



MANAGING MOUNTAIN WATERSHEDS

Report of the

**International Workshop on Watershed Management in the
Hindu Kush-Himalaya Region**



**Organised by ICIMOD in collaboration with CISNAR,
Chinese Academy of Sciences (CAS), Beijing**

**Chengdu
Sichuan, China
14-19 October 1985**

ICIMOD PHASE I Workshop Series

The International Centre for Integrated Mountain Development began professional activities in September 1984, with the first objective of reviewing development and environmental management experience in the Hindu Kush - Himalaya Region. An International Workshop was planned for each of four major fields to review the state of knowledge and practical experience, and also to provide an opportunity for the exchange of professional expertise with regard to integrated mountain development.

ICIMOD completed Phase I activities in June 1986, having held :

- o the International Workshop on Watershed Management in the Kush - Himalaya -- Chengdu, China, 14 to 19 October 1985
- o the International Workshop on Planned Urbanisation and Rural Urban Linkages in the Hindu Kush - Himalaya Region -- Kathmandu, Nepal, 25 to 29 March 1986
- o the International Workshop on District Energy Planning and Management for Integrated Mountain Development -- Kathmandu, Nepal, 3 to 5 May 1986
- o International Workshop on Off - Farm Employment Generation in the Hindu Kush - Himalaya -- Dehra Dun, India, 17 to 19 May 1986

These Workshops were attended by over two hundred experts from the countries of the Region, in addition to concerned professionals and representatives of international agencies. A large number of professional papers and research studies were presented and discussed in detail. With the permission of the authors, copies of papers in full will be supplied on request, with a charge to cover reproduction and postage costs.

In September 1986, ICIMOD published four summary Workshop Reports. Each is intended to represent the conclusions reached at the Workshop and does not necessarily reflect the views of ICIMOD or other participating institutions.

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G.P.O. Box 3226
Kathmandu
Nepal**

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International Workshop on Watershed Management
in the Hindu Kush - Himalaya Region

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The first of these International Workshops was held most successfully,
thanks primarily to the splendid and untiring efforts of our Chinese hosts in
Chengde, the capital of the mountain province of Sichuan – the most populous
province of China – and, delightfully for the enthusiastic foreign
participants, in Guus Xiao, the capital of one of Sichuan's most mountainous
counties.

This Workshop Report summarises the discussions of this international
meeting in the hills of China, organised by ICIMOD jointly with the Chinese
Academy of Sciences. Apart from subsequent publication of selected papers
from this most interesting Workshop, one of the more significant long-term
results is expected to be the establishment by ICIMOD of a systematic network
within the Region for the sustained exchange of information and experience
on the integrated management of mountain watersheds.

International Centre for Integrated Mountain Development
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Kathmandu, Nepal

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of the two Workshop organisers: Dr
Zhang Mingtao of the Chinese Academy of

A special acknowledgement is due to Dr
Tejwan for their contributions to the prepar

and his assistants

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In the preparation of this report an attempt has been made to reflect the views and interpretations expressed by the participants at the Workshop. These views and interpretations are not attributable to the International Centre for Integrated Mountain Development (ICIMOD), and do not imply the expression of an opinion concerning the legal status of any country, city, or area of its authorities, or concerning the delimitation of its frontiers or boundaries.

Foreword

As a newly established International Centre focusing directly on the issues of integrated mountain development in the Hindu Kush-Himalaya Region, the first priority of ICIMOD has been to review the current state of knowledge and of particular field programme experience in selected fields, with the intention of organising an International Workshop in each case to bring together leading experts and professionals from the countries of the Region, and from international agencies and organisations much further afield, for a face-to-face professional exchange of knowledge and experience.

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ICIMOD would like to express its warmest thanks, on behalf of all international participants, to the Chinese Academy of Sciences in Beijing, and to the Government of the Province of Sichuan, for most generous hospitality and support in the organisation of the Workshop's professional discussions and field visits. Particular thanks are due to Professor Sun Honglie, Vice-President of the Chinese Academy of Sciences, and to Dr. Li Wenhua, Director of the Commission on the Integrated Survey of Natural Resources, and Member of the ICIMOD Board of Governors, for their invaluable support and encouragement. The opening of the Workshop with an address by Dong Zhiyong, Deputy-Minister of Forests, of the People's Republic of China, was greatly appreciated. In thanking all concerned, special mention must be made of the leadership and organising ability of the two Workshop organisers: Dr. Kk. Panday of ICIMOD and Zhang Mingtao of the Chinese Academy of Sciences.

A special acknowledgement is due to Dr. Kk. Panday and to Dr. K. G. Tejwani for their contributions to the preparation of this summary Report.

Colin Rosser
Director

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Introduction

The grandeur and beauty of the Himalaya are world - renowned, yet few people are aware of the area's unique problems. Himalaya ecosystems are more densely populated by human beings and their livestock than mountain ecosystems elsewhere. The consequent pressures on natural resources are taking a rising toll ; people living in the mountains are hard - pressed to meet their subsistence needs, and downstream residents share the adverse environmental and socioeconomic impacts. Upland and lowland populations are caught in a vicious cycle of deteriorating social, economic, and biophysical environments, not only at a microscale, but also on the larger river basin scale, transcending national boundaries.

Management of natural resources has been the focus of efforts to promote ecological balance and the well - being of Himalayan populations for nearly three decades. Many national and international meetings have been held, but the first regional effort and information exchange took place in October 1985, when ICIMOD and the Commission for Integrated Survey of Natural Resources (CISNAR) of the Chinese Academy of Sciences (CAS) collaborated in the organisation of an International Workshop on Watershed Management in the Hindu Kush - Himalaya, held in the People's Republic of China.

Prior to the Workshop, state - of - the - art country review papers were prepared by expert nationals of the concerned countries and ICIMOD staff to delineate the watershed management problems of the Hindu Kush - Himalaya Region, examine the causes and consequences of degradation, and compile information regarding development programmes, institutional structures, research and training facilities, and government policy priorities and legislation.

The specific objectives of the Workshop were :

- to review and evaluate progress made in the field of watershed management in the countries of the Hindu Kush - Himalaya
- to exchange practical project experience on a regional basis, with particular emphasis on identifying common constraints such as knowledge, skilled manpower, finance and organisation, and more effective programme implementation

- to identify key priorities, on the basis of this assessment of experience, for concerted action in the field of watershed management at national and regional levels
- to promote regional cooperation in research, training, and information exchange, for integrated mountain development in the Hindu Kush - Himalaya Region

Sixty participants attended, including professionals of relevant government departments from China, India, Nepal, and Pakistan, professionals from ICIMOD and the Chinese Academy of Sciences, and individual academics and consultants from countries of the Region. Staff members from multilateral and bilateral agencies and university departments from outside the Region, concerned with watershed management in the Himalaya, also participated.

The Workshop activities, over a period of six days, included nineteen paper presentations, group and panel discussions, and a two-day field visit to Wolung Nature Reserve, where watershed management for wildlife conservation and mountain environment rehabilitation is being practised.

The Workshop Report summarises the discussions into three main themes: Pressures on Watersheds, Management of Watersheds, and Policy and Planning Framework. This is followed by Recommendations and Conclusions of the Workshop. Paper summaries are presented in Annex 4.

Workshop Discussions

The discussions of the Workshop centred around three main themes :

- Pressures on Watersheds
- Management of Watersheds
- Policy and Planning Framework

To set the pace of the Workshop, as well as to emphasise the need for progressive and cumulative discussions, the Workshop commenced with the presentation of special reports of the recommendations of two recent international meetings:

- *Integrated Watershed Management in the Asian Region*, East-West Center, Honolulu. January 1985 (presented by Dr. Christopher Gibbs)
- *Expert Consultation on Watershed Management*, FAO, Kathmandu, February 1985 (presented by Mr. L. S. Botero)

The first focused on policy and institutional issues ; the second concentrated on strategies, approaches, and systems for integrated watershed management.

The key Workshop papers contributing to the development of themes and issues for the Hindu Kush - Himalaya were review papers on Bangladesh, Bhutan, China, India, and Pakistan. The Hindu Kush - Himalaya Region is vast, with great variation in altitude, latitude, climate, ethnic composition, socioeconomic conditions, and political systems. Field conditions are characterised by diversity both at the macroscale and the microscale.

While these variations were reflected in the papers, discussions, and ideas generated at the Workshop, it was also noted that the Region has many common attributes, such as inhabitation predominantly by subsistence farmers, inaccessibility due to poor infrastructure facilities, and widely scattered settlements. Other features of this mountainous region include high altitude peaks, deep valleys, difficult access, high rates of soil erosion and mass wastage under high rainfall conditions, high wind velocity and wind erosion on semi - arid plateaus, overgrazing, shortage of fuelwood, and severe environmental difficulties.

Theme One : PRESSURES ON WATERSHEDS

Natural Forces

The Hindu Kush - Himalaya is one of the youngest mountain systems in the world, thus subject to high rates of natural erosion. Rivers originating in the Region carry much more silt than those originating elsewhere. Furthermore, natural prevailing conditions contribute to serious erosion and watershed instability. The concentration of heavy rainfall for short durations, long steep slopes, long dry seasons, and intermittent periods of high speed winds are notable natural factors which contribute to the erosion and mass wasting. While monsoon rains affect a large portion of the Hindu Kush - Himalaya, high velocity erosive winds are most common in the northwestern part of the Himalaya.

