Protection Act was enacted.

The Burma Wildlife Act, 1936, with minor amendments from time to time, was in force until 1994 and issues addressed included

- the establishment of wildlife sanctuaries,
- the prohibition of hunting within reserved forests without license,
- the protection of certain species including elephant, rhinoceros, tapir, gaur, banteng, goral, serow, thamin, masked finfoot, pea-fowl, and argus pheasant,
- closed seasons for the hunting of various other species of mammals and birds,
- the prohibition of certain hunting methods, and
- wide powers of enforcement including arrest and seizure and confiscation of weapons and other articles used in committing the offence.

However, the protection required for the conservation of wild flora and fauna and their ecosystems or habitats was missing. The old wildlife act was outmoded and did not address the important issues within the present concepts of biodiversity conservation. Hence, new legislation (the Protection of Wildlife, Wild Plants and Conservation of Natural Areas Law) was promulgated in 1994, filling gaps in the 1936 Burma Wildlife Protection Act. Issues addressed included

- habitat or ecosystem protection;
- the control of activities, in addition to hunting, within a wildlife sanctuary, such as trespassing, establishing settlements, and damaging vegetation;
- the protection of endangered carnivores, including tiger, leopard, clouded leopard, wild dog, and bear;
- the protection of certain other species clearly in need of either complete or partial protection, such as red panda, gibbon, and dusky leaf monkey;
- the addition of more species to the list of completely protected, normally protected, and seasonally protected wildlife species;
- the establishment of national parks and other categories of protected area as well as wildlife sanctuaries; and
- the legal control of activities harmful to wildlife outside protected areas.

Biodiversity conservation needs and potential in Myanmar

Challenges in biodiversity conservation

Pidaung Wildlife Sanctuary, established in 1918, was the first game sanctuary in Myanmar and the first to generate awareness about the protection of wildlife.

The Wildlife Protection Act, 1936, prevented the hunting of wild animals, but the conservation of habitats or ecosystems was not addressed. The wildlife population in Myanmar has declined in past years due to indiscriminate killing, hunting, and habitat destruction. Two species of rhinoceros (Javan and Sumatran) are now feared to be extinct. Elephant habitats and numbers have also dwindled in recent years through hunting and the destruction of forests. Flora and fauna have gradually decocased due to the increase in agricultural croplands, human dwelling areas, habitat destruction, and illegal gathering and hunting for trade.

"biodiversity conservation entails a shift from defensive efforts towards seeking to meet people's needs from biological resources while ensuring the long-term sustainability of the nation's biotic wealth"

The more recent concept of biodiversity conservation differs from traditional nature conservation. Biodiversity conservation entails a shift from defensive efforts towards seeking to meet people's needs from biological resources while ensuring the long-term sustainability of the nation's biotic wealth. In sum, biodiversity conservation seeks to maintain the human life support system provided by nature, and the living resources essential for development.

Strengthening biodiversity conservation

To address biodiversity conservation and sustainable utilisation of forest resources, the Forest Department, under the Ministry of Forestry, has implemented the PAS in addition to the reserved forest system.

With the assistance of the United Nations Development Programme (UNDP) and the Food and Agriculture Organization (FAO), the Nature Conservation and National Park Project was carried out, from 1981 to 1984. Its objectives addressed the conservation of natural ecosystems, the protection of endangered species of wild flora and fauna, and the development of a system of national parks and nature reserves. When this project finished the present Nature and Wildlife Conservation Division was formed, as one of the directorates of the Forest Department, with responsibility for biodiversity conservation.

Actions to be taken for conservation of biodiversity

Problems

- Although Myanmar's forest cover is still in good shape in about half of the country, and 30 protected areas have been established, the protected area percentage is the lowest in Asia. Currently it is 2.2% of the total land area of the country.
- The increasing population has placed heavy stress on biodiversity to the point of endangering some species.
- Destruction and fragmentation threaten habitats of migratory and resident species.
- Loss of species due to the uncontrolled capture of wildlife for the illegal market, fragmentation of habitats through forest destruction, and poaching are due to a weak institutional framework of human resource allocation, the need for suitable facilities to monitor and patrol, and lack of funds. These aspects must be examined thoroughly.
- The motive behind the use of natural resources is personal gain. An increase in awareness about conservation problems and in people's roles in causing the problems is required.
- Two levels of biodiversity conservation (species and ecosystem) have been addressed. The genetic diversity level has yet to be addressed through the establishment of totally protected areas (TPAs) as an insurance against genetic loss and erosion, as part of the Myanmar conservation strategy.
- In 1994, the Law for the Protection of Wildlife, Wild Plants and

"the protected area percentage is the lowest in Asia"

Conservation of Natural Areas was promulgated. The legislation now addresses issues of habitat conservation neglected by the old legislation. However the new legislation still uses the old classification of species protection (totally protected, protected, and seasonally protected). This does not reflect the real status of species as classified internationally under the IUCN red data system and CITES appendices and thus the threats they face.

However the new legislation has underscored the need for wider scope in protecting species and includes the following.

Wildlife Protected under the New Legislation

Wildlife	Totally protected	Protected	Seasonally protected
Mammals	39	12	2
Birds 50	43	13	
Reptiles 9	6	0	

The effective protection of these species in the context of global conservation concepts and management strategy, in practical terms, is the most imperative issue. Wild plant protection now falls under the domain of the new legislation. Those that are endangered or threatened with extinction have to be classified, as the existing protection categories (for example, seasonally protected), cannot be applied to endangered plants.

- The intricate relationship of ecologically fragile species with particular forest ecosystems must be thoroughly understood. Management plans must take this into account when considering the effective conservation of species and habitats.
- The management of biodiversity in Myanmar is largely ineffective and suffers from inadequate scientific direction and weak enforcement. A lack of funds has always hampered effective management.
- As a developing country, Myanmar faces issues like unsustainable land-use practices, lack of clear-cut land-use policy, encroachment, deforestation, poaching, illegal transboundary trade of wildlife resources, weakness of law enforcement, insufficient trained staff and human resources, lack of available funds and equipment, and lack of expertise and researchers.

Major issues to be resolved

The fundamental issues to be resolved to prevent loss of biodiversity in terms of the various ecosystems and their constituent species and populations are:

- conflicts in land use with conservation given the least priority,
- a gap in the knowledge required about biodiversity in order to plan properly for its conservation and management,
- a low protected-area percentage of the country,
- unbalanced representation of biodiversity in the protected network,
- lack of protected area coverage in major watershed areas,
- ineffective management and conservation of biodiversity and weakness of law enforcement both inside and outside protected areas, especially for illegal transboundary trade in wildlife and their parts,

"the long-term development objective is the conservation of a nature system that is the life-support system of mankind"

- insufficient institutional and legislative provisions for biodiversity conservation and management of protected areas, and
- lack of environmental awareness among the public and decision-makers.

Objectives

The long-term development objective is the conservation of a nature system that is the life-support system of mankind. This includes purifying water, recycling oxygen, carbon and other essential elements, maintaining the fertility of soil, and providing food from the land, fresh water, and sea.

The National Forest Policy requires protected area land coverage of 5% of the country, while the total area so far established is just over 2% (there are 25 sanctuaries and 5 parks within 6 bio-units, out of 10 delineated in the country). In addition, the protected area network is still far from representing the whole spectrum of ecosystems. A comprehensive and well-designed network is required speedily to reach the targeted 5% land coverage in the short term and 10% in the long term for the protection of wild flora and fauna that might otherwise be in danger of extinction.

Immediate objectives should be

"the protected area network is still far from representing the whole spectrum of ecosystems"

- in the short term, to establish a network of protected areas covering 5% of the country's area, encompassing representative samples of various ecosystems that exist in Myanmar,
- to check loss of biodiversity outside protected areas,
- to strengthen the capacity and institutional capability of the Nature and Wildlife Conservation Division of the Forest Department,
- to promote a conservation education programme,
- to promote effective management of all wild species of flora and fauna in general and endangered species in particular,
- to promote biodiversity research and data collection,
- to introduce buffer-zone management in areas peripheral to protected areas,
- to promote ecotourism,
- to strengthen the ex situ conservation and research roles of botanical gardens and zoological gardens,
- to undertake initiatives on national biodiversity inventories, strengthen the national database, and produce periodic national biodiversity assessments, and
- to control illegal trade in wild flora and fauna.

The technical approach to model management for Pidaung wildlife sanctuary

Model management of the protected area system (PAS)

Model management is sustainable management of biodiversity resources within a specific working scale. It represents the environmental, social, and economic forces at play within the land base fully through a partnership among the interested parties that operates transparently and on the basis of consensus. The model PAS partnership works to identify, develop, and apply innovative biodiversity resource management options to the prescribed territory.

A model PAS identifies goals, sets priorities, and establishes policy guidelines for the overall programme. It is inclusive and key land users and other stakeholders represented in the geographic region are included in the partnership.

A model PAS uses and demonstrates community-based, environmentally appropriate practices and techniques. The overall objectives and programme of work are based upon ecosystem approaches and reflect a vision of sustainability.

A model PAS will have the support of the appropriate national, regional, and/or local governments that have jurisdiction over the land and other interested communities and private-sector representatives related to natural resource management. A model PAS programme of work should also relate to a national or regional forest sector plan.

Scope of activities

A model PAS must be of a size that includes the full range of forest uses and values in the surrounding geographic region. The activities undertaken reflect the realities and needs at local and national level and need to focus on supporting an increase in the knowledge base, assessing impacts, and supporting new approaches to sustainable development.

A governance structure to address a broad range of values

A model PAS is managed in an integrated manner for all natural resource values identified as important by the partnership. The management process is both participatory and transparent. The governance structure reflects the cultural, social, political, and economic realities of the region. Additionally, the governance structure supports consensus building amongst the partners.

Cooperation/sharing

A model PAS partnership agrees to share its experiences and knowledge throughout the course of planning and implementation. At local, regional, national, and global level, a model PAS shares with other model PAS experiences of successes and lessons learned on critical aspects of PAS management that underlie the search for new models of sustainability. A model PAS also provides opportunities for urban-based interested parties to participate and to have an impact on the evolutionary processes supporting sustainable forest management (SFM).

Model protected area system implementation

To implement a model PAS, three aspects need to be considered

- the initial steps taken to create a model PAS,
- the options for organisation, government, and management, and
- the operation of a model PAS (or what the model PAS does).

"the model PAS should have a diversity of flora, fauna, and ecosystems"

There is no standard template for creating or operating a model PAS. The creativity of the local partnership, and specific regional, cultural, or other circumstances will all influence the form and function of the model PAS that is ultimately created.

Major considerations in developing a model protected area system

- Sustainable development of biodiversity and its ecosystems
- Basic concepts of, and formation of, criteria and indicators
- Institutional strengthening
- Field-level application of SFM with the participation of all stakeholders, particularly local people
- Addressing the diverse local nature, social, cultural, and economic conditions
- Coordination, cooperation, and information exchange among model PAS activities through networking

Selection of a model protected area system

The model PAS should have a diversity of flora, fauna, and ecosystems, with the inclusion of existing endangered species and fragile habitats being particularly important. The more representative of the richness of flora and fauna, and the entire ecological zone, the better qualified the site is to be selected as a model PAS. The size of the potential site should be sufficient to support integrated management for the protection of natural resources.

"the potential site should be legally and practicably secured"

The potential site should be legally and practicably secured by implementing measures such as the notification of PAS status; the notification of protected wild flora and fauna; boundary demarcation of the core zone and buffer zone; law enforcement against illegal poaching and the trading of herbs, wildlife, and their parts; control of encroachment; fire management; and control of the rights and privileges of indigenous people. The site must be accessible and suitable for training, education, and research activities.

Reliable data concerning biological diversity, the social and economic conditions of local people, and forest conditions should be available along with records of past management activities natural regeneration, a biological diversity inventory, and other significant activities.

Although the area selected for establishing a model PAS does not need to be a perfect site from the biodiversity conservation perspective, it must, as much as possible, be representative of the richness of flora and fauna, and the entire ecological zone.

"it must, as much as possible, be representative of the richness of flora and fauna, and the entire ecological zone"

Future considerations for the management of model protected area systems

Upgrading personnel and skills in protected-area and buffer-zone management

Requirements

- To recruit qualified scientists directly from the international pool and from other government organisations
- To promote skill development in various fields for staff of the Nature and Wildlife Conservation Division, Forest Department
- To establish wildlife training centres in appropriate areas
- To strengthen institutional capability by acquiring more office, field, and research equipment
- To implement protected-area and buffer-zone management effectively.

Action to be taken

- Recruitment of qualified professional people
- Overseas and local postgraduate and certificate training courses and overseas study tours to be undertaken
- An internal training programme to be conducted by expatriate scientists (from, for example, the Smithsonian Institution, the Wildlife Conservation Society, the Japan Wild Bird Society, and the California Academy of Sciences) including courses on biodiversity, ecology, entomology, herpetology, bird banding, and species surveys
- Reorientation course to be conducted
- The promotion of transparent exchange of biodiversity information and closer collaboration with international scientific organisations and non-government organisations.

Preparation of national biodiversity inventory inside and outside protected areas

Requirements

- To list known and recorded species of flora and fauna in Myanmar (about 300 species of mammals, 360 species of reptiles and amphibians, 1.000 species of birds, and 7,000 species of plants)
- To identify species recorded elsewhere but not recorded in Myanmar
- To identify scientifically new species (as yet unrecorded anywhere)

Action to be taken

A biodiversity inventory will be prepared by expatriate and national scientists. It will include checklists of species already recorded in Myanmar, species recorded elsewhere but not recorded in Myanmar, and scientifically new species and will indicate the invaluable species richness of the country. Periodic and timely biodiversity inventories and assessments will be used by researchers and decision-makers at all levels before making policies and decisions.

Development of programmes for conservation in situ

Requirements

- To increase the percentage of protected area coverage of the country
- To define the boundary of each protected area
- To initiate basic infrastructural development of the park
- To assess the status of known species of flora and fauna in each protected area and produce a checklist

"mobile education programmes in villages and around the protected areas"

- To promote conservation education programmes
- To promote ecotourism
- To introduce buffer-zone management

Action to be taken

- The establishment of networking amongst PAS areas
- Conservation in situ to be carried out by expatriate and national scientists along with trained staff of the Nature and Wildlife Division of the Forest Department
- Mobile education programmes to be conducted in villages in and around the protected areas along with socioeconomic surveys
- Basic ecotourism to be initiated with the introduction of facilities such as trails, board walks, sign boards, a minimal number of log cabins or chalets, and information centres
- Buffer-zone management activity including agroforestry, community forestry, nursery establishment for trees (including fruit trees), the introduction of income-generation activities for rural people, community development by improving village roads, ensuring a water supply, and supplying sustainable assistance to rural people for education and health care.

Assessment of the status of various species of flora and fauna under the international red data classification

Requirements

- To list known and recorded species of flora and fauna in Myanmar (about 300 species of mammals, 360 species of reptiles and amphibians, 1,000 species of birds, and 7,000 plant species)
- To sort the species in relation to endangerment according to the IUCN red data classification, the CITES appendices, and the protected categories of the Protection of Wildlife, Wild Plants and Conservation of Natural Area Law, 1994 and to compare endangerment among them.