The view was expressed that the sediment generated and delivered by the natural processes is so immense that the intervention of humans may have negligible impact on erosion and sedimentation rates. This view was forcefully countered by others who felt that because human beings and livestock are concentrated in narrow belts of 500 to 2,000 m elevation, the impact of their intervention is highly significant.

It is, however, recognised that not all types of mass wastage mean loss of land resources. Many of the cultivated sloping fields are colluvial deposits and alluvial fans. The process of land resource loss and creation by natural forces has been and continues to be very dynamic. Many types of geomorphological changes are going on in these mountains, about which our understanding is limited.

Demographic Pressures

It is generally believed that population pressure on the fragile and vulnerable mountain resources is causing serious degradation of the mountain areas. Forest and grass cover has to a great extent protected the mountains from their natural susceptibility to erosion. Humans, in their search for arable land, fodder, firewood, timber, and minerals have removed that protective cover. High population densities of 1,432 persons per square kilometre of cultivated land in the Indian Himalaya, and 403 to 1,723 in watersheds of Pakistan and elsewhere, are reported. Even in situations where population pressures are not generally high (e.g. Bhutan) local hot spots occur where humans cause severe deterioration of the watersheds.

Due to agro-ecological as well as socioeconomic variations, the nature of human interventions is also variable (e.g. shifting cultivation in northeast India; greater emphasis on grazing and animal husbandry in the drier semi - arid Pakistan Himalaya and Tibet; large - scale settled agriculture in the middle hills of Nepal, Sikkim, Uttar Pradesh, and Himachal Pradesh in India; and grazing and transhumance practices in the alpine and the sub - alpine zones of the Nepal and Indian Himalaya).

Questions arose as to the ways and means to manage the human population. Some spontaneous and unplanned migration does take place (often of males). Though this is not a significant phenomenon in total numbers except in Nepal, it is highly significant with respect to socioeconomic impact. The possibility of a large transfer of excess population to areas of productive land and economic opportunity is remote, due to unavailability of surplus arable land. Therefore, efforts have to be concentrated on increasing the productivity of available resources through efficient and ecologically sound management, and creating off-farm employment opportunities while simultaneously promoting family planning measures to reduce population growth rates.

Livestock Pressures

Livestock population is another key factor leading to deterioration of watersheds in the Hindu Kush - Himalaya Region. The livestock population increases steadily, keeping pace with human population growth. Nepal is reported to have the highest livestock density per unit area of cultivated land in the world. The continued increase in livestock population results in intensive and extensive overgrazing of pastures, degradation of forests, complete removal of vegetative cover, and compacting of the soil.

Well-established grazing systems are practised by sedentary agriculturalists and nomadic pastoralists. The increase in cultivating marginal lands and grazing in forests and pasture lands disturbs conventional grazing rights and transhumance practices. The voluntary sharing of, and restrictions/controls on, grazing developed by local people are being disturbed, leading to conflicts of interest as well as deterioration of watersheds. One of the current key issues of watershed management in Bhutan, China, India, Nepal, and Pakistan is unregulated and unrestricted grazing practices. The problem of fodder deficit, particularly in the winter months, is common throughout the Region.

Development Pressures

Construction of roads, building of dams and reservoirs, power generation, mining, logging operations, and the establishment of industries, have created influences leading to severe degradation of watersheds. Along with bringing about direct and indirect increases in demands on natural resources, these activities are frequently carried out with political and economic imperatives overriding technical and environmental considerations.

Urbanisation and tourism also contribute adverse pressures on the environment. Establishment of an equilibrium between the positive and negative pressures exerted by the processes of development in the resource - constrained mountain economies has proved to be an elusive exercise.

Techniques and Management Practices

Mountain people have responded to the challenges over the centuries, in ecosystems varying from dry cold desert to temperate alpine zone and sub-tropical/temperate valley. They have practised agriculture, agroforestry, and animal husbandry, and managed forests, soil, water and other resources. Considering the excellent land terraces, unique methods of developing and maintaining irrigation channels in the hills, appropriate cropping patterns and crop varieties, and selection of trees for agroforestry practices, for example, one can but wonder at the wisdom and intelligence of these farmers.

Yet, several signs of improper resource management are also seen : maintenance of unproductive livestock and inadequate animal feed, construction of outward sloping terraces, excessive lopping of trees for fodder, wastage in the use of firewood, setting fires to pasture and forest grazing lands, and increase in frequency of shifting cultivation, for example. The causes of such actions are not limited to technical parameters, but relate to broader socioeconomic and political issues, which may involve land tenure systems, property rights, pricing structures, credit policies, export - import policies, and overall development strategies.

Some conflicts in developmental activities were also pointed out. For example, fruit tree planting in the hills is considered proper conservation - oriented development. However, it depends heavily on forests for packing materials, which leads to deforestation. Research to find alternative cheap packing materials was emphasised as a solution, rather than discouraging horticulture development in the hills.

It was also pointed out that the study of glacial lake outbursts is necessary in planning for hydropower and irrigation schemes in the Hindu Kush - Himalaya, in order to take into account sedimentation, water flow, and possible catastrophes.

Socioeconomic Pressures

All mountain watersheds, but particularly those of the densely populated Hindu Kush - Himalaya, have inherent biophysical and socioeconomic constraints which impinge on the pace, quality, and level of development. Some of the major constraints include : isolation, inaccessibility, widely scattered settlements, poor infrastructure facilities, and lack of monetisation.

These constraints and the absence of alternative income and employment opportunities compel the growing population to continue working in and depending on the agricultural sector. The agricultural sector itself is subject to constraints such as limited arable land with highly fragmented holdings, extension of cultivation to less productive marginal and steeply sloping land, decline in the use of organic manure, virtually no application of chemical fertilisers or other improved agricultural inputs, and lack of markets and marketing facilities. Highly unequal land holdings and insecurity of tenancy

seriously hamper the conservation activities. Poor or landless households have to rely on the forests and public lands for livestock rearing, and they are inclined to use them indiscriminately. Any restrictions upon such access to forests and public lands will immediately affect their livelihood ; legal sanctions will not solve the problems of conservation without an assault on poverty itself.

Theme Two : MANAGEMENT OF WATERSHEDS

The previous section dealt with various pressures on watershed resources and the consequent degradation of watershed conditions. It has clearly emerged from the discussions that with increasing population, the pressures on natural resources, such as land, forest, and pasture, will continue to grow. The **sustainable productivity** of the natural resource base, and as a result that of hill agriculture itself, is seriously threatened. The Region is trapped in a vicious cycle of declining resource productivities, reduced economic growth, low investments, and great pressure on limited resources, leading to deteriorating environment and further decline in resource productivities. The resulting poverty and low level of development are accentuated and reinforced by many factors. Similarly, while physical features and rugged terrain pose serious constraints to infrastructure development, many diverse and small agro-ecological zones prevent wide applicability of improved agricultural technologies.

In this context, it is evident that management of watersheds has to be undertaken with the main objective of reducing poverty within the watersheds; welfare of the watershed inhabitants should be the most important concern in any watershed management programme.

At present, many watershed programmes are narrowly focused on improving the physical conditions of the watershed itself, seldom taking account of **upstream - downstream interactions**, or agricultural and non - agricultural linkages. They also tend to have a pronounced sectoral focus, rather than a comprehensive view of the total farming system.

The discussions on watershed management issues are presented in four broad areas :

- Natural Resource Management
- Infrastructure Development and Mining
- Natural Watershed Hazards
- Institutional Innovation and Organisational Changes

Natural Resource Management

The main objective of resource management is to bring enhanced resource productivity on a sustainable basis. The management must effectively deal with the complex interactions manifested in the existing use of land, forest,

and pasture. The food - fodder - manure - fuel linkages in the hills constitute an important area of focus. Land use involves trade - offs within food, fodder, and energy production. Watershed problems also arise from simultaneous overuse and under - utilisation of resources. For instance, overuse of forest resources results in deforestation, erosion, and landslides ; whereas, over - mature forests have increased forest fire hazards and water quality problems.

Erosion, loss of topsoil, landslides and nutrient leaching, over the years, have reduced soil productivity and consequently food production in the hills. Due to physical and human pressures on natural resources, hill agriculture is in a state of transition. There is a need to understand these changes and to assess potentials for further increases in agricultural production.

Land Use. Extreme views were expressed regarding the changes in agricultural land use. Some maintain that cultivated area in the hills has increased rapidly by bringing **marginal and sloped land** under cultivation. Others have pointed out that such changes have been limited to particular areas. At present, lack of reliable land use data makes it difficult to draw definite conclusions, although the general perception was that more land has been brought under cultivation. A sound data base on land use is essential to formulate effective **land-use policies** for watershed management.