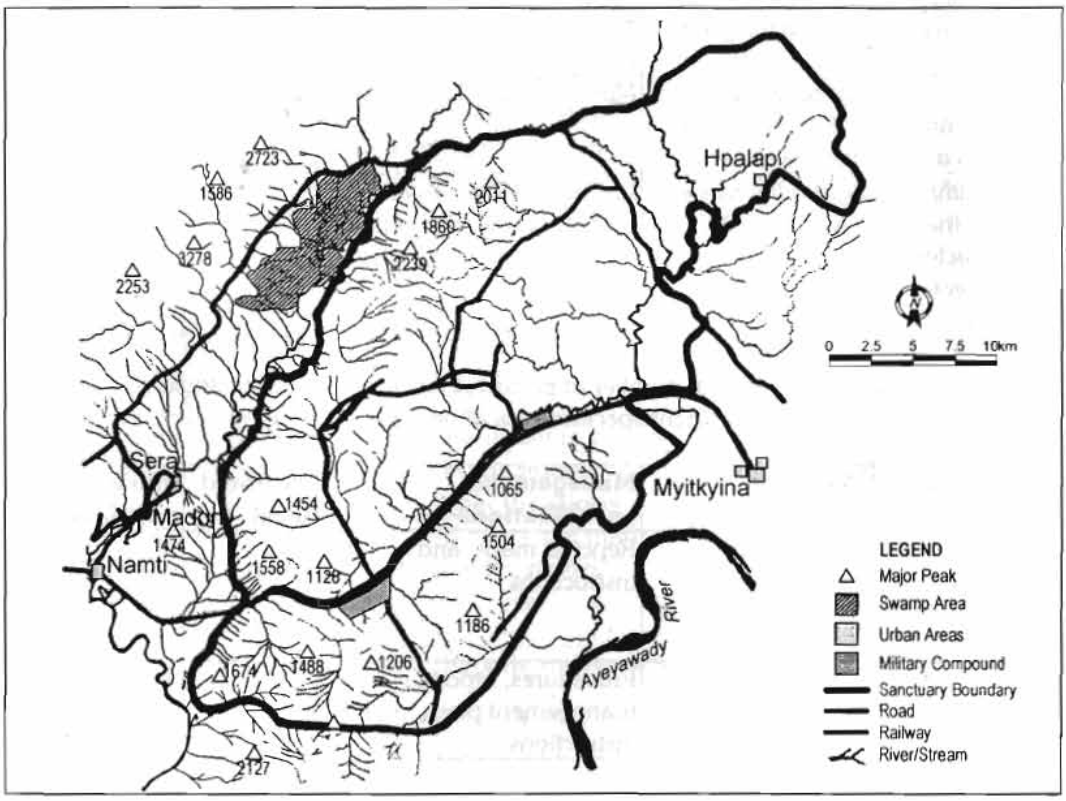
Actions to be taken

- Endangered species appearing in the IUCN red data classification and CITES appendices to be identified among the recorded species of flora and fauna in Myanmar
- Comparisons of species' endangerment between the IUCN red data classification, the CITES appendices and the protection categories of the Protection of Wildlife, Wild Plants and Conservation of Natural Area Law, 1994 would to be prepared.

Recommendations: criteria and indicators for biodiversity conservation

Whereas 'criteria' define the essential components of biodiversity conservation, 'indicators' are ways of describing a criterion. Together, they serve as the basis for monitoring and evaluating progress towards sustainable development in biodiversity.

To achieve proper establishment of a model PAS, several criteria related to the conservation and maintenance of biological diversity, including ecosystems, species, and genetic diversity need to be addressed (see below). At species' level, special attention should be given to the protection of endangered, rare, and threatened species. The establishment and management of a geographic system of protected areas of representative forest ecosystems can contribute towards maintaining biodiversity.



Criterion 1 — Ecosystem diversity

Indicator 1 — Statistics regarding the number of protected areas, the extent, range of size, and average percentage of different forest types of protected areas, and the percentage of boundaries demarcated

Required activities and management specifications at national and management unit level

Required activities	**Management specifications**	**National level**	**Management unit level**
1. Register the number of existing protected areas	Maps, reports, and registers	+	+
2. Identify representative areas suitable to be designated as protected areas and procedures, maps	Criteria to satisfy PAS	+	+
3. Extend the PAS up to 5% of the country's land area in the short term and 10% in the long term	National Forest Policy, 1995 and Wildlife, Wild Plants and Natural Areas Law, 1994	+	+
4. Identify and register areas and percentages of different forest types in each protected area	Maps of major forest types	+	+
5. Identify and register the range of size, the average size of the protected areas, and the percentage of boundaries demarcated	List of protected areas, records of size, and reports of boundary demarcation	+	+

Indicator 2 — Percentage of total number of protected areas connected biologically
Required activities and management specifications at national and management unit level

Required activities	**Management specifications**	**National level**	**Management unit level**
6. Register the percentage of protected areas which are connected by biological corridors	Reports, maps, and instructions	+	+
7. Protect and maintain the existing biological corridors	Procedures, reports, management plans, and instructions	+	+

Criterion 2 — Species' diversity

Indicator 3 — Existence and implementation of procedures to identify endangered, rare, and threatened species of forest flora and fauna

Required activities and management specifications at national and management unit level

Required activities	Management specifications	National level	Management unit level
8. Implement measures to identify, protect, and conserve endangered, rare, and threatened species	Procedures, instructions, list of endangered species, identification method, and existing laws	+	+
9. Review and monitor the list of endangered species and amend as necessary	Amend the list of endangered species as required	+	-
10. Designate and manage buffer zones	Buffer-zone management and reports	+	+

Indicator 4 — Number of endangered, rare, and threatened forest-dependent species
Required activities and management specifications at national and management unit level

Required activities	Management specifications	National level	Management unit level
11. Conduct flora and fauna surveys	Surveys and reports	+	+
12. Identify and register endangered, rare, and threatened species and endemic and indicator species	Field inspection, regular surveys, research and local information	+	+

Indicator 5 — Percentage of original range occupied by selected endangered, rare, and threatened species

Required activities and management specifications at national and management unit level

Required activities	Management specifications	National level	Management unit level
13. Identify existing ranges and percentage occupation by endangered, rare, and threatened spices	Reports and maps of habitat ranges	+	+
14. Maintain and enhance the percentage of the original ranges within the extent of the protected areas	Reports and records	+	+

Criterion 3 — Genetic diversity

Indicator 6 — Existence and implementation of a strategy for in situ and/or ex situ conservation of the genetic variation within commercial, endangered, rare, and threatened species of forest flora and fauna

Required activities and management specifications at national and management unit level

Required activities	**Management specifications**	**National level**	**Management unit level**
15. Strengthen conservation measures for key species and areas of natural habitats	List species, management plans, instructions, and reports	+	+
16. Retain undisturbed, unique, and critical areas in production forests	Maps, reports, and notification	+	+
17. Review and revise existing laws and strategies relating to conservation of the genetic variation within endangered, rare, and threatened species	Conservation strategies and related laws	+	-

Criterion 4 — Management guidelines

Indicator 7 — Existence and implementation of management guidelines to keep undisturbed parts of each production forest to protect endangered, rare, and threatened species

Required activities and management specifications at national and management unit level

Required activities	**Management specifications**	**National level**	**Management unit level**
18. Identify and undertake designation of areas to be retained undisturbed in production forests for the purpose of biodiversity conservation	Maps, list of flora and fauna, and reports	+	+
19. Disseminate information regarding endangered species of forest flora and fauna to be protected	List of endangered, rare, and threatened species. Maps, reports, and notification	+	-
20. Implement measures to protect seedling trees, nesting sites, niches, and other biologically significant features	Instructions, procedures, and reports	+	+
21. Designate other areas of national significance for biological conservation	Law, departmental instructions, and reports	+	+

Criterion 5 — Monitoring and evaluation

Indicator 8 — Existence and implementation of procedures for assessing changes in biological diversity of the production forest compared with areas in the same forest type kept free of human intervention

Required activities and management specifications at national and management unit level

Required activities	**Management specifications**	**National level**	**Management unit level**
22. Undertake flora and fauna surveys in production forests before and after human intervention	Flora and fauna surveys guidelines, instructions RS/GIS/GPS database	+	+
23. Implement guidelines and prescriptions of the environmental impact assessment report	Reports, departmental guidelines, and environmental impact assessment procedures	+	+
24. Introduce mechanisms to minimise the impact of human intervention on biodiversity	Reports, instructions, and code of practice for forest harvesting	+	+
25. Identify undisturbed areas as controls for comparison	Reports, maps, and records	+	+
26. Undertake research activities to monitor the impact of human intervention on biodiversity	Research activities, reports and results, and dissemination	+	+

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List of Rare, Vulnerable and Endangered Species of Wild Flora and Fauna Endemic to Kachin State

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"such diversity is a reflection of altitude, eco-geographical setting, climatic variation, and the fact that this state is situated in the transitional zone between tropical Indo-Malaysian flora and fauna"

Introduction

Kachin State is flanked by Tibet and Yunnan of China and Assam of India. The Himalayan ranges (the Tibet-Myanmar frontier range in the north-west and the China-Myanmar frontier range in the north-east) are rich in flora and fauna and their biodiversities are among the most spectacular on Earth. Such diversity is a reflection of altitude, eco-geographical setting, climatic variation, and the fact that this state is situated in the transitional zone between tropical Indo-Malaysian flora and fauna in the south and temperate and alpine Sino-Himalayan flora and fauna in the north.

Endemic wildlife

Northernmost Myanmar belongs to the eastern edge of the Hindu Kush-Himalayas, which is a narrow strip along the western escarpment of Yunnan Province, once part of continuous land formation. This mountainous region contains flora and fauna communities of Miocene origin isolated since the last glaciation (Ward 1932, 1944, 1949).

Because of the special geological and climatic conditions of the region, its rich biodiversity is characterised by unique flora and fauna (vegetation ranges from humid tropical rainforest to temperate forest, alpine forest, alpine rangeland, and tundra).

Fauna

Animal species endemic to this region include *Budorcas taxicolor*, Pseudois nayaur, *Nemorhaedus cranbrooki*, *Selenarctos thibetanus* (Himalayan Black Bear). *Neofelis nebulosa* (clouded leopard), *Cervas unicolor*, *Moschus moschiferus*, *Felis temmincki*, *F. marmorata*, *Nemorhaedus goral*, *Panthera uncia* (snow leopard), *Ailurus fulgens*, *Muntiacus muntjac*, *M. putaoensis* and many others species of Caprinae* and wild ungulates. The Class I National Protected Species found in Kachin State include *Elephas maximus*, *Rhinoceros unicornis*, *Panthera tigris*, and *Panthera pardus*.

"its rich biodiversity is characterised by unique flora and fauna"

Aquatic species

It is estimated that there are about 200 endemic species of fish. Germplasm occurring in Kachin state includes some peculiar oceanic and

mountain characteristics. The Indostomidae*, Syugnathidae*, Aulostomidae*, and Schizothoracinae families are also endemic. Freshwater turtles (Emydidae* family) and two species of common otter (*Lutra lutra* and *Lutra* sp.) occur in Malihka River, Indawgyi Lake and in many lakes of Tanine.

Butterflies

There are probably about 1,020 butterfly species in Kachin State. Unique and colourful grassland, mountain, and woodland butterflies can be seen throughout the state. Out of the 10 families of butterflies in the world, 9 families are indigenous to Kachin State; these include Satyridae, Parnassiinae, Lycaenidae, Lepidoptera (Insect family), and Nymphalidae.

Birds

Kachin State is home to most of the Sino-Himalayan avifauna. There is a large wintering population of common cranes, and one of the endangered black-necked crane species *Grus nigricolis* is found seasonally in Indawgyi Lake. More than 200 species of migratory birds and permanent waterfowl inhabit the natural wetland of Indawgyi.

Flora

About 50% of Himalayan flora are endemic in the northernmost and the north-eastern part of this region. Vertical elevation and steep valleys produce many favourable regional environments, which retain many of the pre-Tertiary-period flora.

Regarding gymnosperms, the presence of six ancient conifer families, namely Pinaceae, Taxodiaceae, Cupressaceae, Podocarpaceae, Cephalotaxaceae, and Araucariaceae are good evidence of the primitiveness of flora endemic to Kachin State. These six conifer families have fossil records extending back to the Mesozoic era. Another interesting family, which is confined to the north-eastern part of Kachin state, is the ancient Ginkgoaceae. Primitive families such as Gnetales and Cyatheaceae occur throughout the state. Regarding angiosperms, many species belong to the Palaearctic realm and plants include elements of three phyto-geographic regions, the Sino-Himalayan, Assam, and Indo-Malaysian regions. Typical temperate species of Ericaceae, Juglandaceae, Primulaceae, Betulaceue, Aceraceae, Tilliaceae, Schisandraceae, Theaceae, Caprifoliaceae, Aquilariaceae, Colchicaceae, Araliaceae, and Fagaceae are also endemic.

Tropical rain forest species of families such as Dipterocarpaceae, Combretaceae, Verbenaceae, Hypericaceae, Moraceae, Meliaceae Myrtaceae, Lythraceae, and Caesalpiniaceae, exist in almost all parts of the state.

Three species of progenitor rice species, *Oryza granulata*, *O. rufipogon*, and *O. officinales* (ancient ancestors of today's rice (*Oryza sativa*)) thrive very well in Myitkyina Plain, Putao Plain, Hu Kaung Valley, Nan-Yin Hka Valley, Ba-maw Plain, and Mai-Hka-Than-Lwin Division. New endemic species are still being discovered.

Some rare and endangered flora species

Euryale ferox Salisb.

Of the family Nymphaecaeae and subfamily Euryalaceae (plant family), this species is commonly known as the thorny lotus or fox nut gorgon. It is aquatic and indigenous to Kachin

"this precious and rare species of Orchidacea, classified in the CITES appendices, was first discovered by F.K. Ward in 1920"

State occurring mainly in Mo-Kaung, Nan Mathi, Hopiin Mo-hnin, and Indawgyi Lake. In Myanmar, this species can only be found in Kachin State. With the population status of *Euryales* decreasing, it has almost disappeared in Mo-Kaung and only a small number of plants can be seen in Indawgyi Lake. Therefore, this species should be classified as an endangered species.

Paphiopedium wardii (var.)

This precious and rare species of Orchidacea, classified in the CITES appendices, was first discovered by F.K. Ward in 1920 at Nogmung, Parignandin, on the Mali-Hka route and was named (after him) in 1937. Another, new, variety was discovered in April 2000 at Sone Pian Village, Putao Township.

The two *wardii* varieties have different flowering periods. The newly discovered variety is showier and lacks marble spots on the leaves. It is very rare and can only be found in Putao Township and Sein-Lon. It should therefore be graded as a protected species

"of the family Meliaceae, this fragrant species is commonly known as Mawlamyaing mahogany. It is the main source of an essential oil that is extensively used in traditional Chinese medicine and Tibetan medicine"

Cedrela toona

Of the family Meliaceae, this fragrant species is commonly known as Mawlamyaing mahogany. It is the main source of an essential oil that is extensively used in traditional Chinese medicine and Tibetan medicine. Due to over-harvesting, the population is on the verge of regional extinction. In 2000, the oil extracted from *Cedrela toona* was 1,760 kyats per litre.

Aquilaria agallocha

The only species of Aquilariaceae in Myanmar, it is commonly known as aloewood or eagle-wood and exists in Hukaung Valley, Mo-Hnin, and Putao Township. It is a highly valuable trade commodity and extensive illegal trading has led to over-extraction and a decrease in population.

Coniferales

The Taxodiaceae family is of great historical interest; today it shows only a relict distribution and this small amount of species is called a living fossil. They came into existence before the Tertiary period. This family includes one precious tree *Taiwania cryptomerioides*, also known as Chinese coffin wood or Japanese cedar. It can now only be found in Myanmar in the regions of Kaung-Lan-Phyu, Hphi-Zaw, and Chaung-makaw and the population is gravely threatened because of its extensive use in embalming. The seed of *Taiwania* has become evolutionally infertile and the vitality of this species is in a critical condition.

"the Taxodiaceae family is of great historical interest"

Very rare species of Pinaceae (*Pinus wallichiana* (blue pine), *Thuja occidentali*, *Tsuaga brunoniana*, and *T. yunnanensis*) exist in Adung Valley and Mai-Hka-Than-Lwin Division in the primeval forest just below the snowline. Other surviving and rare species, belonging to the

Podocarpaceae family, are *Podocarpus macrophyllum* and *P. wallichianus*; these occur in Saw-Law Township, Adung Valley, and Mai-Hka-Than-Lwin Division. *Cephalotaxus fortunei* and *C. mannii* are very rare species; they belong to the Cepholotaxaceae family which is comprised of ancient conifer and Pre-Tertiary flora. The existence of these plants allows the study of phyto-geography.

The nearly extinct conifer, *Taxus baccata*, known as the Himalayan yew is confined to Mai-Hka-Than-Lwin Division.

Species of the Araucariaceae (monkey-puzzle tree family) and Cupressaceae families, and the Himalayan cypress, *Juniperus chinensis*, *Juniperus squamata*, and *Araucaria* spp. can be found in Saw-Law, Adung Valley and on the west flank of Mai-Hka River. These conifers are all declining in population. The relic and rare plant sources of the Tertiary period reduce year by year because of evolutionary pressure; the seeds of the conifers are nearly infertile and out of 500 seeds, only 10 can be grown. There is great concern in the people of Kachin State to protect these surviving conifers.

Ginkgo biloba

Another extremely precious species, the world-famous *Ginkgo biloba*, belongs to the Ginkgoaceae family. *Ginkgo biloba* is the only plant of its kind to exist in the world. It is a surviving plant of the early Tertiary period. The extinction of ginkgo could be avoided by artificial cultivation in China. Wild *Ginkgo biloba* is indigenous to the Chimali Pass, Mai-Hka-Than-Lwin Division. But the population is next to nothing. Possible causes of declining ginkgo numbers are given below.

- In the flowering period, the female ginkgo plants emit an unbearable smell, so they are cut down
- the slash-and-burn process of swidden cultivation causes a considerable loss of Ginkgo plants at Htaw Gaw
- according to traditional Chinese medicine, *Ginkgo biloba* has medicinal value and its kernels are edible and precious. Natural ginkgo plants are uprooted and traded through the Chinese border. Some of the villagers in Chiba Township are involved in ginkgo trading.

Camellia sinensis

Camellia sinensis belongs to Theaceae (the tea family) and is also known as the ten-thousand-flower tree. It can be seen in Chibwe Township and Saw-law Township. Indiscriminate clearing for taungya cultivation has caused the loss of valuable *Camellia* species.

Cyathea spinulosa

Cyathea spinulosa, one of the ancient gymnosperms, belongs to the Cyatheaceae (tree fern family) and is commonly known as the tree fern. Ten years ago, it was abundant and was found in Putao, Machambaw, and Non-Moung Township. Nowadays, the population has decreased and, in some forests, this species has already disappeared. It has economic value because it can be used for handicrafts. The mass production of handicraft articles can lead to loss of the species.

Paris polyphylla

This is a very rare plant and only exists in Myanmar. The popular name is seven-leaves-and-one-flower. It can only be seen in Adung Valley, Tahumdung, and Gawang. *Paris polyphalla* is a

"large amounts of the plants are collected by Lisu people and they engage in trading. This species needs protection"

world-endangered species and its population has decreased hugely. It has medicinal value and is widely used in Chinese medicine. The root and stem are the main ingredients of the famous Yunnan white medicinal powder and it is also believed to be a remedy for cancer. Large amounts of the plants are collected by Lisu people and they engage in trading. This species needs protection.

Rhododendron spp

The existence of rhododendrons in the Myanmar section of the Sino-Himalayas dates back to the Mesozoic era of the Cretaceous period. This area is considered to be the birthplace of mountain rhododendrons and more than 200 species exist here. These mountain flowers are world famous and highly ornamental. But some of the species are rare, others have become endangered through neglect, and the populations of some species have decreased due to the clearing process of shifting cultivation.

"these mountain flowers are world famous and highly ornamental"

Wild rice

The rudimentary types of wild rice and their ancestors such as *Oryza officinales*, *Oryza rufipogon*, and *Oruza granulata* thrive very well. These wild rice can be found in the whole state particularly in Myitkyina Plain, Nam-Yin-Hka Plain, Bamaw Plain, Putao Plain, Hu-kaung Plain, and Mai-Hka-Than-Lwin Division.

A trace of these progenitor varieties indicated that wild rice is indigenous to Kachin State and that Kachin State is one of the original locations for rice cultivation. More than 100 varieties of wild rice ancestor local races are cultivated by dry and wet farming in the isolated northern region.

But many local varieties of rice have become extinct in the last 10 years; because the productivity of the local crop is lower than other varieties, it is neglected or replaced by high-yielding varieties. This will cause a loss of biological wealth in the next few decades.

"many local varieties of rice have become extinct in the last 10 years"

Plant resources such as wild rice and their ancestor varieties provide precious material for breeding new varieties of rice, including improved high-yielding varieties.

Endangered fish species

The endangered species of the fish *Indostromous aradoxus** has been recorded as endemic and it can be found in stagnant parts of Indawkyi Lake and Nan-kwaye Stream near Myitkyina. This species is used as an aquarium fish and is traded live for ornamental purposes. It is a Pre-Tertiary species. Another oceanic species, *Doryichthys dunckeri**, known as the pipe fish, is indigenous to Nankwaye Stream, Nan-Taing Stream, and Indawgyi Lake. These fish are widely captured and traded live and some private companies are involved in illegal fish trading. As a result the population is gravely threatened. Another strange-looking oceanic species is *Parasphaerichthus ocellatus**, known as the trumpet fish. This species is

ideal for the aquarium and is found in Mo-kaung Township, Nan-kyawe Stream, and Indawgyi Lake. It can be traded for US $5 per fish. Another new endemic fish, known as the Dennial Lepard fish, can be found in In-Hkaine-Bon Mountain Lake and Indawgyi Lake. These mountain fish are also captured in considerable quantities and need to be protected and conserved.

Very rare mountain fish of the Schizothoracinae family, known as iced-water fish, are endemic to the catchment mountain stream of Mai-Hka and can be found in the upper part of the Mai-Hka River.

Socioeconomic activities such as gold mining can cause barriers to fish migration. A lot of mercury and cyanide are used in gold extraction and are dumped into the headwater of the Irrawaddy. The pollution of the water with these toxins affects fish breeding habits and populations are decreasing. At the current rate, these activities could lead to an irreversible effect.

Recommendations

- Appropriate methods to maintain the aquatic diversity of Kachin State need to be designed and implemented.
- Effective protection against the large-scale, illegal fish trade needs to be implemented.
- Efforts should be made to produce a detailed document of the wild flora and fauna of Kachin State.
- Effective action should be taken for the conservation of Pre-Tertiary flora.
- Education, by participatory methods, about forest conservation and genetic source conservation should take place.

Conclusions

Kachin State is rich in flora and fauna, both new and old, and has natural conditions favourable for the growth of many plants. This natural endowment together with the existence of old and surviving plants of the Jurassic period and Tertiary period has given the region a special significance. Today, most plants of the Jurassic, Quaternary, and Tertiary period are already extinct and new ones have evolved. Only a few plants including *Cyathea spinulosa*, *Ginkgo biloba*, *Taiwania cryptomerioides*, and some conifers have survived through the ages. Such surviving plants are highly precious.

In addition, Kachin State is one of the places of origin of wild rice. Genetic sources of wild rice and their ancestors are available in almost all parts of the region and these are valuable sources for breeding new varieties of rice. These resource plants play a very important role in maintaining the ecological and economical stability and equilibrium of the state.

The preservation of conifer forests and isolation of *Ginkgo biloba* as a solitary specimen hold great potential for ecotourism. This ecosystem needs urgent, effective protection and conservation and these activities could help achieve these aims.

Extended Abstracts of Selected Papers

Problems Facing Conservation in Pidaung Wildlife Sanctuary

U. Khin Maung Hla
Park Warden
Pidaung Wildlife Sanctuary

"forest depletion and wildlife are being caused by poaching, shifting cultivation, habitat disturbances, and population pressure"

- An inventory in 1999 listed 107 plant species, 103 bird species, and 20 mammal species. Forest depletion and wildlife are being caused by poaching, shifting cultivation, habitat disturbances, and population pressure.
- Difficulties in conserving the area and communicating with the local communities include the use of traditional practices, language barriers, and insufficient incomes.
- Technical programmes should address people's income, fuelwood requirements, and cash-crop planting techniques. Help and collaboration from other agencies and departments would also be beneficial.

Interpretation of the current status of land use in Pidaung Wildlife Sanctuary, using remote sensing and geographic information systems (by U. Nyan Hlaing, Staff Officer, GIS Section)

To assess current land use, remote sensing (RS) and geographic information (GIS) systems are essential tools in the field of forest management and conservation. Satellite images are also widely used in various fields such as forestry, agriculture, mining, civil engineering, construction, and defence.

A view of land use in Pidaung Wildlife Sanctuary was obtained from the recently recorded image from the land observation satellite (LANDSAT-7) in March 2000. Next the existing vegetation cover was interpreted and classified. The results of RS interpretation (Table 29) illustrate the current land-use status.

"satellite images are also widely used in various fields such as forestry, agriculture, mining, civil engineering, construction, and defence"

Table 29: Current Land Use Status of Pidaung Wildlife Sanctuary

Land-use class	Area (ha)	Area (sq.m)	Percentage
Good forest	7,327	73,282,590	10.49
Degraded/scrubland/shifting cultivation	27,493	274,931,488	39.38
Swamp	1,720	17,203,068	2.46
Bamboo	870	8,703,518	1.24
Agricultural/grassland	29,499	294,989,269	42.25
Water body	2,897	28,974,779	4.15
Total	69,807	698,084,712	99.97

The land-use images show that good forest cover occurs in the south-west and north-west (about 7,327 ha, only 10.49% of the area). The degraded forests and bamboo brakes (40.62%) are good resources that would presumably recover if the area was carefully protected. The swamps and streams (water bodies) (6.61%) are favourable sites for avifauna and reptiles.

In conclusion, the wildlife habitats in the sanctuary are still in good shape. Other excluded areas should be analysed and assessed for rural development and for the provision of good buffers to the protected areas.

The status of bird species and their conservation in Pidaung Wildlife Sanctuary (by U. Thein Aung, Park Warden, Hkakaborazi National Park)

According to records from 1960 there was a rich biodiversity of birds in Pidaung Wildlife Sanctuary. Although the abundance of wild animals, especially large mammals, has declined and huge areas of natural habitats were destroyed during the Second World War, a large number of bird species still inhabit the sanctuary.

According to a recent report by the Park Warden, 101 bird species have been recorded and some rare forest birds, such as green peafowl, hornbill, and pheasant, inhabit the remaining natural forest of the northern part of the sanctuary.

The current status of bird species indicates that some remaining species and their habitats will need to be protected in time.

Recommendations

- A systematic ornithological survey should be carried out to study the presence and abundance of bird species in the sanctuary.
- Further forest cutting should be restricted. The local community should be educated about the importance of conserving bird species.
- The remnant natural forest area should be strictly protected for conserving roosting and breeding sites.

Recommendations for addressing land-use conflicts in Pidaung Wildlife Sanctuary (by U. Zaw Weik, Director of the Forest Department, Kachin State)

Pidaung Forest Reserve was initiated in 1918, and extended to 72,448 ha in the 1940s. Settlements and permanent agriculture encroached on 2,619 ha, and now a net area of 69,829 ha forms the wildlife sanctuary within the protected area system.

There are currently three villages of hill tribes (Kachin, Lisu, Maru, and Lacheik) with a population of 2,815, some settlements of army regiments, and some railway stations.

Constraints on forest management include forest cutting, fuelwood and charcoal production, grazing, shifting cultivation, and poaching. These disturbances are unavoidable due to the sanctuary's accessibility and to population pressure.

In conclusion, recommendations from the forest management perspective are that

- Fuelwood plantations should be established for local supply.
- Community forestry practices should be introduced to the residents.

"fuelwood plantations should be established for local supply"

- To change land use by introducing good agroforestry systems
- Local communities should be helped to use efficient stoves, to solve fuelwood problems.
- Education programmes should be extended to foster better understanding and a mutual relationship between the Forest Department and local communities.
- New methods for domestic cattle farming instead of traditional grazing should be introduced.

The outcomes from the discussions of the workshop are expected to be beneficial in finding an integrated management system suitable for both the local communities and the wildlife sanctuary.

'Preparing a Model Management Plan for Pidaung Wildlife Sanctuary'

Myitkyina, Kachin State, Myanmar
Workshop Report
December 12-14, 2000

Highlights of the Workshop

It was a successful training workshop that invited participation from people from the grass roots and it used local languages to address the objectives because the majority of people were from Myanmar. The 32 participants included village representatives and field staff of Piduang Wildlife Sanctuary — as requested by the International Centre for Integrated Mountain Development (ICIMOD). They also included officials from the Forest Department and local government and staff of Kachin University, Hkakaborazi National Park, and Indawkyi Wetland Wildlife Sanctuary. More detailed information about the participants is given in Appendix 1. The training workshop was held in Myitkyina, the capital of Kachin State, at the Forest Department; this venue was chosen to minimise costs of the workshop, which was planned as a low-cost, high-efficiency training activity. By reducing costs, more local people could be invited to participate.

The workshop was a joint venture of ICIMOD and the Forest Department of the Ministry of Forestry of Myanmar. It forms part of the ICIMOD project on 'Promotion of Regional Collaboration for Biodiversity Conservation and Management in the Eastern Himalayas' supported by the World Environment and Resources' Programme of the John D. and Catherine T. MacArthur Foundation. The overall goal of the project is to improve biodiversity conservation in the eastern Himalayan region. The project is working primarily with China, Myanmar, and Nepal.

It is important to initiate and enhance biodiversity conservation, based on public participation in natural resource management in Myanmar, especially in the northern part of the country. There is large area of natural primary forest with rich biodiversity. At the same time population pressure and illegal poaching are increasing. Traditional shifting agriculture (taungya), charcoal making, and slash-and-burn cultivation are the key driving forces threatening biodiversity. The workshop on 'Sub-regional Consultation on Conservation of Hkakaborazi Mountain Ecosystems in the Eastern Himalayas' was held on 25-29 October 1999, in Putao, Myanmar. 'Preparing a Model Management Plan for Pidaung Wildlife Sanctuary' is a follow-up to this workshop.

As part of the workshop, a one-day field visit to Pidaung Wildlife Sanctuary was organised to survey the present state of the ecosystems and the lifestyle of the local people. There are some tracts of good quality forest at watershed head areas, and people understand the importance of protecting them. Extensive farming is practised within Pidaung Wildlife Sanctuary where the Lisu, Kachin, and Rawang people live together peacefully. Degraded forest and bush and tall grasses occupy the slopes and valleys. Some wetland has been converted into paddy land. The team also visited the confluence of Nmai Hka River and Mali Hka River along the road, from where it can be seen that good quality forest exists in some higher parts of the hills.

Background

"what experiences can be learned from the management of Pidaung Wildlife Sanctuary?"

Pidaung Wildlife Sanctuary has been selected for a case study; the experiences with Pidaung Wildlife Sanctuary will provide experiences for other national parks. Some national parks of Myanmar may have been in the same situation as Pidaung Wildlife Sanctuary 70 years ago, with a rich wildlife and low population pressure. Now many large mammals have declined in number, or disappeared, and there are difficulties in dealing with the conflict of interest between the parks and local communities. Why are rhinoceroses and elephants not found now? Can any measures be taken to change this? What experiences can be learned from the management of Pidaung Wildlife Sanctuary? What suggestions can be made to improve the management of Pidaung Wildlife Sanctuary? These were some of the questions that could be raised for open discussion at the workshop.

The objectives of establishing Pidaung Wildlife Sanctuary were as follow.

- To protect and conserve the existing biodiversity in a systematic way, aiming at promoting the existing ecology of wild plants and animals
- To introduce extension activities related to environmental conservation that are intended to educate the local communities
- To strive for the participation of local communities in the programmes of environmental conservation and to assist in the social and economical progress of the communities

"measures have been taken, including evaluation of species for conservation, boundary demarcation for legal protection, the setting-up of signboards to display law, implementation of regulations"

There are also new issues that should be considered which relate to the present socioeconomic status of and population increase in this region. The encroachment of taungya (shifting agriculture) and the settlement of villages has destroyed many animal habitats. The Forest Department is still making efforts to conserve the existing wildlife and rehabilitate the degraded forest. Some measures have been taken, including evaluation of species for conservation, boundary demarcation for legal protection, the setting-up of signboards to display law, implementation of regulations, dissemination of knowledge of environmental protection and biodiversity conservation, and the construction of three guard-posts. A buffer-zone area has been established in the southeast of the sanctuary and some technology transfer activities have been carried out here.

The constraints for biodiversity conservation of the sanctuary are lack of funds, lack of manpower, and increasing pressure of human activity and conflict between conservation and development.

Objectives of the Training Workshop

A strategy and practical action plan are required for Pidaung Wildlife Sanctuary; this was addressed at the workshop with the following objectives.

- Review the experience and lessons of management of Pidaung Wildlife Sanctuary with particular emphasis on management of nature reserves

and biodiversity conservation in areas with larger populations. The predicted future and alternatives for the sanctuary could be proposed and discussed.

- Discuss the management system and organisational development for Pidaung Wildlife Sanctuary. Public participation and community-based management are important issues for improving the management of the sanctuary. Who are the practical and potential stakeholders? Is it possible to establish non-government organisations? Is it possible to form natural resource user groups (such as forest user groups and Water User Associations (WUAs)
- Enhance implementation of existing laws and regulations of environmental protection and biodiversity conservation, which must be listed in local agendas.
- Increase efforts towards technology transfer for local area development and poverty alleviation, including continuation of the current fruit-tree programme. A number of activities can be targeted, including improved cooking stoves, cash crops, biogas, and beekeeping.

The study and discussion of improved management of Pidaung Wildlife Sanctuary should focus mainly on the management system, operation mechanisms, resource policy, and the relationship with the local community.

It is important that information is exchanged and experiences are learned from others in order to improve the management of Pidaung Wildlife Sanctuary. There must be a shift from management controlled by the administration office to management by administration and all stakeholders. A number of successful ventures can be examples to Pidaung Wildlife Sanctuary, including the ecotourism development of Jiuzhaguo Forest Park in west Sichuan, China, the programme of biodiversity collaboration and integrated management of mountain ecosystems in Hongqiang, Chuxiong, Yunnan, China, and the Parks and People Project (PPP) and community forestry in Nepal.