Given the limitations on the expansion of potentially productive land, agricultural development will have to be more intensive than extensive. In this context, improvement of **land-use efficiency** often requires effective implementation of land reform, so that inequity of land distribution can be remedied and tenancy rights secured. This is likely to induce farmers to improve their management of land resources. It has been indicated that soil and water conservation measures, particularly in conjunction with irrigation, can result in more intensive cultivation of land since the farmer's risks using costly modern inputs such as fertiliser, pesticides, and improved seeds are considerably reduced. Such a process can lead to expansion of food production and crop residues ; the latter can augment fodder supplies and considerably reduce livestock pressure on forest and pasture. Similarly farm biomass can substitute for fuelwood from the forest. Such complementarities between agriculture and water resources are to be fully exploited.

Land - use capability assessment, and classification of land according to watershed hazards, provide the basis for management of land to improve economic conditions as well as ecological stability. Curative measures are needed, especially for those watersheds regarded as **critical hot spots**. Preventive land and soil conservation measures can be applied more or less uniformly over the rest of the watershed. Hot spots, such as marginal lands and sloped terraces, which are prone to soil erosion and landslides, may need to be removed from crop cultivation and brought under tree cover through horticulture, agroforestry and afforestation schemes. Land use diversification away from cereal crops has to be made possible through the provision of physical infrastructure, improved technology, marketing, and credit services.

Forest and Pasture. Shortage of fodder is a key problem in hill areas, followed closely by scarcity of fuelwood. Simple closure and fencing of forests as measures of management may not address these problems and may even be counterproductive. One proposed remedy is to replace cattle by buffalo to reduce the grazing problem. This, however, frequently entails overcoming social constraints and may require introduction and adoption of forage crops in the hill farming system.

Due to growing livestock populations in agro - pastoral and transhumance zones, the combined grazing pressures on some mid - altitude forests and pastures have increased tremendously. This has been caused by lowering of transhumance grazing areas in winter and raising of the summer pastures. Forest and pasture in such areas have shown rapid decline in productivity. Indigenous regulatory institutions of pasture and forest use have become ineffective in these areas due to **overlapping jurisdictions**. An integrated programme of pasture improvement, livestock breeding, and institution development should be focused on these **high pressure zones**. Similarly, agroforestry and fuelwood-fodder plantations are needed in the agropastoral zones to reduce fodder scarcity. It has also been indicated during discussions, that stall feeding would be acceptable when land use is extended throughout the year, with the introduction of suitable crops for fallow periods. Thus, it has become clear that the fodder situation can be improved only when a commensurate set of agricultural policies related to crops, livestock, and agroforestry are adopted to transform the farming system.

Fuelwood demand curtailment, reforestation, and afforestation programmes constitute another important area. It was indicated that fuelwood demand can be curtailed by adoption of improved stoves. However, some participants indicated that the adoption and utilisation of improved stoves has suffered due to lack of appropriate designs.

Reforestation and afforestation programmes, through community involvement in planning, planting, and harvesting can greatly ease the problem of fuelwood supply. The success of community forestry, with the innovations of **social fencing**, and with strong community participation, has been encouraging and its replicability in other areas needs to be tested. It was indicated that **resource security** is a key factor in ensuring the participation of villagers in community forestry programmes.

Water Resources. Water resource development in the Region is dominated by large power and irrigation projects, which mostly benefit the people of downstream regions outside of the watersheds. These large projects, however, generate local costs which are to be borne by residents of the watershed. It was emphasised that water resource development in the watersheds ought to be carried out in a manner complimentary to the improvement of hill agriculture. In this respect, water resource development objectives should be to provide irrigation water and energy to the watershed communities, for the improvement of agriculture and development of small - scale industries. The great potential for small - scale hydropower and lift irrigation schemes was also mentioned as a means of improving economy and ecology of watersheds.

Infrastructure Development and Mining

The management of infrastructure development and mining activities in the context of watershed management primarily focuses on **preventive measures**. The major objective is to reduce adverse environmental impacts on the watersheds from the construction of roads, irrigation canals, power dams, tunnels, large reservoirs, and mining and quarrying activities. Furthermore, increased road access often induces commercial mining, quarrying, and logging activities which have adverse ecological impacts.

Environmental impact assessment of infrastructure and mining projects in watersheds is crucial. However, the methods and techniques for assessment of direct environmental impacts are not fully developed. In the majority of the watersheds of the Region, data required for such assessment is non-existent. Lack of knowledge about various biophysical processes constrains the design of an appropriate data base for **forecasting future impacts and designing preventive methods**.

Due to high costs associated with analysis and adoption of remedial measures, often environmental impact analyses are deliberately ignored in designing and implementing infrastructure and mining schemes.

Appropriate legislative and procedural changes are needed to ensure that all infrastructure projects conduct environmental impact analysis before their implementation. Research on ecologically sound infrastructure technology for the mountains is essential.

Natural Watershed Hazards

Nearly all watersheds face natural hazards, such as forest fires, quake-induced landslides, river damming and dam bursting, flash floods, mass wasting, and glacial lake outbursts. To effectively deal with such catastrophic events, early warning systems should be devised.

It has been indicated that delineation and mapping of flood, landslide, and acute erosion zones has generally not been carried out. Also, human activities and growth of river valley settlements have considerably increased such hazards.

Forest fire hazards can be considerably reduced by eliminating forest burning practices, and landslides can be prevented through afforestation and stabilisation of vulnerable slopes. Similarly, glacial lakes can be drained to a safe level. Such preventive measures can be taken only after basic data on these hazards is made available through primary data collection and field research. Thus, there is a need for field research, mapping, and assessment of various hazards. In the context of large dam projects, afforestation schemes, and infrastructure investments, preventive measures can substantially reduce the risk of natural hazards.

Institutional Innovations and Organisational Changes

The need for more effective institutions and organisations, both at the national and community levels, was repeatedly stressed. The desirability of a national and/or regional watershed authority has remained controversial. There are a wide spectrum of possible institutional arrangements, ranging from a coordinating body to an all encompassing planning and executing agency with respect to watershed management.

Techniques to deal with the biophysical aspects of watershed management are generally well known, however the organisational and institutional innovations needed to implement them are not adequate. Given the scale of watershed management problems, governmental agencies with limited budgetary and manpower resources are unable to cope with watershed management at the local level. Watershed plans, which do not explicitly take into account the potentials of local institutions and non - governmental organisations are likely to fail ; government agencies must learn to become enablers of local action, rather than the actors themselves. The planners and technocrats often presuppose that local residents are mismanaging natural resources. However, improved terracing on private lands and forest and pasture management on community lands have been the response of the farmers to maintain the stability and sustainability of the agro - ecological system for centuries.

It was pointed out that the axe, the sickle, and the plough are far less dangerous weapons for environmental damage than the sociopolitical processes that use the farmer and the environment for political gain. More emphasis is needed on positive incentives instead of negative control, and on planning through popular participation rather than top-down approaches. The local residents must be able to control and share benefits from watershed management schemes if they are to cooperatively participate. Given the opportunity to organise, hill farmers can bring forth cooperative movements like *Chipko*, to safeguard their own livelihood and interests.

Non-Governmental Organisations. The main role of the non-governmental organisations is to create greater awareness of watershed problems among policy and decision makers, and to help the farmers to organise themselves. Non - governmental organisations can play the vital role as an intermediary between farmers and development agencies in facilitating the transfer of resources and technology, and in providing training. Such organisations can also play catalytic roles in inducing people's participation in managing watersheds.

Indigenous Institutions. The role of indigenous institutions primarily lies with the regulation and management of common property and natural resources with open access, such as forests, pastures, and water. As already indicated, the replicability of many community schemes, including forestry and irrigation, depend to a large extent on the effectiveness of the indigenous institutions to induce people's participation. Many traditional cooperative

institutions have decayed on account of penetration of markets, nationalisation, and changes in government legislation, with the result that "tragedy of the commons" situations prevail in many open access community resources. Revival of such institutions often requires that the resource security and benefits derived are assured at the household, group, and community levels.

Theme Three : POLICY AND PLANNING FRAMEWORK

Watershed management requires a coherent planning and policy framework which includes not only those policies directly concerned with watershed resource management, but also other development policies. In order to bring about ecologically sound development, there is a need for long - term plans and policies for natural resource conservation and management. Such plans and policies should be designed within an overall national development context and should pay particular attention to supporting policy measures, such as reducing population growth, increasing off - farm employment and income, development of alternative energy resources, and minimising adverse environmental effects of infrastructure development, urbanisation, industrialisation and commercial agricultural activities.

Also, improvements in resource management are greatly influenced by broader socioeconomic and political factors, which may involve land tenure systems, property rights, pricing structures, credit policies, export - import policies, and overall development strategies. Effective land-use policies can provide an integrative framework for overall management of natural resources. In this regard, land capability assessment and land classification are crucial for designing and application of policies related to diversification, and intensification of land use for food and cash crops, horticulture, fodder, and forage crops. Similarly, livestock policies related to selection and improvement of breeds, gradual elimination of unproductive animals, along with appropriate policies and institutions designed for the management of common property resources, such as forestry, pasture, and water, will complement land-use policy.

A lively debate ensued during the Workshop concerning the need and efficacy of viewing the **watershed as a planning unit**. No firm conclusions emerged as to whether this would provide the stipulated planning and management benefits, although it was made clear that watersheds provide a logical choice for comprehensive analysis and study of watershed problems and solutions. A concern was voiced as to the practicability of restructuring administrative boundaries for the sake of carrying out watershed planning. Gaps in data, information, and knowledge were thought to be serious constraints in planning and management efforts. It was indicated that the Region has very few hydrometrological stations and networks. Similarly, inadequate data on vegetative cover, land use, watershed conditions, and intensities of resource use has so far prevented a comparative analysis of

human and animal population pressure vis-a-vis the carrying capacity of the agro-ecological systems. This has further constrained land - use policy formulation and implementation processes, and consequently has reduced the effectiveness of watershed management efforts.

The role of donor agencies should be to build institutional capabilities in planning, research, and training at the national level, and management capacity at the district and local levels. Often, donor agencies are directly involved in the planning and implementation of watershed projects frequently undertaken with large financial and technical assistance. This has often accentuated the **dependency syndrome** both at national and local levels and has greatly reduced the local initiative and capacity for self-help. Therefore a built-in mechanism should be introduced in such projects to generate local resources to partially meet the cost of the project and also to develop local capacity to manage the project. Watershed projects often require long-term commitment of resources. Donors should extend their commitments for longer periods than the usual five years, if necessary. When watershed project funding has to discontinue before the completion of the project, it must be recognised that initial investments may not yield the expected benefits.

Project Planning, Implementation, Monitoring and Evaluation

Watershed management projects have multiple objectives encompassing goals of both development and conservation. These projects have multisectoral and multipurpose characteristics, often incorporating multiple uses for a number of watershed resources, such as land, forest, and water. Furthermore, watershed projects tend to be extended over wide geographical areas and often require long-term commitments. This demands a comprehensive approach in planning and implementation. The formulation and planning of such projects must entail an integrated approach, with appropriate emphasis on the various sectoral components/activities of the project. Project feasibility studies in this context require information on the technical coefficients and parameters of the various project components. An appropriate method for valuation of these coefficients and parameters into benefits and costs is needed. However, environmental effects which entail indirect and long-term benefits are difficult to quantify and incorporate in project analysis framework. For instance, afforestation projects generate direct and quantifiable benefits, such as forest products, and indirect benefits, such as increased water yields and reduced erosion and landslides. These indirect benefits are difficult to assess. Thus, the need for development of methodology to assess and evaluate such indirect benefits is crucial. Incorporation of both direct and indirect benefits of these projects will enhance their economic feasibility, and thus attract the attention of policy and decision makers in their favour.

Implementation of watershed projects is often constrained due to lack of coordination among different sectoral development agencies. The merits and demerits of two types of institutional arrangements to implement watershed projects were discussed. One consists of an autonomous watershed authority with full executive powers, where the sectoral agencies' personnel are

seconded to this authority and are directly under its administrative control. The second arrangement consists of the type of structure where the lead agency, particularly the Department of Watershed Management or Forestry, coordinates project activities carried out by the sectoral agencies without bringing them under the administrative control of the lead agency.

Lack of trained manpower at the project site and delayed disbursement of funds from the centre to the field were identified to be the main hindrances in project execution. Also, low salary and inadequate incentives do not attract professionals to work for watershed projects in remote mountain regions. Similarly, farmers need to be compensated for the contribution of their labour to the projects, and for loss of income resulting from watershed conservation measures and new resource use policies, such as prevention of cultivation on marginal, steeply sloping, and erosion-prone lands, or restricted use of degraded forests. The compensation could be direct income payment or provision of alternative employment opportunities.

Monitoring is often weak or lacking in watershed management projects. Project implementation can be substantially improved through proper feedback from regular monitoring; this should be incorporated into project design. In many watershed projects, there is a long gestation period before project benefits are realised. Impact evaluations done during the early stages cannot assess total benefits and costs. There is a need to conduct such evaluations at an appropriate time, when the full impact of the project is considered to have been realised. Methodologies for both monitoring and evaluation of such projects should be developed.

Research, Extension, and Training

The need for research, extension, and training was highlighted for effective planning, implementation, and policy formulation. Research and training infrastructure is generally inadequate in the Region; moreover, national capacity in this area with respect to watershed management is at a low level.

The long-term research needs for effective watershed planning and management encompass a wide range of areas. Research on technology related to agriculture, livestock, forestry, pasture, and other areas is deemed necessary to improve productivities. Methodology research on land capability classification is also considered necessary. Research on landslides and erosion processes, mass wasting, and glacier dam bursts is important in the context of water resource development. Research on population migration and local institutions is needed for the development of suitable population policies and institutional innovations. Another important research area is systemic interactions among energy, agriculture, livestock, pasture, crops, and related technologies. Finally, policy research particularly related to impact of land use changes, transfer and adoption of technology, and the effectiveness of institutional measures is necessary. (See Recommendations for elaboration of priority research areas.)

Organised extension agencies are needed for the implementation of community afforestation, soil conservation, and erosion control schemes, which require dissemination of new techniques and methods. Such agencies are currently non-existent; the development of a cadre of **watershed extension workers** has to be launched through an extended training programme. Given the diverse nature of technical training, various kinds of extension workers may need to be trained. At present, limited training facilities exist to cater to this need in the Region.

The documentation and dissemination of research findings, training methods, and successful technology adoptions are needed. Exchange of information and experience among professionals of the Region will greatly help the transfer and dissemination of appropriate technologies. The participants strongly felt that the documentation and exchange of information on various aspects of watershed management should be central to regional cooperation in the Hindu Kush-Himalaya Region.

- Training and Systematic Information Exchange

While most of the concerns expressed in discussions during the plenary sessions and group meetings have been reported in the Workshop Discussions, specific suggestions made by the working groups are presented below:

Policy and Project Priorities

1. Watershed management requires a coherent policy framework which includes not only those policies directly concerning watershed development but also those which have indirect effects. Because of this need for a comprehensive type of watershed management, the First Project Group has recommended that the Government should - with plans to examine watershed management in the national development context, and pay particular attention to the following policy measures, such as encouraging diversification of rural income, increasing off-farm income, promoting development of alternative energy sources, and the mitigation of the negative environmental effects of other development activities such as road building, urbanisation, and commercial agriculture.
2. Some participants voiced the opinion that in order to effectively plan, coordinate, and implement watershed policies, a separate Watershed Authority needs to be created, under which specific watershed organisations will be required, with legal authority, to work across societal and administrative boundaries to deal with whole watersheds.
3. Intensive watershed activities, involving such curative measures as engineering structures and relocation of agricultural activities, should be confined to critical watersheds with severe erosion where high-value investments must be safeguarded. In these areas, watershed authorities may be required to take on comprehensive implementation of activities spanning a number of sectors.

Recommendations and Conclusions

Three working groups met during the Workshop to deliberate on the following major areas of concern :

- **Policy and Project Priorities**
- **Research Priorities**
- **Training and Systematic Information Exchange**

While most of the concerns expressed in discussions during the plenary sessions and group meetings have been reported in the Workshop Discussions, specific suggestions made by the working groups are presented below :

Policy and Project Priorities

1. Watershed management requires a coherent policy framework which includes not only those policies directly concerning watershed development, but also those which have indirect effects. Because of this need for a comprehensive view of watershed management, the first priority at the national level is to develop long - term plans to examine watershed problems within the national development context, and pay particular attention to supporting policy measures, such as encouraging decreased population growth, increasing off - farm income, promoting development and use of alternative energy sources, and the mitigation of the negative environmental effects of other development activities such as road building, urbanisation, and commercial agriculture.
2. Some participants voiced the opinion that in order to effectively plan, coordinate, and implement watershed policies, a separate Watershed Authority needs to be created, under which specific watershed organisations will be required, with legal authority, to work across sectoral and administrative boundaries to deal with whole watersheds.
3. Intensive watershed activities, involving such curative measures as engineering structures and relocation of agricultural activities, should be confined to critical watersheds with severe erosion where high-value investments must be safeguarded. In these areas, watershed authorities may be required to take on comprehensive implementation of activities spanning a number of sectors.

4. Of more importance in the long run is the idea that a small number of key preventive approaches should be selected for a massive programme to be implemented by relevant sectoral agencies, non - governmental organisations and other concerned groups throughout the upland areas. The role of the Watershed Management Department, in this case, may be that of a facilitator providing training, technical inputs, and expert services, and disseminating information to other agencies.
5. Finances for watershed management activities may be generated from the beneficiaries, but should be commensurate with the benefits received by different sectors of the population. To the extent that downstream residents and the nation as a whole receive direct benefits in the form of prolongation of the life of hydropower installations, less flooding, or less road maintenance cost, those beneficiaries should pay the cost. This can be in the form of a surcharge on the use of the protected resource.
6. The watershed management programme should explicitly consider the welfare of upland residents. Such programmes should diversify and increase the income and employment of rural people without causing resource degradation. Programmes should provide economic incentives to motivate for action.
7. All legislation concerning ownership and use rights of land, trees and other forest resources, grazing and water resources, and local organisational authority for managing common lands should be assessed and modified to remove current ambiguities, contradictions, and disincentives for sound land management.
8. Institutional innovations should be encouraged at the governmental, non - governmental, and local levels to enable greater responsiveness to local conditions and people. This includes the need to identify and develop innovations through action research, intermediary organisations, and more effective local organisations, as well as to restructure government organisations to allow them to play a more facilitating role based on local circumstances.
9. Other development sectors should play a supporting role by placing greater priority on providing social and economic services to the often neglected upland residents.
10. Where watersheds are shared by more than one nation, it would be desirable to develop common policies and coordinate watershed development actions. In the short run, international cooperation can be strengthened through information exchange, joint training activities, and the exchange of scientists and practitioners.