Workshop Programme (see Appendix 2)

The workshop agenda is shown in Appendix 2. On the second day of the workshop a discussion session took place, chaired by U. Kyaw Nyunt Lwin (Director, Forest Department) and coordinated by Professor Chen Guangwei, Division Head, Mountain Natural Resources, ICIMOD. The participants were divided into two groups, the first group discussed 'Development and Conservation of Biodiversity and Its Ecosystems in Pidaung Wildlife Sanctuary' and the second group discussed 'Social and Economic Development of the Community and Other Interested Parties'

Workshop Recommendations for the Management Plan of Pidaung Wildlife Sanctuary

An executive committee under the state nature and wildlife steering committee to be formed for Piduang Wildlife Sanctuary with the following members.

Chairman of Kachin State Peace and Development Council or nominee of Chairman	(Chairman)
Representative of Kachin State Peace and Development Council	(Vice-Chairman)
Representative of Northern Command	(Member)
Manager, Myanmar Timber Enterprise	(Member)
Manager, Myanmar Agriculture Enterprise	(Member)
Director, Livestock and Breeding Department	(Member)
Director, Land Record Department	(Member)

Director, Representative (to be designated from the main government ministry)	(Member)
Head of Basic Education Department (Kachin State)	(Member)
Head of Police (Kachin State)	(Member)
Union Solidarity Development Association (Kachin State)	(Member)
Director, Forest Department (Kachin)	(Secretary)

Under the State Nature and Wildlife Steering Committee, an Executive Committee will be formed for implementation of conservation in Pidaung Wildlife Sanctuary. The membership will consist of the following personnel.

2. A model management plan for Pidaung Wildlife Sanctuary will be prepared.

   The Director of the Nature and Wildlife Conservation Division, Forest Department will take responsibility for planning the model management of Pidaung Wildlife Sanctuary, with support from the Director of Kachin State Forest Department. The following factors will be considered
   - by identifying the existing species of flora and fauna and their ecosystems, a classification of zones for wildlife conservation management according to protection measures required will be carried out; categories will include core zone, buffer zone, development zone, and settlement zone;
   - education and public awareness; and
   - clearly defined signposts related to the management of zones.

3. Restoration of Pidaung Wildlife Sanctuary will be carried out and will include the following.
   - A review of the effectiveness of the existing staff; if necessary, recruitment will be carried out.
   - Training programmes will be developed (Professor Chen Guangwei).
   - The illegal collection of forest products, charcoal making, illegal livestock grazing, and shifting cultivation practices will be strictly prohibited, according to existing laws and regulations.
   - Forest fire protection programmes will be planned.
   - Relevant technology and information sharing with international organisations will be introduced (Professor Chen Guangwei).
   - A joint project proposal to raise funds to support actions in the sanctuary will be prepared (Professor Chen Guangwei).

4. Fuelwood plantation sites will be allocated inside and in the surrounding areas of the sanctuary, to fulfil the needs of the local community. The Forest Department will provide seeds, seedlings, technology, allotted budget funds, and other necessary assistance.
5. Use of fuelwood substitutes and effective, energy-saving stoves will be introduced.

6. A community forestry programme will be introduced and promoted to fulfil the basic needs of the community.
7. Shifting cultivation practices will be banned and permanent agricultural practices together with a tree-planting programme will be encouraged.
8. Under the guidance of the regional authority, the Kachin State Peace and Development Council, an agroforestry system will be implemented with cooperation of the departments concerned.
9. Domestic livestock breeding will be encouraged in order to reduce traditional poaching.
10. Poor and abandoned lands will be allocated as grazing areas for domestic animals under a rotation system.
11. To increase awareness about the value of wild flora and fauna and the environment and to encourage participation by local people, extension activities will be introduced, through schools and religious organisations.
12. Ways and means of achieving cash crop production and promoting family income will be explored.
13. A wide variety of activities aimed at increasing the living standards of local people and promoting knowledge about nature conservation will be encouraged.
14. Ecotourism will be introduced in accordance with the development of the sanctuary and the attraction of Kachin traditions.
15. Funding and technological assistance from local and international organisations will be sought for community development.

Appendix 1: **List of Participants**

U. Hla Aung
Member
Peace and Development Council,
Gut-Shan-Yan Village

U. Khin Aung
Head
State Peace and Development
Council

U. Thein Aung
Park Warden
Hkakaborazi National Park

U. Zaw Aung
Coordinator
Union of Solidarity and
Development Association,
Myitkyina Township

Professor Chen Guangwei
Division Head
Mountain Natural Resources,
ICIMOD, Nepal

U. Khin Maung Hla
Park Warden
Pidaung Wildlife Sanctuary,
Myitkyina

U. Nyan Hlaing
Staff Officer
GIS Division, Forest Department

U. Saw Tun Khaing
Country Programme Coordinator
Wildlife Conservation Society
(Myanmar Program)

Lieutenant Colonel Mg Mg Latt
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Mayan Village, Myitkyina

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Planning and Statistics Department,
Ministry of Forestry

Daw Kala Ya Lu
Demonstrator
Department of Botany, Myitkyina
University

U. Kyaw Nyunt Lwin
Director
Extension and Education Division

U. Dai Lyun
Member
Nan Kawe, Myitkyina

U. Win Maung
Staff Officer
Forest Department , Myitkyina

Lieutenant Colonel Hla Moe
No. (7) Central Training Defence

U. Mya
Assistant Director
Forest Department, Kachin State

U. Hla Myint
Professor
Department of Geology, University
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U. Bauk Naw
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Peace and Development Council, Gut-Shan-Yan Village
U. Man Dar Naw
Member
Peace and Development Council, Gut-Shan-Yan Village

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Nature and Wildlife Conservation Division, Forest Department

U. Khin Maung Oo
Assistant Director
Forest Department, Kachin State

Daw Aye Than
Lecturer
Department of Botany, Myitkyina University

U. Hla Thaung
Chairman
Village Peace and Development Council, Gut-Shan-Yang Village

U. Sein Tun
Park Warden
Indawkyi Wetland Wildlife Sanctuary

U. Zaw Weik
Director
Forest Department, Kachin State

U. Htein Win
Manager
Myanmar Timber Enterprise, Kachin State

U. Htein Win
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Appendix 2: **Workshop Agenda**

12-12-2000

09:00	:	Opening Ceremony
09:00-09:10	:	Welcome Address by U. Kyaw Nyunt Lwin, Director of Forest Department, Myanmar
09:10-09:20	:	Welcome Address by Administrative Authority (Kachin State)
09:20-09:30	:	Welcome Address by Division Head of Mountain Natural Resources, ICIMOD
09:30-10:15	:	Group Photo and Tea
10:15-11:00	:	Presentation on 'The Mountain Ecosystem and Model Managemant Plan for Pidaung Wildlife Sanctuary', by Resource Person, ICIMOD
11:00-11:10	:	Discussion
11:10-11:35	:	Presentation on 'The Assessment and Evaluation of Conservation Value for Pidaung Wildlife Sanctuary' by U. Saw Htun Khaing, C0oordinator, WCS)
11:35-11:45	:	Discussion
11:45-12:45	:	Lunch
12:45-13:05	:	Presentation on 'Suggestions Concerned with Land Use for Pidaung Wildlife Sanctuary' by U. Zaw Weik, Director, Forest Department, Kachin State
13:05-13:15	:	Discussion
13:15-13:35	:	Presentation on 'The Technical Approaches to Model Management for Pidaung Wildlife Sanctuary' by U. Htun Nyo, Deputy Director, NWCD and U. Sein Htoon Linn, Assistant Director, Planning and Statistics Department
13:35-13:45	:	Discussion
13:45-14:15	:	Tea
14:15- 14:35	:	Presentation on 'The Finding of the Current Land Use Condition and Socioeconomic Pressure on

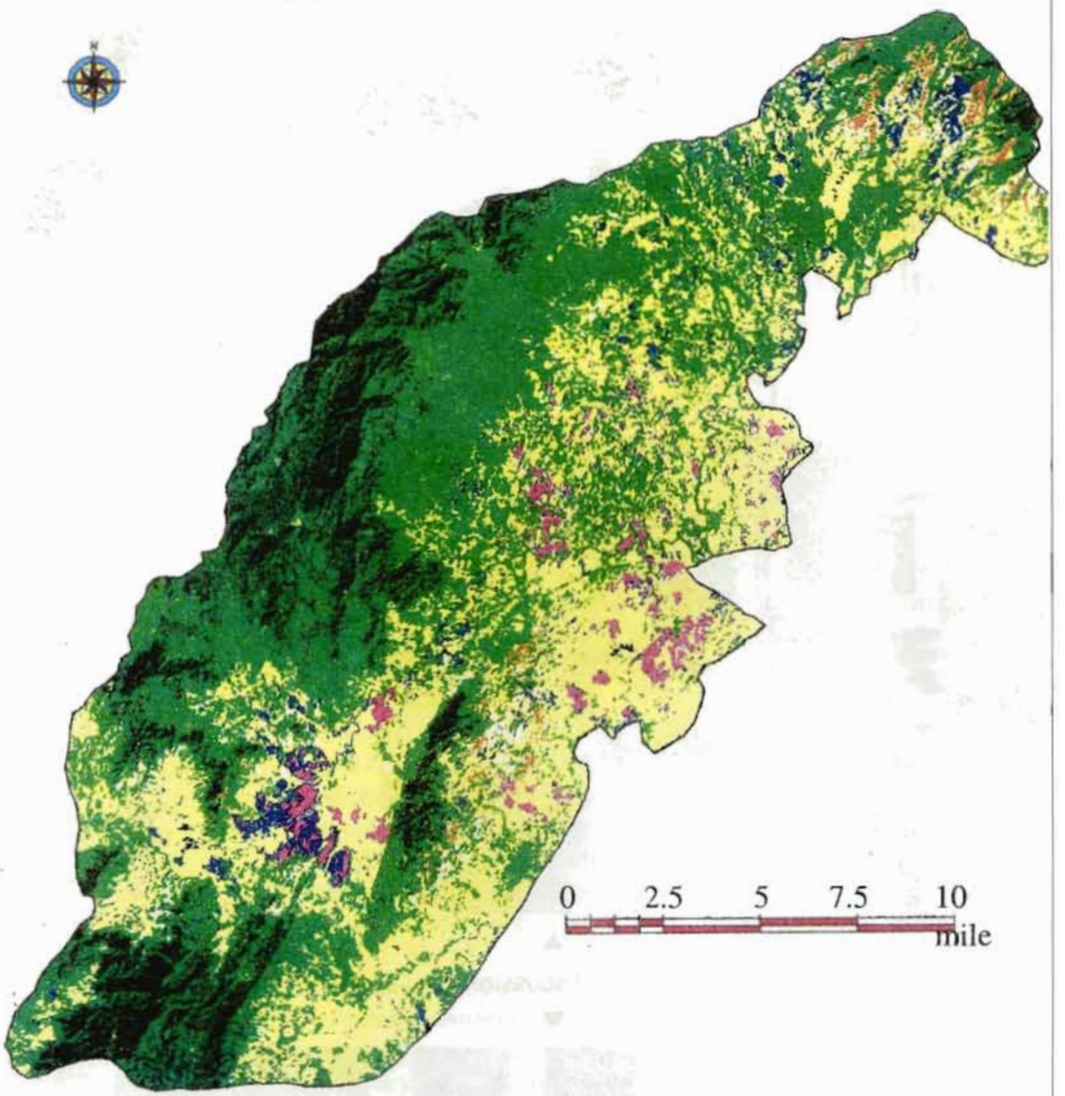
		Pidaung Wildlife Sanctuary Using Remote Sensing' by U. Nyan Hlaing, Staff Officer, GIS Section
14:35- 14:45	:	Discussion
14:45-15:05	:	Presentation on 'Check List of Birds and Their Conservation in Pidaung Wildlife Sanctuary' by U. Thein Aung, Park Warden, Hkakaborazi N.P.
15:05- 15:15	:	Discussion
15:15- 15:35	:	Presentation on 'The Current Status and Problems of Wildlife Conservation in Pidaung Wildlife Sanctuary' by U. Khin Maung Hla, Park Warden, Pidaung Wildlife Sanctuary
15:35- 15:45	:	Discussion
15:45- 16:05	:	Presentation on 'List of Rare Valuable and Endangered Species of Wild Flora and Fauna Endemic in Kachin State' by D. Kala Ya Lu, Demonstrator, Botany Department, Myitkyina University
16:05- 16:15	:	Discussion
16:15	:	Closing
13-12-2000		
09:00-12:00	:	Group Discussion
12:00- 13:00	:	Lunch
13:00-14:00	:	Group Presentation and Deliberations on the 'Model Management Plan for Pidaung Wildlife Sanctuary'
14:00-16:00	:	Recommendations and Plenary Discussion

14-12-2000		**(Field Trip)**
08:00	:	Breakfast
08:30	:	Departure for Pidaung Wildlife Sanctuary (about 29 km from Myitkyina)
	:	Excursion on Agroforestry and Community Development
09:30	:	Departure from Pidaung Wildlife Sanctuary to Gut-Shan-Yang Village (about 6 km)
	:	Discussions with the Local Community
10:15	:	Departure from Gut-Shan-Yang Village
11:45	:	Arrival at Myitsone (starting point of the Ayarwaddy River) (about 45 km)
12:00	:	Lunch
13:00	:	Study of 'Biodiversity of the Mountain Ecosystem and Land Use'
	:	Back to Myitkyina

Forest are a protected by villagers, Pidaung Wildlife Sanctuary

The area at the foot of the hill was cleared by local people practising taungya

Digitally Classified Land-Use Map of the Pidaung Wildlife Sanctuary Area



	(Acres	(Sq.m)	(Per Cent)
Good Forest	18107.88	16557.83	10.49
Degraded Forest / Scrub Land/Shifting Cultivation	67934.64	62119.38	39.38
Bamboo Breaks	2150.61	1966.52	1.24
Swamp	4250.82	3886.95	2.46
Water Body	7159.57	6546.71	4.15
Agriculture/Grass Land	72890.85	66651.33	42.25
Grand Total	172494.37	157728.71	100.00

Scale 1:230,000
Source: Landsat 7TM Satellite Image (March 2000)
Produce by: Forest Department RS & GIS Section

Presentation at the workshop

▲

Group discussion

▼

Introduction to Part 4

Report of Collaboration on and Integrated Management of Mountain Ecosystems in Hongqiang, Chuxiong, Yunnan Province of China

Hongqiang is one of the sites of the project of the International Centre for Integrated Mountain Development (ICIMOD) on 'Regional Collaboration for Biodiversity Management in the Eastern Himalayas and Models for Integrated Management of Himalayan Ecosystems'. The project duration at this site was from January 1998 to December 2000. It provides a valuable case study for other projects in this region with similar objectives.

This report has been prepared as a post assessment of the project. Two short-term field surveys were conducted in September and November 2000, with the aim of revealing the impact of the project, investigating activities in local non-government organisations related to biodiversity conservation and ecosystem management, and identifying follow-up activities for future development. The report is based on the two surveys and previous project progress reports.

The detailed account of the project addresses conservation and ecosystem management within the specific environmental and socioeconomic conditions in the area, and includes information on training and education, dissemination of knowledge, the benefits of the project to the area, and the role of the Hongqiang Community Association for Biodiversity Conservation.

In addition, the report demonstrates how post-project follow-up activities, such as short-term surveys and the presentation of data, results, and discussion, provide a good opportunity for reviewing the impact of projects and for disseminating new information and ideas that have been learned.

Report of Collaboration on and Integrated Management of Mountain Ecosystems in Hongqiang, Chuxiong, Yunnan Province of China

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Prof. Kang Yunhai, Deputy Division Head, Yunnan Academy of Social Sciences
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Prof. Xue Jiarong, Forest Specialist, Southwest Forestry College, and
Prof. Long Chunlin, Country Coordinator of the Project, KIB-CAS

Background

Hongqiang is a Yi nationality community in the buffer zone of Zixishan Nature Reserve (ZNR) in Chuxiong, Yunnan (Figure 14). The ZNR, called Zixishan or Zixi Mountains, is located in central Yunnan and has an elevation of between 1,950m and 2,502m above sea level. It is dominated by evergreen, broad-leaf forests and pine forests. According to recent biological surveys, 1,300 species from 146 families of vascular plants have been found in the reserve. Among them, 120 species from 49 families are medicinal plants. It is rich in Theaceae, including nine species of camellia. Over 40 species from 9 families of mushrooms and about 100 species from 43 families of vertebrates including 61 bird species have also been recorded in the nature reserve. Some rare and endangered animals such as leopard, red panda, peacock, and golden pheasant are found in the nature reserve. Five of them are national protected species under grade one of the State Red Classification.

Zixishan has a historical position in religion in Yunnan. It is said that there were 66 forest lands, 77 nunneries, and 88 temples in the mountains about 400 hundred years ago. Traditional culture and indigenous knowledge have strongly affected biodiversity in the region. Local people have a tradition of managing, conserving and using biodiversity.

The Hongqiang Community Association for Biodiversity Conservation (HCABC) was founded in 1998. Since its establishment, HCABC has played an important role in biodiversity conservation and the extension of agricultural technology in the community.

Before this project, a pilot project was carried out at this case site (from 1995 to 1997, supported by the MacArthur Foundation and ICIMOD). The project team, aided by active participation from local government and the community made many multi-disciplinary achievements. Major activities and results include (1) a socioeconomic survey in Hongqiang; (2) biodiversity research, including indigenous knowledge and cultural contexts in biodiversity management; (3) the extension of 198 energy-saving stoves; (4) building of 1,100 water tanks for upland fields; (5) rehabilitation of the Yi Traditional Culture Centre; (6) establishment of a new school building with an area of 3,000m^2; and (7) publishing three papers and one booklet. The donors of the project were satisfied with these results. Therefore, the proposal for the current project was approved by the funding agencies.

The objectives of this project were as follow.

- To create greater awareness and knowledge about the sustainable ecosystem management of ZNR and its buffer zone

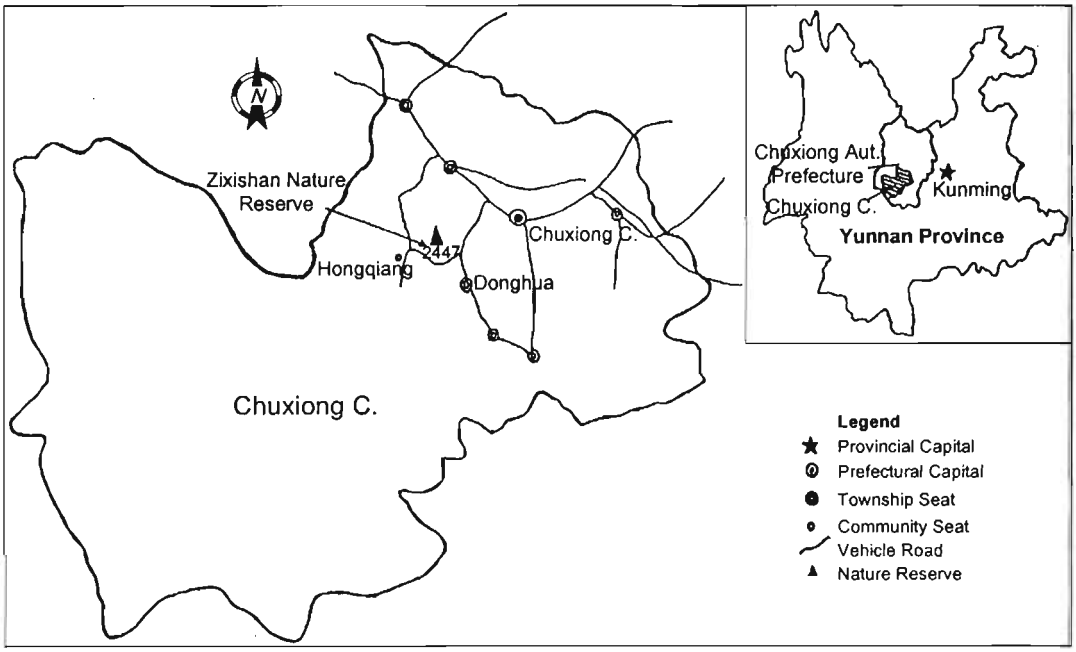

Figure 14: **The Location of Hongqiang Community, Chuxiong, Yunnan, China**

- To prepare a management plan for ZNR and its buffer zone
- To train local officials and villagers in biodiversity management
- To improve the quality of the forests
- To study traditional cultural beliefs and to promote them incorporating modern development requirements

After three years, we believe the project team reached these objectives.

The original tasks of this project were as follow.

- To organise training courses, for 20-30 officials of government organisations and staff of NGOs on integrated management of natural and man-made ecosystems in Chuxiong, including ZNR and its buffer zone
- To organise field trips for 30-40 officials in Chuxiong, who work in the field of natural resource management, to visit Hongqiang
- To lead farmer-to-farmer exchanges within and between communities in the ZNR buffer zone
- To train members of the newly established HCABC
- To compile training material in local languages and undertake education about the environment and biodiversity conservation in the primary school of Hongqiang
- To create a demonstration plot (2 ha) of mixed forest for pine forest improvement (and consequently increase seedling numbers of native alder (*Alnus nepalensis*) in Hongqiang)

The total grant was US $20,000: this comprised two components of US $10,000, one from the MacArthur Foundation and the other from UNEP.

Activities (1998-2000)

Training

First Beekeeping Training Workshop

The First Beekeeping Training Workshop was held in Hongqiang on 27-28 June 1998. Beekeeping is one of the traditional practices that use biodiversity in the Zixishan area. Local people can harvest honey twice a year for self-consumption. We realised, during our field trips in the area, that honeybees were extremely important not only for honey production but also for the whole agroecosystem. Many fruit trees (pear, peach, apple, and plum) and crops (rape seeds, pulses, and vegetables) can only harvest a good yield with pollination by bees.

Professor Kuang Bangyu and his colleagues were invited to the workshop. He is a professor at the Yunnan Agricultural University and has developed very successful management techniques for beekeeping in mountainous Yunnan, and is known respectfully as 'the King of Beekeeping in Yunnan'. If people in Hongqiang adopted his techniques, honey yield would increase by 5-8 times. Thus people would not only meet their own demands but also sell to tourists or at the local market. Twenty-nine local people participated in the workshop (see Appendixes 1). Professor Kuang and his colleagues trained the local people by means of lectures, videos, and practical demonstrations.

First Seminar on Environmental Education

The First Seminar on Environmental Education was held in Hongqiang Primary School on 10-15 September 1998. Based on the textbook (or training material) compiled by Zhang Fangyu, Yu Liliang, and Long Chun-lin (see later section on 'Training materials'), the seminar was given through lectures and field observation to all the students (197) at the school, by Zhang Fangyu and Yu Liliang. Both Mandarin and local languages were used in the seminar so that all the students could understand the content of the textbook.

Second Beekeeping Training Workshop

The Second Beekeeping Training Workshop was organised in Hongqiang on 20-24 September 1998. The major objectives of this workshop were to further progress beekeeping management techniques and to replace local traditional bee boxes with improved ones. Two lecturers from the Beekeeping Institute of Yunnan Agricultural University, Wang Jianming and Zhou Danyin, carried out the training, while 33 students from the university acted as volunteers to help (see Appendixes 2). About 65 farmers were trained (see Appendixes 3). Thirty-six groups of honeybees were transferred from old boxes to improved ones.

Seminar on Fruit Tree Management and Animal Husbandry

The Seminar on Fruit Tree Management and Animal Husbandry was held in Hongqiang on 26-28 September 1998. This seminar focused on agroforestry production in traditional orchards and on breeding of traditional black goats. Two agricultural experts from the Yunnan Agricultural University, Professor Yang Wenliang and Professor Peng Helu were invited to deliver the seminar. Twelve farmers from Hongqiang and three officials from local government attended the seminar (Appendixes 4).

"the objective of this workshop was to train policy-makers, government officials and staff from management agencies of the nature reserve, and environmentalists in NGOs in biodiversity conservation and sustainable uses of natural resources"

First Workshop on Natural Resource Management and Community Development

The First Workshop on Natural Resource Management and Community Development for officials and staff from government and non-government organisations was held in Zixishan, Chuxiong, on 24-28 November 1998. The objective of this workshop was to train policy-makers, government officials and staff from management agencies of the nature reserve, and environmentalists in NGOs in biodiversity conservation and sustainable uses of natural resources. Twenty-seven participants attended the workshop (see Appendixes 5), which was delivered by Lu Xing from the Yunnan Institute of Geography and Yang Qing from the Yunnan Academy of Forestry.

Second Seminar on Environmental Education

The Second Seminar on Environmental Education for students was held in Hongqiang Primary School on 10-15 March 1999. Zhang Fangyu, our project consultant, and Yu Liliang, from the Folk Cultural Association of Chuxiong, gave the seminar as two courses every afternoon. About 120 students attended the seminar.

Major topics included natural forests in Hongqiang, biodiversity and its significance, the relationship between forests and water, bio-totems in traditional Yi culture, and national and regional laws of environmental protection. Examples from local society were used so that the students could understand them very easily. The training material ('Textbook of Biodiversity Conservation') compiled by the project and HCABC was used during the seminar.

Third Beekeeping Training Workshop

"the objective of the workshop was to train local beekeepers so that they could harvest more honey after the bee boxes had been improved"

The Third Beekeeping Training Workshop was held in Hongqiang on 26-28 March 1999. The objective of the workshop was to train local beekeepers so that they could harvest more honey after the bee boxes had been improved. Zhang Xuan, a lecturer from the Beekeeping Institute at Yunnan Agricultural University, taught local beekeepers the harvest techniques through courses and demonstration in Hongqiang. Sixteen local beekeepers participated in the workshop (see Appendixes 6).

Three honey-harvesting machines were brought to the community to help the local people collect honey. Local farmers were very surprised that there was so much honey in their improved bee boxes. For example, Wang Jianhai's family could harvest only 2 kg of honey from each bee box in a year when they used the old bee boxes. However, they collected 5.5 kg honey from each box only two months after they adopted the improved boxes. The yield has been increased by 15-20 times. This is a big achievement and increases the enthusiasm of local people for bee keeping.

Second Workshop on Natural Resource Management and Community Development

The Second Workshop on Natural Resource Management and Community Development was held in Chuxiong on 22-24 May 1999. It was delivered

by Lu Bin (Senior Fellow, Yunnan Academy of Forestry) and Du Yong (Forester and Division Head, Yunnan Provincial Department of Forestry). Eighteen trainees including policy-makers, nature reserve staff, and members of HCABC participated in the workshop (Appendixes 7).

Lectures covered the functions of nature reserves and the concepts and examples of ecotourism and agrobiodiversity. The policy-makers and nature reserve staff are very interested in ecotourism because Zixishan Nature Reserve (ZNR) has been opened to the public but it is resulting in pollution of the reserve. Members of HCABC are interested in agrobiodiversity. They like to have forests, various crops, fruit trees, animals, bees, and many others species in their agroecosystem.

Training Workshop on Bamboo Cultivation and Management

A workshop on bamboo cultivation and management was organised in Hongqiang on 12-13 August 2000. Bamboo experts, Professor Xue Jiarong and Professor Du Fan from Southwest Forestry College, were invited to deliver the training. Twenty-five participants from HCABC and villages attended (Appendixes 8).

The lectures comprised six parts: (1) general introduction to bamboo; (2) propagation techniques and seedling preparation; (3) land preparation and transplantation; (4) fertilisation, selective logging, and management; (5) disease and pest control; and (6) harvesting and marketing. After the lectures, a field demonstration was conducted in a private bamboo garden of Hongqiang Village.

Dissemination

Publications

The project team has completed six papers and one piece of training material since the beginning of the project. Some articles have also been published.

In addition to publications, some of the project results are being disseminated through conferences. These include the 'Second International Symposium on Plant Resources', the 'Anniversary Congress of the Chinese Society of Botany', and the 'Symposium on Sustainable Development in Mountain Areas in Yunnan'. All three symposia invited Professor Long Chun-lin to a give keynote presentation on the project activities and achievements from Hongqinag, Chuxiong, Yunnan.

The publications are

Liu Aizhong; Long Chun-lin (1999) 'Advances in Ethnobotany'. In *Advances in Plant Sciences*, Vol. 2, pp 166-173. Beijing: China Higher Education and Heidelberg: Springer-Verlag

Liu Ai-zhong; Pei Shengji; Chen Sanyang (1999) 'Plant Worship of the Yi People in Chuxiong of Yunnan, China'. In *Ethnobotany*, 11: 1-8

Liu Ai-zhong; Pei Shengji; Chen Sanyang (2000) 'An Investigation and Study on the Plant Worship by the Yi People in Chuxiong, Yunnan'. In *Chinese Biodiversity*, 8(1): 130-136

Liu Ai-zhong; Pei Shengji; Chen Sanyang (2000) 'Investigation and Studies on Sacred Groves of the Yi People in Chuxiong, Yunnan'. In *Ethnobotany and Sustainable Utilisation of Plant Resources*, pp 271-280. Kunming: Yunnan Science and Technology Press

Long Chun-lin (1999) 'Participatory Conservation and Community Development— Practice in the Buffer Zone of Zixishan Nature Reserve in Yunnan, China'. In Yunbin, Ai (ed.)

Proceedings of the Symposium on Sustainable Development in Mountain Areas in Yunnan, pp 209-213. Kunming: Yunnan Science and Technology Press

Long Chun-lin; Zhang Fang-yu; Pei Shengji; Chen Sanyang (1999) 'Impact of Traditional Yi Culture upon Biodiversity in Zixishan of Yunnan'. In *Chinese Biodiversity*, 7(3): 197-204

Training Materials

The environmental training material, entitled 'Textbook of Biodiversity Conservation' was compiled by Zhang Fangyu, Yu Liliang, and Long Chun-lin, illustrated by Liu Yi and Liu Yitao, and issued by the HCABC and the project in August 1998. It is the first training material for local government officials, farmers and primary school students to address the protection of biodiversity in China. The textbook consists of the following sections: (1) love nature; (2) powerful forests; (3) the broad-leaf forest is a treasure house; (4) protect birds while conserving forest; (5) forest is equal to a purification factory; (6) big trees contain water; (7) foster seedlings; (8) everybody will praise my home town; (9) colourful flowers; (10) no forest, no mushrooms; and (11) significance of reforestation. A beautiful illustration is attached to each section.

"the first training material for local government officials, farmers and primary school students to address the protection of biodiversity in China"

The HCABC have issued 1500 copies of the textbook. Most of them are used for teaching in Hongqiang Primary School and some of them are used by farmers, local government officials, and members of the HCABC. Many people in the field of biodiversity conservation in China (including Taiwan and Hong Kong) have paid great interest to this textbook and, as a result, about 30 copies have been sent to different people from different organisations in China. This is very useful for the dissemination of research results and working experiences, and for raising public awareness about environmental protection.

Dissemination/Exchange of Biodiversity Conservation and Community Development Experiences in Mountain Ecosystems

The experiences from Hongqiang, including the methodologies and results, might be useful for other places in southwest China, where the biophysical and cultural environments are very similar. Such experiences can be disseminated through meetings. With this consideration, a seminar on Experience Dissemination/Exchange of Biodiversity Conservation and Community Development in Mountain Ecosystems was held in Chuxiong, Yunnan, China on 18-21 November 1999.

The main objectives of the seminar were to disseminate the project findings and to increase awareness of biodiversity conservation and integrated management of natural resources. Six participants from Sichuan, two from Guizhou, one from Chongqing, one from Hunan, seven from Yunnan, and two from international organisations were invited to attend the seminar (Appendix 9). They represented a broad background from government organisations from provincial, through county to township level, research institutions, and universities. Participants were

required to share and exchange their experiences encountered in biodiversity conservation and rural development in mountainous southwest China.

Zhang Fangyu, Consultant to the ICIMOD-UNEP/MacArthur project in Chuxiong, was the first speaker in the seminar. He gave a presentation entitled "Strategies for Biodiversity Conservation and Sustainable Rural Development in Hongqiang, A Yi Community in the Buffer Zone of Zixishan Nature Reserve". He summarised the project activities and achievements in the past few years and he emphasised the role and significance of the HCABC in the conservation of biological and cultural diversity and sustainable rural development in the community. It is remarkable that traditional culture, religious beliefs, and indigenous knowledge have been playing an important role in biodiversity conservation according to the case study from Hongqiang.

Professor Kuang Bang-yu, Director of the Beekeeping Institute of Yunnan Agricultural University, emphasised the important role of bees in agroecosystems in his presentation entitled 'Discussion on the Relationship between Honeybee and Agrobiodiversity'. Beekeeping in mountain ecosystems not only provides local people with honey and other bee products (including beeswax, royal jelly, and pollens) it can also promote local agroecosystems and improve agricultural yields through pollination by honeybees. Hongqiang, as one of the demonstration cases of beekeeping in Yunnan Province, under the supervision of Professor Kuang, has benefited from the improved techniques of beekeeping developed by Professor Kuang's institute.