Research Priorities

1. **Bio-physical** : Research on various important elements of geomorphic, hydrological, and biotic processes was felt to be necessary, particularly: alternative fuel and fodder resources and their use on marginal lands for pasture and forestry development, productivity losses in natural resources and land capability assessment methodology, and factors inducing landslides, sedimentation, and erosion. The study of mass wasting and glacial dam/lake outbursts and identification of hot spots should be carried out through field survey techniques, as well as remote sensing. Appraisal of glacio - hydrologic data for both short- and long - term forecasting of major hazardous events is needed for the design of early warning systems.
2. **Human and Institutional** : With the exception of aggregate demographic data, the existing database related to ethnic perceptions and culture and information on indigenous resource institutions is presently inadequate, demanding further field surveys and research. Similarly, demographic data needs to be contextualised in relation to the resource base. Further research is necessary on : different types of migration and implications for resource use, forms of common property rights, forms of national parks and forest reserves and their impacts on local communities, and finally, on various methods of technology transfer to the farmers.
3. **Rural Production Systems** : Further research was also considered important on resource productivities, different forms of land use, and the linkages and interrelations among various sectors, namely, forestry, agriculture, and livestock. It was felt to be particularly important to conduct research on the implications of development efforts on various resource-use and resource productivities.
4. **Policy Research** : The important areas of policy research identified were: an assessment of the impacts of government policies on various resource-use and resource productivities, and comparison of the cost-effectiveness of different types of watershed conservation measures, particularly the efficacy of technical engineering vis-a-vis the biological measures of land/resource conservation. Further, it was stressed that there was a need to examine distributional effects of watershed programmes at local, regional, and national levels.

Training and Systematic Information Exchange

1. Watershed Management requires a multidisciplinary approach, with training in forestry, agriculture, horticulture, animal husbandry, soil science, hydrology engineering, sociology, economics, mass communication, and extension methods.

2. Perspective planning for manpower requirements for the Hindu Kush - Himalaya Region in different disciplines needs to be done by each country to determine training requirements.
3. Courses should be developed for training at different levels and in various disciplines.
4. Short orientation courses are needed for policy makers and planners.
5. Short training courses and visits to demonstration sites, particularly in locations of successful watershed management projects, should be arranged for the beneficiaries in the watersheds.
6. Refresher courses of the latest techniques in various fields should also be arranged for all levels of personnel.
7. Courses of forestry and soil and water conservation training institutes need to be examined to ensure a balance between watershed management techniques, implementation issues, and a sensitised understanding of local resource use.
8. An information directory of the institutes and universities engaged in work relating to watershed management in the Region is required listing scientists and professionals working in related disciplines. The directory is also to include information of professional societies in the countries of the Region. The directory needs to be updated each year and distributed to all regional institutes and universities.
9. A nodal agency should be identified in each country, to collect, process, and disseminate information concerning watershed management. The nodal agency in each country should be suitably equipped to conduct the exchange of information assigned.
10. Relevant literature and information regarding mountain resource management should be collected from other parts of the world for the nodal agency information network proposed.
11. An abstracting service may be developed to summarise and publish relevant information from journals, periodicals, reports, and scientific papers relating to watershed management in the Region.

Conclusions

A number of key issues may be identified for more effective watershed management throughout the Hindu Kush - Himalaya. These are :

- the need for a fuller understanding of the consequences of continuing population growth -- both human and livestock -- in the mountains on watershed management and for urgent policy and programme action. Related to this is the issue of diversification of farming systems and provision of off-land employment, to relieve the increasing pressure on vulnerable mountain habitats.
- the need for thorough examination and understanding of practical measures for mountain resource management and farming systems to ensure food and energy security. It was recognised that while there is an overall knowledge gap in these areas, mountain pasture management, with regard to grazing, improved fodder production, and better animal husbandry, is a particularly neglected field.
- the need for large - scale training facilities, planning, implementation, and monitoring and evaluation in watershed management, as well as the need for awareness of integrated development and use of mountain resources of land, soil, water, and vegetation on a sustainable basis.
- the need for more effective institutions, with emphasis on positive incentives rather than negative controls, more concern with consultation and participatory roles, and in particular, better ways of achieving constructive common property resource management.
- the need to include appropriate technology alternatives (particularly in energy, transport, processing and packaging of agricultural produce, etc.) as essential ingredients of integrated watershed management.
- the need for sharing of experiences within the Region and the need for integrating biophysical and socioeconomic approaches.

Annex 1. Workshop Programme

DAY ONE		SESSION 3	
CHAIRMAN	Dr. Li Wenhua	WATERSHED MANAGEMENT EXPERIENCE IN THE HINDU KUSH - HIMALAYA REGION : AN OVERVIEW	
Opening and Welcome Remarks	Prof. Sun Honglie Vice-President, CAS Workshop Co - Chairman	CHAIRMAN	Dr. Colin Rosser
Introduction	Dr. Colin Rosser Director, ICIMOD	Presentation by	Dr. Kk. Panday
Address	Kang Zhenghuang Vice-Governor, Sichuan	Discussion	Country Review Papers
Address	Dong Zhiyong Vice-Minister of Forestry	DAY TWO	
Vote of Thanks	Dr. Li Wenhua Executive Deputy-Director, CISNAR Workshop Co - Chairman	SESSION 4	
SESSION 1		PROBLEMS AND PRESSURES ON MOUNTAIN WATERSHEDS	
INTRODUCTION TO THE WORKSHOP		CHAIRMAN	Dr. L. Ljungman
Workshop Programme	Dr. Kk. Panday, ICIMOD Workshop Co-Coordinator	Forest Administration in South-West China Dong Zhiyong	
Watershed Management in the Asia Pacific Region Workshop, held in Honolulu, January 1985	Dr. C. Gibbs	Livestock System Dynamics and Watershed Resources Dr. P. Alirol	
Experts Consultation Meeting on Watershed Management, held in Kathmandu, February 1985	L. S. Botero	Watershed Management and Food Security Dr. K. G. Tejwani	
SESSION 2		People's Motivations for Sustaining Upland Resources Anis Dani and Dr. G. Campbell	
SUMMARIES OF COUNTRY REVIEW PAPERS Bangladesh, Bhutan, China, India, Nepal, Pakistan		Rational Utilisation and Protection of Plant Resources Prof. Wu Zhengyi	
CHAIRMAN	Dr. Colin Rosser	Hill Farmers as Watershed Managers Dr. M. Banskota	

DAY TWO	DAY THREE
SESSION 5	SESSION 7
<p>PANEL DISCUSSIONS AND GENERAL DISCUSSION OF SESSION 4 PAPERS</p> <p>CHAIRMAN Dr. C. K. Sharma</p> <p>MEMBERS Prof. K. Iwatsuki</p> <p> M. N. Venkatesan</p> <p> Dr. K. R. Qureshi</p> <p> Prof. Zhang Rongzu</p>	<p>MANAGING THE MOUNTAIN WATERSHEDS</p> <p>CHAIRMAN J. L. Maskey</p> <p>Hindu Kush-Himalaya Erosion and Sedimentation in Relation to Dams Dr. V. Galay</p> <p>Assessment of a Small Watershed Using Aerial Photography Brian Carson</p> <p>Forestry and Watershed Mangement in the Indian Himalaya Dr. R. V. Singh</p> <p>Forestry Management in the Nepal Himalaya Dr. K. Shepherd</p>
SESSION 6	<p>Institutional and Organisational Framework</p> <p>Dr. C. Gibbs</p>
<p>MEASURES FOR PROMOTING MORE EFFECTIVE ACTIONS IN WATERSHED MANAGEMENT IN THE REGION</p> <p>Group Discussions</p> <p>CHAIRMEN</p> <p>Kumar Upadhyaya Policy and Project Priorities in Watershed Management</p> <p>Prof. J. Ives Research, Monitoring, and Evaluation</p>	<p>SESSION 8</p> <p>PANEL DISCUSSION AND GENERAL DISCUSSION OF SESSION 8 PAPERS</p> <p>CHAIRMAN M. N. Venkatesan</p> <p>MEMBERS Dr. Noor Mohammad</p> <p> M. M. D. Joshi</p> <p> Prof. Guan Junwei</p> <p> Prof. W. Haffner</p>
<p>Dr. R. V. Singh Training, Institution Building, and Systematic Information Exchange</p>	SESSION 9
	CONTINUATION OF GROUP DISCUSSIONS

Annex 1. Workshop Programme

Workshop Programme continued

DAY FOUR	
FIELD STUDY	
THEME : Practical Approach to Development with Conservation	
Visit to the School of Forestry in Dujiang and Integrated Utilisation of Biogas Complex	
Introduction of Wolong with Films	
DAY FIVE	
Visit to Wolong Nature Reserve	
DAY SIX	
SESSION 10	
ROLE OF INTERNATIONAL AGENCIES IN INTEGRATED WATERSHED MANAGEMENT IN THE REGION	
Panel Discussion on Aid Agency Experiences	
CHAIRMAN	Dr. K. R. Qureshi
MEMBERS	L. S. Botero, FAO L. Ljungman, World Bank
SESSION 11	
WORKSHOP CONCLUSIONS AND RECOMMENDATIONS FOR THE REGION	
CO-CHAIRMEN	Dr. Li Wenhua, CAS Dr. Colin Rosser, ICIMOD
Presentation and Discussion of Group Reports	
Closing of the Workshop	

Annex 2.