Wang Jianhai, Head of Hongqiang Community, told the participants that biodiversity conservation and rural development can exist together, based on experiences of the last few years. He explained that the ongoing project has greatly improved awareness of the ecological environment. Local people understand that the nature reserve is their source of water and non-timber forest products. In addition to paying more attention to the conservation of the nature reserve, they have agreed to establish water source-protected areas (total area of 1000 ha) in the community. Through education and training, particularly in agricultural techniques like fruit-tree management and agroforestry techniques, local people have received more products from their farm land.

The main contents of the seminar were disseminated through papers dispersed at the workshop, and through Chuxiong Television Station on the evening of 19 November 1999. This seminar and the ICIMOD-UNEP/MacArthur project were also reported through other media, such as Yi's Prefecture News and Chuxiong Radio.

The two-day seminar achieved its objectives. The participants stated that they had learned a lot from the project site and also from each other.

Farmer-to-Farmer Exchanges

Two Farmer-to-Farmer Exchanges had been organised at the time of writing.

Six farmers from Laoshaohe Community visited Hongqiang on 12-13 July 1999. This community is located in the buffer zone of the ZNR. Farmers from Laoshaohe mainly observed the water tanks, the energy-saving stoves, and the HCABC. They had very productive talks with the people in Hongqiang about agricultural production and biodiversity management. Zhang Fangyu and Wang Jianhai coordinated this activity.

Chen Liming, the local facilitator of the project, took a group of 10 farmers from Hongqiang to Shuzuo Township, Chuxiong from 3-5 September 1999. Shuzuo is known in Chuxiong for its

good agroforestry management and rural economy. Farmers from both communities shared a lot of experiences of agricultural production and forest management. In particular, farmers from Hongqiang paid much attention to the fact that the people of Shuzuo grow green manure in their orchards in autumn and winter after they have harvested fruits and summer crops like corn and soybean. Several farmers of Hongqiang indicated that they would grow green manure on their lands in the winter. Participants of the Farmer-to-Farmer Exchanges are listed in Appendix 10.

Hand-in-Hand Project

The first activity of the Hand-in-Hand Project was proposed by the project team in August 1998. It involves a household from the Kunming Institute of Botany (KIB) supporting a family from Hongqiang who are too poor to afford for a child to finish primary school education. The project was initiated in early September at the KIB. At the end of September, the organisers of the project accepted 4,220 yuan, 717 books and 788 pieces of clothing from 112 staff and graduate students of KIB. On 1-2 October, representatives from KIB came to Hongqiang and met the students at Hongqiang Primary School. The staff and graduate students from KIB have established a partnership with 23 local students (Appendix 11) who are very poor. These students will be supported financially by their partners at KIB until they finish their primary school education. It was poignant that the meeting was organised on the National Day of China (October 1).

"farmers from both communities shared a lot of experiences of agricultural production and forest management"

The project team organised the second activity of the project on 1-2 July 1999. Thirty-one students from Hongqiang Primary School were brought to Kunming and met their partners. They visited Kunming Botanical Gardens, Kunming Children's Centre, and the Exhibition of the Animal Kingdom. Students reported that the visit to the city was an eye-opener for them in terms of social, economic, and scientific development, and that they received excellent environmental education.

Alder Seed preparation

In October-November 1998, the project team members had gathered three kg of alder seeds. They came from two species, *Alnus nepalensis* and *A. cremastogyne** (both are native to central Yunnan), that are suitable for growing in Chuxiong. Alder trees are highly appreciated by the local people in the Zixishan area for their beneficial characteristics that include fast growth, nitrogen-fixing properties, and their suitability for timber production and fodder supply and as a green manure. The seeds were treated in March 1999 and the subsequent seedlings were to be used to create a demonstration plot (2 ha) of mixed forest for pine forest improvement so as to increase the number of native alder seedlings in Hongqiang.

The alder seeds were put into hot water first and then sown in a well-prepared nursery. Unfortunately, not enough seedlings grew to cover an area of two hectares, because mice ate most of the seeds after sowing. Thus the project team moved their attention to a demonstration plot of bamboo. Again the area would be two hectares.

Demonstration of Bamboo Cultivation

Introduction

Currently, more than 1,000 bamboo species of 70-80 genera have been recorded around the world. Some 40 genera and 400 species of bamboo are present in China and Yunnan is the province with the richest bamboo biodiversity in China. In the whole province of Yunnan there are 210 woody bamboo species within 28 genera distributed naturally and the total area of bamboo forests in Yunnan is estimated to be 331,000 ha. Scientists have predicted that new species and genera of bamboo will be discovered in Yunnan in the future. Therefore, Yunnan is commonly accepted as the original and modern distribution centre of bamboo in the world.

People in China, especially those in south and southwest China, traditionally collect, cultivate, manage, and use bamboo. In all indigenous communities of Yunnan, bamboo is widely used in daily life, for construction, for making furniture and paper, for weaving, for handicrafts, for aesthetic purposes, and as food (bamboo shoots). Because of its significance, bamboo can be seen in every community in south and southwest China.

The Chinese people love bamboo so much that China has been called a country with a bamboo civilisation. Traditionally, bamboo was praised as one of the three intimate friends of human beings, along with pine and red plum, for its ability to withstand severe cold. In the classical gardens of China, bamboo is grown as an indispensable element among ornamental plants. Su Dongpo (1036-1101), one of the most famous writers in Chinese history had a very famous saying about bamboo, which every Chinese person knows: "I can manage life without meat; I could not, however, tolerate living in an environment without bamboo".

There are 25 ethnic groups living in Yunnan and most of them are polytheists. Some groups consider bamboo as their totems and worship them. For example, the Yi people in Chengjiang of central Yunnan believe that the golden bamboo (*Phyllostachys nigra* [black bamboo]) is their ancestral god and Yi families in Chuxiong, Yunnan, worship the rhizome of a species of *Fargesia* (grass). Bamboo is endowed with the meanings of birth, regeneration, and long-life in Taoism.

Based on its functions in economy, culture, and religion, it is easy to understand why the indigenous people in Yunnan have managed, conserved, used, and cultivated bamboo for many generations. Major bamboo species found in local communities in central Yunnan include *Fargesia yunnanensis* (grass family), *Dendrocalamus bambusoides*, *D. farinosus*, *Phyllostachys nigra*, *Neosinocalamus affinis*, *Chimonobambusa yunnanensis*, *Yushania polytricha* (grass plant), and *Bambusa intermedia*, some of which have been introduced for cultivation in Yunnan.

In the place of the alder cultivation, the establishment of a bamboo demonstration plot will help to gather many useful bamboo species and to demonstrate their economic, cultural, and religious value to the people. The supply of bamboo resources from such a demonstration plot could hold much potential for future development. Most attention will be paid to conservation of the most useful bamboo species that provide food in the form of edible shoots in central Yunnan.

Objectives

- To establish a bamboo demonstration plot of species useful to central Yunnan.
- To demonstrate the significance of native bamboo in economy, culture, and religion.
- To demonstrate bamboo propagation methods to the indigenous communities.
- To increase public awareness of biodiversity conservation through the HCABC.

Main Activities and Results

Traditionally, local people in Hongqiang manage, conserve, and use biodiversity, including that of bamboo, and their active participation in the project activities has made the bamboo demonstration plot very successful. The main activities are outlined below.

- First, a survey of the project site and its surrounding areas was conducted. Bamboo species occurring in central Yunnan were investigated and identified, particularly the useful species.
- A list of bamboo species introduced into the demonstration plot was prepared. They include *Bambusa ventricosa*, *B. lapidea*, *B. intermedia*, *B. glaucescens*, *Chimonobambusa yunnanensis*, *Dendrocalamus bambusoides*, *D. farinosus*, *D. latiflorus*, *Fargesia yunnanensis*, *Indocalamus longiauritus*, *Neosinocalamus affinis*, *N. farinosus*, *Phyllostachys aurea* (fish-pole bamboo), *P. nigra*, *Qiongzhuea tumidinoda*, and *Yushania polytricha*. Among them, *Fargesia yunnanensis*, *Chimonobambusa yunnanensis*, *Dendrocalamus bambusoides*, and *Phyllostachys nigra* are very important to the local people, economically and culturally, and most attention has been paid to these species (Appendix 12).
- The bamboo demonstration plot was established on an area of two hectares in a valley near the Hongqiang Community site in July 2000 (Figure 14).
- The propagation techniques for very important bamboo species were demonstrated through training courses.

"traditionally, local people in Hongqiang manage, conserve, and use biodiversity, including that of bamboo, and their active participation in the project activities has made the bamboo demonstration plot very successful"

Impact of the project

Awareness Strengthening of Biodiversity and Forest Conservation

School Students

After two environmental education activities and the distribution of the 'Textbook of Biodiversity Conservation', all students in Hongqiang Primary School have a good understanding of the significance of biodiversity and the relationships between people and forests, trees, wildlife, and mushrooms. Educated from childhood, they will be able to pass on their knowledge about biodiversity conservation to their parents and neighbours. In the future, they will be better equipped to manage their biological resources than the older generation.

Local Farmers

When the project team first went to the villages in Hongqiang nobody knew what biodiversity meant. Through various training schemes and activities of the HCABC, local farmers started to gain more knowledge about biodiversity, its conservation, and its utilisation. The understanding of relationships between water and forests, mushrooms and trees, birds and insects, snakes and rats, and herbal medicine and the natural environment, has increased local people's awareness of biodiversity conservation and its sustainable uses.

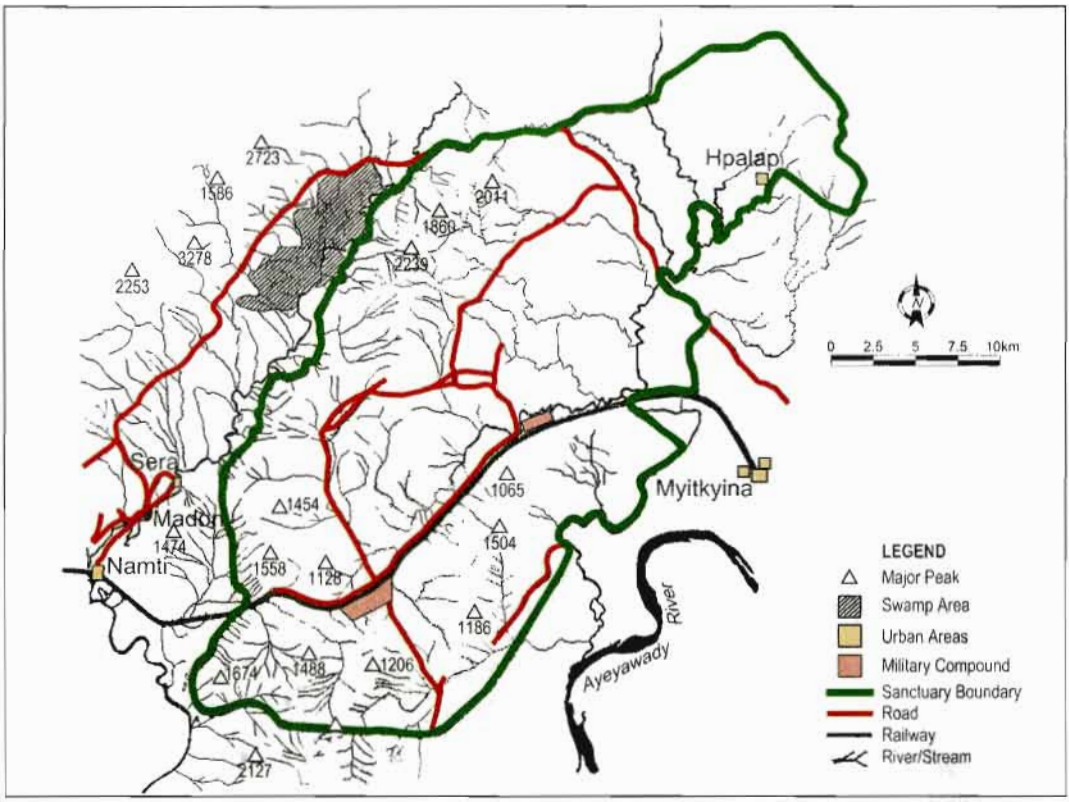

Figure 15: **Skeleton Map of Pidaung Wildlife Sanctuary** (See page 193)

Establishment of the Hongqiang Community Association for Biodiversity Conservation

Understanding the significance of biodiversity, people in Hongqiang realised that biodiversity occurring in the ZNR and its surrounding areas urgently needed to be protected by them. In consultation with the project team members and other experts on biodiversity and the environment, they applied for an association to be formed which would help conserve biodiversity while allowing agricultural techniques to be extended, learned about, and exchanged within the association. Thus HCABC was established on 8 February 1998, the date of the traditional Rhododendron Festival, according to the Chinese lunar calendar.

The regulations of HCABC were issued when the association was founded. It was emphasised that the association is a farmers' NGO for the conservation of biodiversity and the environment in the Zixishan region.

Promotion of Agricultural Techniques through Training

Training on agricultural techniques such as beekeeping, bamboo cultivation, fruit tree management, and animal husbandry has enriched local farmers' knowledge about developing and managing their crops, trees, and animals. Traditional beekeeping could only provide a family with 2 kg of honey per box per year. After the techniques from Yunnan Agricultural University were adopted, the honey yield reached 12-16 kg per box per year. In addition, bee populations have increased in the past three years, helping to increase the insect pollination of crops and fruit trees, and thus productivity from the fields.

"traditional beekeeping could only provide a family with 2 kg of honey per box per year. After the techniques from Yunnan Agricultural University were adopted, the honey yield reached 12-16 kg per box per year"

Some families have grown bamboo in their domestic gardens for many years. Yields of bamboo shoots and culms, however, have been very low compared with those in other bamboo gardens. Cultivation and management techniques of bamboo from Southwest Forestry College have helped local people in Hongqiang to develop their bamboo shoots and culms in both quantity and quality. *Fargesia yunnanensis*, for example, used to provide about 85 kg of bamboo shoots per year in an area of one mu (1/15 ha) in Hongqiang Village. With the adoption of management techniques from the training workshop held in August 2000, the yield of bamboo shoots per year from an area of the same size in 2001 was estimated to be 200 kg; this was because the young culms in the same plot are now larger than the old ones.

Direct Benefits from the Project

The Increase in Crop Yields

The training workshops on fruit tree management and other agricultural techniques have provided local people with agricultural knowledge to manage their crops and fruit trees. During various workshops, experts from Yunnan Agricultural University, Southwest Forestry College, Yunnan Academy of Forestry, and KIB also helped to solve the problems that occurred in agricultural production practices. Thus the yield of crops and fruit trees has increased in the past three years. The cherry trees in Longba Village, for example, did not used to be pruned or trained well. After the training workshop, people in the village trained and pruned their cherry trees in the winter of 1999. As a result, the yield of cherries increased from 180 kg to 330 kg per mu in 2000. Some families harvested twice the amount of cherries than in 1999.

"after the training workshop, people in the village trained and pruned their cherry trees in the winter of 1999"

The building and extension of water tanks has also ensured an increase in crop yield. At the time of writing, over 1500 water tanks had been built. Each tank can supply water for one mu of upland to grow winter maize. Thus the yield of corn can be sustained by regular irrigation in the dry season from October to May. Before this project, only 150-200 kg of winter corn could be harvested from 1 mu of upland. In 1999, people harvested 250-300 kg of corn, using water tanks for irrigation in the winter.

Improved Agroecosystems

With recommendations from the project team, the Hongqiang Community and the HCABC jointly declared 1000 ha of forests to be community protected areas, after an integrated ecological survey. These forests are distributed in different villages and have traditionally provided the villagers with water. Trees here are mostly evergreen, broad-leaf species of Fagaceae, Theaceae, Lauraceae, Ericaceae, and Rosaceae. The declaration of forest protection has not only helped biodiversity conservation in the region, but has also provided a better agroecosystem environment for the local people and for flora and fauna. Local people benefit from a water supply and non-timber forest products such as mushrooms and wild vegetables that can be collected from the protected forests.

"the yield of cherries increased from 180 kg to 330 kg per mu in 2000"

The beekeeping training workshops and the introduction of new techniques for beekeeping over the past three years have stimulated and encouraged local people to raise more bees than before. As important pollinators of flowering plants, bees not only help to increase crop and fruit yield in the community, by pollination, but also make a contribution towards sustaining local agroecosystems.