Workshop Organising Committee

Chairmen

Dr. Li Wenhua	Director Commission for Integrated Survey of Natural Resources (CISNAR) Chinese Academy of Sciences, Beijing
Dr. K. C. Rosser	Director International Centre for Integrated Mountain Development (ICIMOD) Kathmandu, Nepal

Workshop Coordinators

Dr. Kk. Panday	Convenor Watershed Management Programme International Centre for Integrated Mountain Development (ICIMOD) Kathmandu, Nepal
Zhang Mingtao	Commission for Integrated Survey of Natural Resources Chinese Academy of Sciences, Beijing, China

Annex 3.

Papers Prepared

Review Papers

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|--|------------------------------------|
| 1. Watershed Management and Related Issues in Bangladesh with Particular Reference to Hill Areas | Omar M. Ali and S. Ruhulamin |
| 2. The Current State of Watershed Management in Bhutan | Binayak Bhadra and Philippe Alirol |
| 3. Watershed Management in Southwest China's Mountain Region | Li Wenhua and Zhang Mingtao |
| 4. Watershed Management in the Indian Himalaya | K. G. Tejwani |
| 5. Watershed Management in Nepal | M. M. D. Joshi |
| 6. Watershed Management in Pakistan | G. M. Khattak |
| 7. Watershed Management Experience in the Hindu Kush - Himalaya Region | Kk. Panday |

Theme Papers

Problems and Pressures on Mountain Watersheds

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| 8. Hill Farmers as Watershed Managers : Dimensions of Hill Farming Systems and Environmental Change in Nepal | Mahesh Banskota |
| 9. Watershed Management and Food Security | K. G. Tejwani |
| 10. Livestock System Dynamics and Watershed Resources | Philippe Alirol |
| 11. Forestry and Watershed Management in the Western and Central Himalaya in India | R. V. Singh |

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| 12. Hindu Kush - Himalayan Erosion and Sedimentation in Relation to Dams | Victor Galay |
| 13. Recent Debris Flow Activity in the Hengduan Mountains | Tang Bangxing, Liu Suging, Tan Wanpei, and Lin Shijian |
| <i>Managing the Mountain Watersheds</i> | |
| 14. The Present Situation of Forest Administration in the Southwest Region of China and its Role in River Basin Management | Dong Zhiyong |
| 15. Forestry Management in the Nepal Himalaya | K. R. Shepherd |
| 16. The Relations Between Drainage Control and the Exploitation of Natural Resources | Wu Zheng Yi |
| 17. People's Motivations for Sustaining Upland Resources | Anis A. Dani and J. Gabriel Campbell |
| 18. Assessment of a Small Watershed Using Aerial Photography : An Example from a Remote Hill Region in Nepal | Brian Carson |
| 19. Institutional and Organisational Aspects of Watershed Management | Christopher Gibbs |
| 20. Recommendations of Expert Consultation Meeting on Watershed Management, February 1985 | L. S. Botero |

Supplementary Papers on the Hindu Kush - Himalaya
(*Not Presented*)

China

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| 21. Economic Plants of the Hengduan Mountain Region | Liu Zhaoguang |
| 22. The Rainstorm and its Runoff Over the Himalaya and the Transverse Mountains | Wu Xiangding
Lin Zhenyao
Zhang Yiguang, and
Guan Zhuhua |
| 23. A Comparative Study of Geo - ecological Conditions and Environmental Problems Between the Himalaya and the Hengduan Mountains | Zheng Du |

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| 24. Guidelines for the First - Stage Research of Watershed Management in the Dry Valleys of the Hengduan Region | Zhang Rongzu
Sun Shangzhi, and
Wu Sugong |
| 25. Exploitation and Utilisation of Natural Resources in the Hengduan Mountains | Li Mingsen and
Sun Shangzhi |
| 26. Exploitation of Marshlands and Marsh Meadows Meadows and Rational Use of Grassland Resources in Ruoergai Region | Qiu Faying and
Chen Qingheng |
| 27. Cutting of Forest and Soil Conservation in Alpine Coniferous Forests of West Sichuan | Ma Xuehua |
| 28. Geothermal Energy as a Key to Comprehensive Development of Energy Sources in Tengchong County of West Yunnan | Tong Wei and
Zhang Mingtao |
| 29. River Basin Management and Resource Exploitation in the Hengduan Mountains | Cheng Hong and
Ni Zubin |
| 30. Debris Flows and Their Prevention and Control in Jiuzhaigou Scenic Spots of the Hengduan Mountain Region | Liu Suqing
Tang Bangxing
Tan Wanpei, and
Liu Shijian |
| 31. A General Introduction to Debris Flows and Their Comprehensive Control in Heisha River, Liangshan, Sichuan | Wu Jishan
Tian Lianguan, and
Zhang Youfu |
| 32. The Problems of Soil and Water Conservation in Southwest China | Guan Junwei |
| 33. Forest Felling and Regeneration in the Southwest Mountain District of China | Han Yufen |
| 34. Animal Husbandry and Watershed Management in the Himalaya - Hengduan Region | Huang Wenxiu |
| 35. Bibliography of Exploitation, Management and Utilisation of the Hengduan Mountains | Chinese Academy
of Sciences |
| 36. Integrated Development of the Erhai Region | Zhang Mingtao and
Chen Chuanyou |
| 37. Runoff Effects of the Cutovers in the Alpine Forest Areas | Chen Chuanyou |

Other Countries

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| 38 | Economic Factors Affecting Watersheds of Northern Pakistan | K. R. Qureshi |
| 39. | Economics of Watershed Management in the Himalayan Region of India | S. L. Shah |
| 40. | Managing Catchments, Reservoirs and Commands as a System in the Himalaya | M. N. Venkatesan |
| 41. | Agricultural Development in Relation to Watershed Management Problems in Nepal | A. N. Bhattarai |
| 42. | Plans, Policies and Programmes in Watershed Management in Nepal | P. M. Baisyat |
| 43. | Planning for Combined Approaches to Integrated Regional Development and Watershed Management in Mountain Areas | P. Gueller |
| 44. | International Cooperation and Assistance to Watershed Management in Nepal | K. P. Upadhyaya |
| 45. | Research and Training in Watershed Management in Nepal | E. R. Sharma |
| 46. | Range Management in Watersheds of Pakistan | Noor Mohammad |
| 47. | Problems of Sediment Load in Water Resource Development of Nepal | C. K. Sharma |
| 48. | Watershed Degradation in Nepal | K. B. Malla |
| 49. | Watershed Management in the Indian Himalaya with Emphasis on Forestry Education and Training | K. M. Tiwari |

Annex 4.

Summaries of Papers *

Reviews

WATERSHED MANAGEMENT AND RELATED ISSUES IN BANGLADESH WITH PARTICULAR REFERENCE TO HILLY AREAS

Omar M. Ali and S. Ruhulamin

In Bangladesh, though cultivation and high intensity rainfall form ideal conditions for erosion, no single institution is responsible for watershed management, and no district or national level plan exists. Uneven distribution of rainfall is compounded by uncontrolled shifting cultivation, high deforestation due to over - exploitation, population displacement from the Kaptai reservoir and immigration from plains areas. Steps toward settlement and afforestation are being taken by the Chittagong Hill Tracts Development Project, and the Forest and Agricultural Extension Departments. The establishment of a Department of Soil Conservation and Watershed Management has been proposed.

THE CURRENT STATE OF WATERSHED MANAGEMENT IN BHUTAN

Binayak Bhadra and Phillipe Alirol

Priorities for watershed management in Bhutan are institutional development, research, and training. Multi - sectoral policies to coordinate resource sectors are needed ; no institution is solely responsible for WSM and no

data base necessary for policy analysis is presently lacking. Topsoil loss is estimated to be low, due to mild precipitation. Orchard and cash crop cultivation generally benefit the watersheds. The exception is cardamom cultivation in the south, which often encroaches on forest. Increasing animal pressures pose a threat to forests and pastures in northwestern Bhutan's inner valleys. Policies have been introduced to regulate logging and improve crop rotation, sloped terracing and pasture lands.