Improved Livelihood

Through environmental education and agricultural technology training organised by the project team, local people in Hongqiang understand that their livelihood could be improved by conserving and using biodiversity and by using modem agricultural techniques. In 1995, local people in Hongqiang Community had only 217 kg of grains and 960 yuan income per capita per year. By the end of 2000, however, the numbers had increased to 461 kg and 1584 yuan.

With support from the project and many other people, poor children in Hongqiang could go to school to get a primary education. Donors also provide them with clothes, books, and money. These activities helped to reduce poverty and improve livelihood both now and in the future.

In general, local people have benefited from biodiversity conservation and understand the significance of biodiversity to the local ecological environment, agricultural production, and future sustainable development. In addition, local people have traditions to protect trees, including rhododendrons and *Ilex*, and sacred forests in the region. This will help to conserve local biodiversity and improve sustainable socioeconomic and ecological development.

Activities organised by the Hongqiang Community Association for Biodiversity Conservation

The Environmental Protection Regulations of Hongqiang

The HCABC issued the Environmental Protection Regulations of Hongqiang in May 1998. The regulations were produced as a result of a meeting of HCABC members in April. After negotiations by HCABC representatives with the community and natural-village leaders, it was agreed that the regulations could be issued to the community. The major contents of the regulations are given below.

- It is suggested that all people in the community be familiar with the relevant laws issued by central and provincial governments. Such laws include the Forestry Law, the Environment Protection Law, and Regulations for Wild Animals and Plants Protection. Members of HCABC should become the enthusiasts and promoters of these laws.
- The traditional sacred forests and water-source forests of natural villages are the heritage of local folk societies. Villagers should carefully protect these forests.
- It is forbidden to seize or kill animals in the forests, including peacocks, white pheasants, golden pheasants, eagles, monkeys, snakes, deer, musk deer, frogs, and others. Everyone should adhere to this regulation.
- It is forbidden to cut or damage all protected plants, namely camelias, rhododendrons, *Trachycarpus nana* (palm plant), *Manglietia insignis*, *Rosa odorata* (Rose), *Cephalotaxus fortunei*, orchids, and others. It is proposed that some native plants, including black alder, winter *Prunus*, *Quercus*, *Cinnamomum*, *Sorbus*, magnolias, and 20 other species, are protected by the villagers.
- Sacred and water-source forests of natural villages, which harbour many species of plants and animals, should be carefully protected by the people in the community. The total area is

"sacred and water-source forests of natural villages, which harbour many species of plants and animals, should be carefully protected by the people in the community"

1,000 ha. Any activity that affects the forests negatively is punishable by the association or the community.

Environmental Education Activities

The HCABC organises activities at least twice per year. Within these activities, environmental education is one of the most important concerns. In addition to the association providing environmental education directly, members also train other people in the villages who have environmental knowledge.

As mentioned above, the HCABC and project team jointly composed the 'Textbook of Biodiversity Conservation' for villagers and school students. Every member has a copy of this book. Using the descriptions and illustrations in the textbook, members have educated local villagers about biodiversity conservation.

When members know or see somebody making a negative impact on the protected areas, they will stop such activities. If this is difficult to do at the site, they will report it to the association or the community. This has happened in two natural villages and the community and association have punished those responsible for the damage. This has helped to protect biodiversity and forests in Hongqiang.

Training in Agricultural Techniques

With the project team or the community, the HCABC have jointly organised nine training workshops, five of which are on agricultural techniques. Members of the HCABC have priority to receive training. Their knowledge gained from the training is used within their own families and sometimes they also transfer it to other families. It is a kind of farmer-teaching-farmer method.

Members of the HCABC are the pioneers for testing new techniques. When the training workshop on bamboo cultivation and management was carried out, few people in Hongqiang had a good knowledge about bamboo. Those who grew bamboo did not selectively cut bamboo and the density of culms in the fields was high. After training, HCABC members who had bamboo plantations followed the experts' advice and removed some bamboo culms according to the experts' experiences. In 2000 they observed that their bamboo grew bigger and taller than that of other villagers. Their success will encourage other villagers to adopt new agricultural techniques.

"those who grew bamboo did not selectively cut bamboo and the density of culms in the fields was high"

Follow-up activities for participatory biodiversity conservation

The follow-up activities for participatory biodiversity conservation in the buffer zone of ZNR will focus on agrobiodiversity.

As a scientific term, agrobiodiversity has been widely accepted by both scientists and the public for several years. It refers to human-managed or modified biological diversity. It can be divided into four levels: variety

diversity or genetic diversity, agricultural species diversity, agroecosystem diversity, and management type diversity. Agrobiodiversity is regarded as a subset of biodiversity that includes the diversity and variability of animals, plants, reptiles, birds, insects, and micro-organisms, and the in situ and ex situ conservation of genetic resources linked with agriculture. Scientists believe that more biodiversity exists in human-managed ecosystems. Because of land-use system changes, deforestation, population pressure, urbanisation, degradation of land races, and over-harvesting of non-timber forest products, agrobiodiversity is now reducing very rapidly at ecosystem, species, variety, and management system level. The importance of agrobiodiversity, therefore, should be emphasised by the academic, economic, and political sectors.

Fortunately, the significance of agrobiodiversity has captured the interest of scientists and various agencies. Current work emphasises its conservation both in situ and ex situ, through traditional and scientific approaches, and sustainable uses of agrobiodiversity.

A very important document on agrobiodiversity was issued by the Global Environmental Facility (GEF) in 1998: the 'Framework for GEF Activities Concerning Conservation and Sustainable Use of Biological Diversity Important to Agriculture'. There are only two objectives for GEF in supporting agrobiodiversity activities, the conservation objective and the sustainable-use objective. Because it is not possible to conserve all species in a region by using conservation areas alone, the operating programmes support biodiversity conservation and sustainable use outside the designated conservation or protected areas and their integration into the management of natural and modified surrounding areas.

Agrobiodiversity in the buffer zone of ZNR is very high. However, many local varieties of crops and medicinal plants, for example, are being lost because of the introduction of improved varieties or over-harvesting. It is necessary to investigate, conserve, study, and demonstrate local agrobiodiversity for sustainable development in the mountain ecosystems.

The objectives of the proposed activities are given below.

- To document agrobiodiversity in the buffer zone of ZNR.
- To study indigenous knowledge related to agrobiodiversity.
- To develop a conservation strategy for agrobiodiversity.
- To undertake research on sustainable uses of agrobiodiversity.
- To set up a demonstration plot for sustainable uses for technology extension in the Hindu Kush-Himalayas region.

The follow-up activities that correspond to these objectives are discussed below.

Investigation and Inventory of Agrobiodiversity

Agrobiodiversity at agroecosystem, species, variety, and management system level will be investigated and documented in the buffer zone of ZNR. Cultivated plants will be the major targets. Other flora and fauna including honeybees and animals raised by local people will be components in the inventory.

During the investigation, participatory approaches will be adopted. Some important and endemic species/varieties will be selected and screened for further studies. Information on indigenous knowledge related to agrobiodiversity will also be collected and studied.

Agrobiodiversity Conservation and Improvement

Agrobiodiversity can be conserved in traditional ecosystems (in situ conservation) and in newly established collections (ex situ conservation). Traditional agroforestry practices in the buffer zone of ZNR provide an effective model for conservation of agrobiodiversity in local agroecosystems which can be shown as 'fruit trees + *Musella lasiocarpa** + food crops + bees'. Within this system, all the components are native species or long-term cultivated or domesticated species and local varieties. Importantly, *Musella lasiocarpa* is the only species in the genus *Musella* (Musaceae [banana family]), which is endemic to northwest Yunnan and southwest Sichuan. Wild populations are now very difficult to find in the fields. The Yi people in these areas, however, conserve this species in their traditional agroecosystems as a forage plant for pigs.

"some important and endemic species/ varieties will be selected and screened for further studies"

The traditional agroforestry systems in the target area will be selected and screened for agrobiodiversity conservation and improvement. Every component in the system, including trees, crops, bees, and *Musella*, will be checked very carefully in terms of native species and local varieties and only native species or local varieties will be encouraged to be in the systems. The spaces between seedlings and spatial arrangement will be designed according to indigenous knowledge and recent scientific developments.

Demonstration of Sustainable Uses of Agrobiodiversity

Because the protected areas cannot incorporate the complete range of biological diversity of the region, people can conserve biodiversity by growing and raising and using appropriate plants and animals.

Agrobiodiversity in the buffer zone of ZNR can also be well protected through its sustainable use. *Musella lasiocarpa* provides a good example. In the following two sections, two plots designed to demonstrate the sustainable use of agrobiodiversity in mountain ecosystems are discussed. Lessons learned from these plots can be applied to other places in the Hindu Kush-Himalayas where the biophysical environment and cultural background are similar to Zixishan region.

Demonstration of Paris polyphylla Cultivation

Paris is a genus of the Tilliaceae family. The rhizomes of most species in the genus are used as a traditional herbal medicine. Among them, the rhizome of *Paris polyphylla* var. *yunnanensis* is a traditional Yi ethnopharmaceutical medicine. It is naturally distributed in the ZNR and its buffer zone. The wild population, however, is becoming very rare because of over-harvesting. This plant has great marketing potential both now and for the future. It can be inter-cropped with fruit trees. Therefore, the demonstration plot of *Paris polyphylla* will not only show that local people's income can be increased but also that this native species can be conserved within its traditional agroecosystems. Major activities will include

- investigating methods of breeding from seeds and rhizomes and propagation from tissue culture,
- development of planting techniques,
- *Paris*-based agroforestry model selection, focusing on local species and varieties,
- the establishment of a two-hectare demonstration plot, and
- technical extension and farmer-to-farmer exchange.

Demonstration of Medicinal Yam Cultivation

Medicinal yams (*Dioscorea zingiberensis*, *D. deltoidea*, *D. panthaiaca*, and *D. collettii*) are the important raw material for the production of diosgenins which are used for making many hormone-based medicines. Tubers of these plants are products from farm land; they can be harvested three years after planting. The yearly income from medicinal yam cultivation can be three times that from maize or potato cultivation in the target area. These plants can be grown in the traditional agroforestry systems in the buffer zone of ZNR. Major activities for the demonstration of medicinal yam cultivation will be

- investigating methods of breeding from tubers and propagation from tissue culture,
- development of planting techniques,
- yam-based agroforestry model selection, focusing on local species and varieties,
- the establishment of 2 ha of demonstration plot, and
- technical extension and farmer-to-farmer exchange.

Appendix 1: **List of Participants in the First Beekeeping Training Workshop**

(June 27-28, 1998; Hongqiang, Chuxiong)

(Resource Persons: Prof. Kuang Bangyu *et al.*)

Name	Village Name	Sex	Nationality
Wang Jianbing	Zhongcun	M	Yi
Wang Jianlin	Zhongcun	M	Yi
Wang Jianhong	Zhongcun	M	Yi
Zhao Lixin	Zhongcun	M	Han
Zhao Lichun	Zhongcun	F	Han
Chen Yourong	Zhongcun	M	Yi
Chen Youlin	Zhongcun	M	Yi
Shi Youliang	Longba	M	Yi
Liu Xianwei	Hewei	M	Yi
Luo Chaowang	Hewei	M	Yi
Wang Jianwen	Hewei	M	Yi
Luo Chunliang	Hewei	M	Yi
Li Chihong	Hewei	M	Yi
Li Chijiang	Hongqiang	M	Yi
Li Guifa	Hongqiang	M	Han
Li Zhiping	Hongqiang	M	Han
Li Guihai	Hongqiang	M	Yi
Li Zhiyang	Hongqiang	M	Yi
Li Cunfu	Hongqiang	M	Yi
Li Shixiang	Dalongtan	M	Yi
Li Shijin	Dalongtan	M	Yi
Li Zhiwen	Guojiacun	M	Yi
Li Facai	Guihua	M	Yi
Li Zhengfa	Maocaoping	M	Yi
Luo Cunli	Maocaoping	F	Yi
Zhou Fangfen	Dapingdi	F	Han
Wang Jiachong	Hongqiang	M	Yi
Luo Cunfu	Hewei	M	Yi
Li Xianwang	Hewei	M	Yi

Appendix 2: **List of Volunteer Students from the Second Beekeeping Training Workshop**
(September 20~24, 1998; Hongqiang, Chuxiong)

Name	Sex	Organization
Luo CM	M	Eastern Bee Research Institute, YAU
Tao WH	M	Eastern Bee Research Institute, YAU
Li YH	M	Eastern Bee Research Institute, YAU
Wang WS	M	Eastern Bee Research Institute, YAU
Liu JQ	F	Eastern Bee Research Institute, YAU
Feng L	F	Eastern Bee Research Institute, YAU
Wang ZD	M	Eastern Bee Research Institute, YAU
Yang CX	M	Eastern Bee Research Institute, YAU
Li J	M	Eastern Bee Research Institute, YAU
Li ZH	M	Eastern Bee Research Institute, YAU
Pu LM	F	Eastern Bee Research Institute, YAU
Wang XC	M	Eastern Bee Research Institute, YAU
Zhang CF	M	Eastern Bee Research Institute, YAU
Zou J	F	Eastern Bee Research Institute, YAU
Bai BH	F	Eastern Bee Research Institute, YAU
Deng LJ	M	Eastern Bee Research Institute, YAU
He YX	M	Eastern Bee Research Institute, YAU
Shao WQ	M	Eastern Bee Research Institute, YAU
Wang S	M	Eastern Bee Research Institute, YAU
Xiong TL	M	Eastern Bee Research Institute, YAU
Song G	M	Eastern Bee Research Institute, YAU
Li T	M	Eastern Bee Research Institute, YAU
Ou CH	M	Eastern Bee Research Institute, YAU
Ning X	M	Eastern Bee Research Institute, YAU
Bao FH	M	Eastern Bee Research Institute, YAU
Li XK	F	Eastern Bee Research Institute, YAU
Yuan P	F	Eastern Bee Research Institute, YAU
Yang ZY	F	Eastern Bee Research Institute, YAU
Hong JH	F	Eastern Bee Research Institute, YAU
Xiong LX	F	Eastern Bee Research Institute, YAU
Yang SX	F	Eastern Bee Research Institute, YAU
Yang M	F	Eastern Bee Research Institute, YAU
Zhang FQ	F	Eastern Bee Research Institute, YAU

YAU = Yunnan Agricultural University

Appendix 3: **List of Participants in the Second Bee-Keeping Training Workshop**
(September 20~24, 1998; Hongqiang, Chuxiong)
(Resource Persons: Wang Jianming, Zhou Danyin)

Zhongcun village: Li ZZ, Wang JB, Wang JL, Wang JH, Zhao LX, Zhao LC, Chen YR, Chen YL (8 participants)

Longba village: Shi YL, Chen YC, Hu HG, Zhang QL (3 participants)

Hewei village: Liu XW, Luo CW, Wang JW, Luo CL, Li CH (5 participants)

Changchongwa village: Pu CF, Pu CF, Pu WF, He CB, Zhou WC (5 participants)

Wulayi village: Li JD, Hu YL, Chen CW, Li GS (3 participants)

Hongqiang village: Li TH, Li CJ, Li GF, Li ZP, Li GH, Li ZY, Li CF (7 participants)

Laoshaohe village: Li FM, Li FX, Li GH, Luo KW (4 participants)

Gaoshanmu village: Li ZC, Li ZW, Li ZX, Li FJ, Li FY (5 participants)

Dalongtan village: Li SX, Li SJ, Li XB, Wang TW (4 participants)

Xiaolongqing village: Zhang XC, Zhang XF, Wang ZF, Wang ZH (4 participants)

Guojiacun village: Li ZW, Li ZX, Zhou WX (3 participants)

Bainichong village: Zhou WH, Wang WZ (2 participants)

Guihua village: Li FC (1 participant)

Maocaoping village: Li ZF, Luo CL (2 participants)

Dapingdi village: Zhou FF (1 participant)

Jiangxiqing village: Li TY, Li FZ, Li TC, Wang YC, Wang TH (5 participants)

Ganheba village: Zhu CS (1 participant)

Total: 63 participants from 17 villages in Hongqiang.

Appendix 4: **List of Participants in the Seminar on Fruit Tree Management and Animal Husbandry**

(September 26~28, 1998; Hongqiang, Chuxiong)

(Resource Persons: Prof. Yang Wenliang, Prof. Peng Helu)

Wang Yanhua, Leader, Donghua Township, Chuxiong;

Li Guoming, Division Head, Chuxiong Bureau of Agriculture, Chuxiong;

Yang Congyi, Officer, Zixishan Forest Plantation, Chuxiong;

Wang Zongzhi, Zhongcun village, Hongqiang;

Zhang Xianlin, Zhongcun village, Hongqiang;

Hu Yingcai, Zhongcun village, Hongqiang;

Luo Chongjin, Hewei village, Hongqiang;

Luo Zhiwen, Hewei village, Hongqiang;

Li Zongming, Gaoshanmu village, Hongqiang;

Li Fuying, Gaoshanmu village, Hongqiang;

Li Fafan, Hongqiang village, Hongqiang;

Li Guifang, Hongqiang village, Hongqiang;

Li Zhifa, Hongqiang village, Hongqiang;

Wang Yuecheng, Jiangxiqing village, Hongqiang;

Li Chongning, Jiangxiqing village, Hongqiang.