WATERSHED MANAGEMENT IN SOUTHWEST CHINA'S MOUNTAIN REGION

Li Wenhua and Zhang Mingtao

Watershed management, a key to successful integrated mountain development, is critical for the remote Himalaya - Hengduan Region's slow economy. The declining human - land ratio is a fundamental problem. Approximately four - fifths of the population practise agriculture; almost all suitable land is cultivated (0.5 - 2.5 per cent). Forests have been cleared for cultivation, grazing and firewood ; exploitation is 2.3 times forest productivity. During the last fifty years, various departments have conducted WSM projects, using incentives. WSM legislation has included a Forest Law, Grasslands Management Act, and Strategy of Water and Soil Conservation. However, no cross - sector coordinating organisation exists.

* Not all authors have had the opportunity to comment on the summaries presented here ; ICIMOD has tried to reflect as accurately as possible the major points raised by the authors.

WATERSHED MANAGEMENT IN THE INDIAN HIMALAYA

K. G. Tejwani

Erosion and land degradation in India have received government attention since the late 19th century. From 1980, all soil and water conservation programmes have been based on watersheds as units. While large - scale programmes have been undertaken, an accelerated pace and better performance are needed. Land use is to be optimised and productivity increased on a sustained basis in conjunction with population control. Other key issues for better watershed management, at national, regional, institutional and technological levels, include upland - lowland linkages, training needs, long - term planning, remedy versus prevention, and people's participation.

WATERSHED MANAGEMENT IN NEPAL

M. M. D. Joshi

Nepal's hill areas are experiencing heavy topsoil loss and decline in quality and quantity of forests. Marginal lands once supplying fuelwood and fodder are now cultivated ; animal productivity is decreasing. Road construction and irrigation development aggravate ecological instability. Large - scale afforestation activities to provide employment. Watershed Management Programmes include : those planned and implemented with defined boundaries; components of multifaceted Integrated Rural Development Projects ; sectoral projects addressing issues of forestry management; and those implemented to generate data. Environmental management research is conducted by several government agencies and university units.

WATERSHED MANAGEMENT IN PAKISTAN

G. M. Khattak

Watershed management programmes in Pakistan, launched on the assumption that soil erosion and reservoir siltation are mainly caused by defective land use, are executed as development projects, using incentives to ensure soil and water conservation and simultaneously increase local incomes. Success so far has been in afforestation and awareness of mountain farmers. Two main agencies have implemented WSM projects : the Water and Power Development Authority and the Forest Departments. The current need is for a planning and research unit, and intensive, comprehensive management incorporating range management, soil and water conservation, animal husbandry, horticulture, agronomy and social sciences. The major constraint is not financial, but inadequate institutional infrastructure.

WATERSHED MANAGEMENT EXPERIENCE IN THE HINDU KUSH - HIMALAYA REGION

Kk. Panday

The Region is paradoxically diverse, yet about 140 million mountain people share the increasing hardship of being unable to meet their subsistence needs. Although population growth is not an isolated cause of economic problems, it is an important catalyst by the pressure it places on the environment. Animal population, land use, and tenure also contribute to the Region's increasing upland and lowland watershed degradation. Efforts toward stabilisation have reflected diverse situational problems. Regional and international cooperation are vital for financing and provision of technology. A political will to take responsibility for natural resource management within a country is a prerequisite for successful WSM, which is only possible with comprehensive development components. Technologically, the Region is well equipped to start a new era of WSM. An unpleasant question lingers: Do we know too much to exploit, and too little to preserve and enhance, our resources ?

People and Watershed Management

HILL FARMERS AS WATERSHED MANAGERS : DIMENSIONS OF HILL FARMING SYSTEMS AND ENVIRONMENTAL CHANGE IN NEPAL

Mahesh Banskota

Although many types of hill farming systems in Nepal share similar problems -- including population growth, pressure to increase cultivated land, fragmentation of land holdings, and increasing marginalisation of small land holders -- significant physical and socio - economic differences cannot be overlooked. A synthesis of various dimensions (ecological, population, socio-economic and institutional) is needed a for comprehensive understanding of hill farming systems that includes not only the hill farmers, but other units of socio - political decision making. Evaluation of land use alternatives starts with farmer requirements ; the hill farmer is just an entry point into the bigger and more complex hill economy and environment. Better water management and human resource development are critical. Although agriculture remains predominant, the future of hill agriculture and farmers depends on off - farm alternatives.

PEOPLE'S MOTIVATIONS FOR SUSTAINING UPLAND RESOURCES

A. A. Dani and J. G. Campbell

People's participation should not be treated as an end, but as a means to achieve sustained resource use. This initial examination of local participation in WSM activities in the Region indicates that unplanned or spontaneous land use changes have as much relevance for WSM as planned participation. Security of resource tenure, local user group management, and full communication of project information to the people, are key variables for understanding and promoting people's sustained land use in upland areas. A radical reassessment of current land - based planning tools and approaches, which takes into account locally perceived needs and adaptation of existing behaviours, could maximise impact.

Livestock, Pastures and Watershed Management

LIVESTOCK SYSTEM DYNAMICS AND WATERSHED RESOURCES

Philippe Alirol

Livestock system dynamics involve modification of the environment, production and technical factors, and change of system outputs. Animal husbandry, a traditional way to increase watershed carrying capacity, converts biomass energy available in non - cultivable ecological zones and transfers it to farms. Farming system categories include sedentary mixed farming and migratory stock farming (transhumance and pastoral nomadism). In mixed farming systems, degradation is induced by human population growth and consequent increase in livestock, demand for fuelwood and agriland, and development activities. Livestock development priorities, usually given to mixed farming systems, should be given to transhumance and nomadism, which make wider use of watershed resources.

ANIMAL HUSBANDRY AND WATERSHED MANAGEMENT IN THE HIMALAYA - HENGDUAN REGION

Huang Wenxiu

The Himalaya and Hengduan ranges have four ecological zones demanding separate animal husbandry management. (1) In the agricultural lowlands (under 2,500 m) with cattle being 25 - 30 per cent of the total animal population, meat/milk and draught animals should be home - fed with limited summer grazing. (2) In the agricultural - pastoral transition areas (2,500 - 4,500 m), cattle, sheep and horses should be raised but their populations controlled. (3) In alpine meadows (4,500 m) grazing of yak and sheep should be controlled. In the region as a whole, measures eliminating inefficient animals and structurally improving animal groupings are needed both to increase animal production and protect rangelands. Development of oxen (40 per cent of the total

animal population) will be an important part of expected change from intensive to extensive management.

RANGE MANAGEMENT IN WATERSHEDS OF PAKISTAN

N. Mohammad

Range management in Pakistan has primarily concentrated on altitudinal trials of exotic and indigenous species of grasses, fodder shrubs and trees. The Range Policy Directive of 1962 needs updating to emphasise integrated multiple land use. Recommendations include : formulation of range watershed policy, conducting detailed resource surveys and analyses, raising of promising fodder crops, and planting of fruit trees and fast - growing fuel trees. The major constraints to rangeland development are institutional and socio - economic. There is an absence of both people's participation and an independent agency to undertake range management programmes.

EXPLOITATION OF MARSHLANDS AND MARSH MEADOWS AND RATIONAL USE OF GRASSLAND RESOURCES IN RUOERGAI

Qiu Faying and Chen Qingheng

Ruoergai Region, on the east margin of the Qinghai - Tibet Plateau, is an important animal husbandry base. Precipitation larger than evaporation capacity and long periods of low temperatures cause surface water to accumulate seasonally on marshlands and meadows. Drainage has been considered, but would threaten the balance of the hydrological cycle, and cause poor growth of plants, and exposure and expansion of sand dunes. The factors limiting animal husbandry are different forage supplies, pasture areas, and uses in different seasons. Thus, pasture should be rationally controlled and divided for rotational grazing. Draining should be limited, and exploitation, use and improvement of existing pasture should receive attention.

Agriculture and Watershed Management

AGRICULTURAL DEVELOPMENT IN RELATION TO WATERSHED MANAGEMENT PROBLEMS IN NEPAL

A. N. Bhattarai

Terrace cultivation, maintenance of forests, and mixed cropping are examples of traditional watershed management in Nepal. The population explosion has rendered these insufficient. Hill areas have had food deficits from the seventies. Rice, wheat and maize yields are increasing in the Terai, but decreasing in the hills due to difficult and expensive extension and input transportation. Agricultural development in integrated rural development and WSM projects is suffering from administrative, budgetary and coordination problems. Foreign aid has played a major role in producing agricultural manpower and infrastructure, however, a change from project to programme assistance is needed.

WATERSHED MANAGEMENT AND FOOD SECURITY

K. G. Tejwani

Deterioration of watersheds is linked to the continued decline in production of food crops, despite increases in cultivated area in mountain and hill zones. Deforestation and degradation lead to weakening or breaking of the linkages between forests/grasslands and food production, thus threatening food security in both uplands and lowlands. Water resource development for irrigation wherever possible may be one of the keys to ensuring food security. When water resources are developed for irrigation, farmers use fertilisers and improved varieties, and adopt plant protection and soil conservation measures voluntarily, which result in higher food production and conservation.