Total: 15 participants, out of which 12 are villagers, 3 are local officials.

Appendix 5: **List of Participants in the First Workshop on Natural Resource and Community Development**
(November 24~28, 1998; Zixishan, Chuxiong)
(Resource Persons: Mr. Lu Xing, Mr. Yang Qing)

Li Tinghua, Division Head, Chuxiong Bureau of Forestry;

Pu Zhengxi, Acting Director, Chuxiong Bureau of Forestry;

Yang Shengyi, Division Head, Chuxiong Bureau of Agriculture;

Li Yuanhua, Acting Director, Chuxiong Committee for Environmental Protection;

Li Yinggui, Manager General Assistant, Chuxiong Company for Tourism;

Liu Zhaojin, Governor, Donghua Township, Chuxiong;

Peng Yaoliang, Vice Governor, Donghua Township, Chuxiong;

Pu Tianguang, Acting Director, Chuxiong Government Office;

Chen Liming, Director, Chuxiong Office for Foreign Affairs;

Lu Zhanmao, Deputy Director, Chuxiong Office for Urban Management;

Hu Meilan, Member, HCABC

Li Zhaomin, Member, HCABC

Li Guihong, Member, HCABC

Hu Zhaofa, Member, HCABC

Hu Meixiang, Member, HCABC

Li Zhaoqing, Member, HCABC

Luo Fengying, Member, HCABC

Liu Xiezhong, Member, HCABC

Li Chengying, Member, HCABC

Luo Fengxian, Member, HCABC

Li Shixian, Member, HCABC

Zhang Yongxian, Member, HCABC

Li Zhengfu, Member, HCABC

Li Guangfu, Member, HCABC

Li Fengyou, Member, HCABC

Li Kaiming, Member, HCABC

Zhang Fangyu, Consultant, HCABC

Total: 27 participants, out of which 10 are officials from different government agencies, 9 are women, 1 is an environmentalist and project & HCABC consultant, and the others are members of HCABC.

Appendix 6: **List of Participants in the Third Bee-Keeping Training Workshop**
(March 26-28, 1999. Hongqiang, Chuxiong)
(Resource Person: Zhang Xuan)

Wang Jianbin, Zhongcun Village

Wang Jianlin, Zhongcun Village

Wang Jianhua, Zhongcun Village

Zhao Liancai, Zhongcun Village

Chen Yongren, Zhongcun Village

Shi Yongliang, Longba Village

Liu Xuewu, Hewei Village

Luo Cunwu, Hewei Village

Luo Cunlu, Hewei Village

Luo Cunfu, Hewei Village

Li Cunjin, Hongqiang Village

Li Huangfa, Hongqiang Village

Li Guanghai, Hongqiang Village

Li Shixian, Dalongtan Village

Li Zhengwen, Guojiacun Village

Li Fucai, Guihua Village

Appendix 7: **List of Participants in the Second Workshop on Natural Resource Management and Community Development**
(May 22-24, 1999. Chuxiong, Yunnan)

Zou Hengfang, Division Head, Yunnan Provincial Department of Forestry

Yang Weimin, Division Head, Yunnan Provincial Bureau of Environmental Protection

Yang Zonghuan, Division Head, Yunnan Provincial Committee of Plans

Wang Bin, Secret General, Yunnan Provincial Department of Agriculture

Su Zhe, Deputy Division Head, Yunnan Provincial Committee of Sci. & Tech.

Chen Liming, Division Head, Chuxiong Municipal Government

Yang Guanghai, Division Head, Chuxiong Municipal Government

Li Zhengfa, Deputy Director, Chuxiong Bureau of Forestry

Yang Yongxiu, Deputy Director, Chuxiong Bureau of Environmental Protection

Li Lianyun, Deputy Director, Chuxiong Bureau of Agriculture

Ding Zhinxiang, Director, Management Commission of Zixishan Nature Reserve

Deng Yi, Staff, Management Commission of Zixishan Nature Reserve

Li Zhijian, Staff, Management Commission of Zixishan Nature Reserve

Zhong Guiping, Staff, Management Commission of Zixishan Nature Reserve

Yang Yongkang, Staff, Management Commission of Zixishan Nature Reserve

Li Guiyou, Member, HCABC

Wang Jianhai, Member, HCABC

Hu Meilan, Member, HCABC

Resource persons

Lu Bin, Senior Fellow, Yunnan Academy of Forestry

Du Yong, Forester & Division Head, Yunnan Provincial Department of Forestry

Appendix 8: **List of Participants of the Training Workshop on Bamboo Cultivation and Management**

(August 12-13, 2000; Hongqiang, Chuxiong)

(Resource Persons: Xuejiarong, Du Fan, professors of Southwest Forestry College)

Bainichong village: Zhou Hongwei, Wang Wenzeng (2 participants);

Changchongwa village: Pu Changfeng (1 participant);

Dalongtan village: Li Shihua, Li Jianhua (2 participants);

Gaoshanmu village: Li Zhengcheng, Li Zhengfang, Li Fangyu (3 participants);

Guojiacun village: Zhou Wenxiang (1 participant);

Hewei village: Liu Xinwen, Luo Cunwen, Wang Jianwu (3 participants)

Hongqiang village: Li Tianhong, Li Cunjia, Li Guifa (3 participants);

Jiangxiqing village: Wang Yingchang (1 participant);

Laoshaohe village: Li Faming (1 participants);

Longba village: Chen Yaochang, Hu Huaguo (2 participants);

Wulayi village: Li Jinhua, Hu Yonglian (2 participants);

Xiaolongqing village: Zhang Xingcan (1 participant);

Zhongcun village: Li Zongzheng, Wang Jianbin, Chen Yonglan (3 participants);

Total: 23 participants from 13 villages in Hongqiang.

Appendix 9: **List of Participants of the Seminar on Experience Dissemination/Exchange of Biodiversity Conservation and Community Development in Mountain Ecosystems**

Zhang Jinhua, Programme Officer, UNEP

Tang Ya, Project Coordinator and Specialist, ICIMOD

Tang Ming, Division Head, Sichuan Bureau of Land Resource Management

Tu Shengbin, Vice-Governor, Maoxian County Government, Sichuan Province

Zhang Jian, Division Head, Liangshan Prefectural Bureau of Land Resource Management, Sichuan Province

Fu Guangchun, Senior Staff, Forest Department, Sichuan Province

Zhou Jin, Associate Professor, Chengdu Institute of Biology, Chinese Academy of Sciences, Chengdu

Zhang Jianhua, Associate Professor, Institute of Soil and Fertilizer, Sichuan Academy of Agricultural Sciences, Chengdu

Jin Kerong, Senior Staff, Forest Department, Chongqing

Gu Zhongcun, Director and Associate Professor, Institute of Ecology, Jishou University, (western) Hunan Province

Lei Huaguo, Vice-Governor, Jiangkou County, Guizhou Province

Zhou Wei, Program Officer, Guizhou Bureau for Environmental Protection, Guiyang

Pu Chunxi, Vice Mayor, Chuxiong Municipal Government, Yunnan Province

Chen Limin, Division Head, Chuxiong Municipal Government, Yunnan Province

Zhang Fangyu, Consultant, Chuxiong Bureau for Environmental Protection

Wang Jianhai, Head, Hongqiang Community, Chuxiong, Yunnan Province

Kuang Bangyu, Director and Professor, Institute of Eastern Bee, Yunnan Agricultural University, Kunming

Wang Jianming, Lecturer, Institute of Eastern Bee, Yunnan Agricultural University, Kunming

Liu Yiqiu, Lecturer, Institute of Eastern Bee, Yunnan Agricultural University, Kunming

Wang Li, Lecturer, Institute of Ornamental Plants, Yunnan Agricultural University, Kunming

Long Chun-lin, Professor and Project Coordinator, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming

Liu Yitao, Fellow, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming

Li Rong, Graduate Student, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming

Guo Xiaorong, Graduate Student, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming

Appendix 10: **List of Participants of the "Farmer to Farmer Exchange" Activities**

Name	Sex	Age	Village / Community	Date
Wang Tingsheng	M	37	Bacun, Laoshaohe	12-13/7
Li Qionghua	F	26	Lengshi, Laoshaohe	12-13/7
Li Jinhui	F	41	Yilicun, Laoshaohe	12-13/7
Luo Shijin	M	32	Jiulichong, Laoshaohe	12-13/7
Wang Jianhua	M	35	Jiulichong, Laoshaohe	12-13/7
Zhou Jiarong	M	40	Baihuacun, Laoshaohe	12-13/7
Li Zhaofu	M	46	Maocaoping, Hongqiang	3-5/9
Li Shihua	F	24	Dapingdi, Hongqiang	3-5/9
Liu Wenxue	M	29	Hewei, Hongqiang	3-5/9
Liu Ailin	F	25	Hewei, Hongqiang	3-5/9
Li Zhengwen	M	33	Guojiacun, Hongqiang	3-5/9
Li Shijin	M	43	Dalongtan, Hongqiang	3-5/9
Shi Yongjiu	M	30	Longba, Hongqiang	3-5/9
Chen Yongcheng	F	48	Zhongcun, Hongqiang	3-5/9
Li Jinfa	M	32	Hongqiang, Hongqiang	3-5/9
Li Jinqiong	F	34	Hongqiang, Hongqiang	3-5/9

Coordinators/Facilitators: Zhang Fangyu, Wang Jianhai, Chen Liming

Appendix 11: **List of Partnerships in the Hand-in-Hand Project**

Student name	Birth time	Grade	Sex	Nationality		Village Partner in Kunming Institute of Botany (KIB) in 1998
Zhu Guixiu	Sept. 1987	4	F	Yi	Xiaoche	Liu Guifang
Li Zhengfu	Nov. 1988	4	M	Yi	Maocaoping	Li Shunlin
Li Jianghong	May 1988	4	M	Yi	Maocaoping	Liu Yitao
Li Qiongxian	Dec. 1987	4	F	Yi	Wulayi	Li Xiaoming
Li Huayan	Oct. 1988	3	F	Yi	Hongqiang	Li Haiyan
Li Fahui	May 1989	3	F	Yi	Zhongcun	Wu Yu
Li Mingzhen	Oct. 1986	5	F	Yi	Laoshaohe	Gao Juan
Li Tinghui	Apr. 1990	2	F	Yi	Jiangxiqing	Yang Shixiong
Luo Fagao	May 1989	3	M	Yi	Maocaoping	Hao Xiaojiang
Li Falu	Sept. 1990	2	M	Yi	Dapingdi	Zhu Huajie
Liu Jianzhen	Oct. 1986	5	F	Yi	Hewei	Guo Zhenhua
Zhou Wanqiang	Feb. 1985	6	M	Yi	Hongqiang	Yu Hongyuan
Luo Tingli	Sept. 1989	3	F	Yi	Laoshaohe	Gan Fanyuan
Luo Jinshou	Sept. 1983	6	M	Yi	Changchongwa	Ai Xihui
Luo Jinwang	June 1985	6	M	Yi	Changchongwa	Li Lu
Wang Tingsheng	Dec. 1988	4	M	Han	Xiaolongqing	Li Zhengan
Zhou Xiaoyan	Apr. 1989	4	F	Yi	Guojiacun	He Shuzhen
Luo Jinbao	July 1990	2	M	Yi	Zhangjia	Wu Shuguang
Li Shihua	Feb. 1987	4	F	Yi	Jiangxiqing	Yang Jin
Li Xingzhi	Nov. 1987	4	F	Yi	Wulayi	Yang Lixin
Liu Jianguo	Sept. 1988	3	M	Yi	Wulayi	Dong Haijun
Zhou Wancui	July 1986	5	F	Yi	Zhoujia	Long Chunlin
Zhou Wanxian	Oct. 1984	7	F	Yi	Zhoujia	Long Chunlin

Appendix 12: **List of Bamboo Species Cultivated on the Demonstration Plot**

1. *Bambusa multiplex* (Lour.) Raeuschel
2. *Bambusa multiplex* (Lour.) Raeuschel. cv. *alphonse* R. A. Young
3. *Bambusa multiplex* (Lour.) Raeuschel. cv. *fernleaf* R. A. Young
4. *Bambusa texitilis* McClure
5. *Bambusa vulgaris* Schreber ex Wendland. cv. *wamin* McClure
6. *Bashania fargesii* (E. G. Camus) Keng f. et Yi
7. *Chimonobambusa pachystachys* Hsueh et Yi
8. *Dendrocalamus latiflorus* Munro
9. *Fargesia lufengensis* Q. R. Xue, sp. nov. (ined.)
10. *Fargesia fractiflexa* Yi
11. *Fargesia fungosa* Yi
12. *Fargesia yuanjiangensis* (grass family) Hsueh et Yi
13. *Fargesia yunnanensis* Hsueh et Yi
14. *Indosasa hispida* McClure
15. *Phyllostachys heteroclata* Oliver
16. *Phyllostachys nigra* (Lodd) Munro
17. *Phyllostachys pubescens* (grass family) Mazel
18. *Pleioblastus oleosus* Wen
19. *Pleioblastus argentiostriatus* f. *albostriatus*
20. *Qiongzhuea tumidinosa* Hsueh et Yi

Water harvesting on sloping rainfed farmland in Hongqiang Community — *Long Chunlin*

Beekeeping training for local farmers — *Long Chunlin*

Agroforestry is the traditional farming system in the Zixishan region. People grow crops between fruit trees so that they can harvest both types of crop. Most of the crops in agroforestry systems are native species and local landraces. Plants in the picture are cherry, maize, potato and pumpkin
— *Long Chunlin*

Bamboo cultivation and technical training. The Hongqiang Community Association for Biodiversity Conservation (HCABC) was established in 1998, with encouragement and support from the project. In addition to implementing biodiversity conservation activities, HCABC also organises various training workshops for local farmers
— *Long Chunlin*

Musella lasiocarpa is an endemic genus and species of the junction region between Yunnan and Sichuan. Wild populations of this beautiful plant species are threatened and very difficult to find now. The Yi people in Zixishan and its neighbouring regions have domesticated this species and protected it in their traditional farming systems. People use it as a vegetable, pig fodder, medicine, ornamental plant, a soil erosion control plant, weaving material, and wine-making. It is very easy to see a type of *Musella-based* agroforestry in Zixishan region "Fruit trees + *Musella* + Crops + Bees" — *Long Chunlin*

Holy trees are protected by indigenous communities in the Zixishan region. Over 20 species of trees are worshipped by the local people — *Long Chunlin*

Rhododendron delavoyi is a plant totem of the Yi people in Zixishan region. The Yi people worship and protect this beautiful plant. They even have a specific traditional festival for *Rhododendron*, the Yi's Mayinghua Festival, in which mayinghua means *Rhododendron delavoyi* — *Long Chunlin*

About the Editor

Professor Chen Guangwei is currently the Division Head of Mountain Natural Resources at the International Centre for Integrated Mountain Development (ICIMOD). Prior to joining ICIMOD he worked as a scientist for the Chinese Academy of Sciences (CAS).

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Professor Chen has experience as a Director for a national key project of China (Loess Plateau Remote Sensing) and as a Vice Team Leader for an Integrated Scientific Research Team in the Loess Plateau Region at CAS. He was Deputy Director for the Yantai Economical and Technological Development Zone for Science and Technology, Education, and High-tech Industrial Development. He was a Land Use/Capability Specialist for the project 'Management and Monitoring of Fragile Ecosystems in Jin-Shaan-Mong Bordering Region' funded by the Asian Development Bank (ADB); as an Executive Research Scientist for 'Rural Industrial Development in Middle and West of China' supported by the World Bank; for 'Legislation of Natural Resources of the People's Congress of China' supported by the ADB; an Information Coordinator for Leadership for Environment and Development (LEAD)-China ; a Consultant for the Local Agenda of China's 21; Chief Researcher for an Asia Pacific Economic Cooperation (APEC) project 'Improved Flows of Technological Information and Technology: The Role of Science and Technology Industrial Parks'; and Organiser for several exchange programmes between China and United States Assistance to International Development (USAID), between CAS and Adelaide University, and between CAS and the University of New South Wales (UNSW).

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