Forests and Watershed Management

RUNOFF EFFECTS OF THE CUTOVERS IN ALPINE FOREST AREAS

Chen Chuanyou

With China's economic development, forests of the Hengduan Mountains are decreasing. Field surveys where forests have been widely felled show increased sediment content in rivers, more frequent floods and debris flows, decreasing low water runoff and aggravated droughts. Experiments have proven that streams in forest areas have a modulation effect on floods produced by rainstorms. In southwest China, where alpine forest cover is less than 60 per cent, large area forest felling should be decreased, and vigorous action toward afforestation and regeneration taken. All forest on steep slopes along highways and river courses, along with forests on steep slopes with thin soil layer and alpine open forest, should be protected as "water source forest". Logging methods should be improved ; the slide method should be abandoned entirely and aerial tramways and river floating should be developed.

PRESENT SITUATION OF FOREST ADMINISTRATION IN THE SOUTHWEST REGION OF CHINA AND ITS ROLE IN RIVER BASIN MANAGEMENT

Dong Zhiyong

Management of this area is important for river control in China. Under conditions of abundant rainfall, soil erosion and mud - rock flows occur easily ; sufficient forest coverage is critical. Present forest resources cannot meet the needs of both conservation and timber production. The major constraint is lack of finance. Forest protection is mainly through local organisation. Wood processing industry has no regulations for regeneration or forest management. Suggestions include: promotion of local economy, closing hillsides to livestock and fuel gathering, extending afforestation with coordination in development of husbandry, agriculture and hydropower resources.

FOREST FELLING AND REGENERATION IN THE SOUTHWEST MOUNTAIN DISTRICT OF CHINA

Han Yufen

China's southwest mountain district has abundant, mostly virgin, forest resources. Due to high elevations, steep slopes and lack of transportation, forest enterprises are concentrated in certain areas, so both overcutting and severe waste of the resource exist. Light coniferous forests are capable of natural regeneration through flying seeds. To increase speed, aircraft sowing has been ecologically and economically beneficial since the late 1950s. Dark coniferous forests, if cut and not afforested by artificial cultivated seedling, often reduce to meadow. High quality seedlings, ecologically sound planting, and utilisation of container planting, raise survival ratios. To prevent water loss and soil erosion, means of timber collection must be improved.

CUTTING OF FOREST AND SOIL CONSERVATION IN ALPINE CONIFEROUS FORESTS OF WEST SICHUAN

Ma Xuehua

An important means to prevent soil slippage is forest coverage. Current logging and lumber transportation methods cause considerable problems. Suggestions include : using aerial tramways and ground cable logging instead of slide method logging, and using wooden slides instead of floating lumber in small rivers. Forest safety belts should include the upper limit of vertical distribution of forest, steep slopes (over 35 degrees), and road shelter and mountain ridge reserve forest belts.

FORESTRY MANAGEMENT IN THE NEPAL HIMALAYA

K. R. Shepherd

The Nepal - Australia Forestry Project, based on voluntary community participation, has generated local enthusiasm and spurred grazing

restrictions. The main local uses of forests are fodder, fuel and building materials, respectively. Maintenance of viable agricultural systems depends on nutrients from productive forest systems. As neither forested nor private non - cultivated land is fully productive, the only way the mixed farming system can survive is if productivity of these lands is increased substantially. The solution involves an integrated approach to community forestry.

FORESTRY AND WATERSHED MANAGEMENT IN THE WESTERN AND CENTRAL HIMALAYA IN INDIA

R. V. Singh

Forest areas in the western Himalaya are understocked, causing low productivity and ineffective soil and water conservation. Agriculture in the region is mostly rainfed; the farmers must maintain large number of livestock for manure. Agriculture and forest lands are increasingly converted to more profitable use : horticulture. Forest conservation in the region will not be possible until local demands for forest products needed to support agriculture, horticulture, and animal husbandry are met. The strategy for WSM in the region must be to avoid wastage in harvesting and wood utilisation, conserve existing forests, improve agricultural and grassland productivity, and reduce the population of poor quality livestock.

WATERSHED MANAGEMENT IN THE INDIAN HIMALAYA WITH EMPHASIS ON FORESTRY EDUCATION AND TRAINING

K. M. Tiwari

Destruction of civil and soyam forests in India's Himalayan states has occurred despite the existence of scientific forestry education and training for over a century. Initially, forest management emphasised exploitation and revenue collection rather than conservancy. From 1950, road networks in hilly areas were established; forests were depleted for defense purposes, railway sleepers, tea chests, plywood, matchwood and pulp industries, and tea cultivation. The policy of

forestry education in India is highly centralised, through the Forest Research Institute, Dehradun. The current challenge for forestry is to recreate forests to meet people's basic needs. Recommendations include : establishment of an Indian Forestry Academy ; international cooperation ; and training of farmers, development officers and legislators by all Forestry Training Colleges.

Institutional Aspects of Watershed Management

PLANS, POLICIES AND PROGRAMMES IN WATERSHED MANAGEMENT IN NEPAL

P. M. Baisyat

In 1974, the Department of Soil Conservation and Watershed Management was established, primarily to reduce floods and landslides. Since 1975, thirteen projects have directly involved soil conservation and WSM, covering one-third of the country, with bilateral and multilateral assistance. In 1982, a Soil and Watershed Conservation Act was passed. The Seventh Plan (1985-90) gives topmost priority to water resource and agricultural development ; a major government policy is to maintain water resources and environmental conditions by reducing soil erosion. Community participation is being encouraged through the government decentralisation programme. It is recommended that DSCWM expand throughout the country on district and regional levels.

INSTITUTIONAL AND ORGANISATIONAL ASPECTS OF WATERSHED MANAGEMENT

Christopher Gibbs

Understanding institutions and property rights is at the heart of watershed management. Because of the diversity and remoteness of watersheds, management must be adapted and decentralised to local levels. While costs are borne

upstream, many benefits accrue to downstream populations. The division of benefits and responsibilities between public and private interests upstream and downstream are an important foundation for institutional arrangements. Unless these arrangements create appropriate incentives for villagers and agencies, management implementation will probably fail. Building organisations with a capacity for learning is a necessary condition for WSM. Programmes should plan with the people they are aimed at, and learn how to be effective from experience in programme implementation.

PLANNING FOR COMBINED APPROACHES TO INTEGRATED REGIONAL DEVELOPMENT AND WATERSHED MANAGEMENT IN MOUNTAIN AREAS

P. Gueller

Problems of mountain development are generally tackled as comprehensive planning, as a reaction to unsuccessful approaches, or as practical tasks of government administration through link agencies. Functional integration of WSM into comprehensive rural development reflects the necessity to motivate broad segments of the rural population, to increase care for their natural environment. Isolated WSM schemes with narrow scope are unlikely to succeed. WSM must bridge operations on the various levels of government, to village administration and social organisation. WSM projects in Nepal have found a degree of integration by grouping engineering, agricultural, livestock, and forestry components. In the evolution and diversification of Nepal's rural development, both IRDPs and WSMs have found extension and social mobilisation play a central role.

ECONOMIC FACTORS AFFECTING WATERSHEDS OF NORTHERN PAKISTAN

K. R. Qureshi

Increasing exploitation of land to meet basic needs of the expanding population is resulting in widespread soil erosion, under all forms of land use in the region. Successful pilot watershed projects

have encouraged terracing of agricultural land, causing acre yield and income increases of 25 per cent. Existing projects use various subsidy scales for land improvement and conservation, which limit the spread of conservation benefits. Watershed development needs to be integrated with national development. Insufficient attention has been given to the economic needs of the people, and to watershed development in the national budget. Alternative sources of funding, such as hydropower, need consideration.

ECONOMICS OF WATERSHED MANAGEMENT IN THE HIMALAYAN REGION OF INDIA

S. L. Shah

Watershed management projects have been implemented in the Himalayan Region for over a decade, with only partial success. Existing village level institutions are not functioning properly. Political and bureaucratic support both at the policy and field level are necessary. People's basic needs for fuel, fodder and drinking water should receive urgent priority. It has been found that when water resources are developed, conservation practices follow. Other recommendations are: to link subsidies with performance and adoption of technology, to secure long - term funding, to integrate the sectoral approach at the staff level, to consolidate fragmented land holdings, and to give equal importance to checking population growth rates and developing watersheds.

INTERNATIONAL COOPERATION AND ASSISTANCE TO WATERSHED MANAGEMENT IN NEPAL

K. P. Upadhyaya

Through diverse approaches, international donor agencies have contributed : increased awareness of the consequences of watershed degradation ; specifications for watershed management practices ; testing of the socio - economic and institutional mechanisms to promote community participation to implement conservation practices, development of a trained cadre of professionals and technicians ; organisation of on -

the - job training ; and establishment of demonstration watersheds. A review of various project evaluation reports reveals the need for increased time periods for design phases, clear understanding between national and community projects, long - term commitment, better financial flow, strengthening of planning cells, built - in evaluation and monitoring systems, better incentives, and use of NGOs and user groups.

MANAGING CATCHMENTS, RESERVOIRS AND COMMANDS AS A SYSTEM IN THE HIMALAYA

M. N. Venkatesan

The occurrence of floods in the Ganga - Brahmaputra basin has become an annual feature, bringing loss of life, property, and livestock, and aggravating reservoir siltation and ecological degradation. A multi - disciplinary Catchment Area Protection Authority is recommended to make use of flood waters; in the Ganga - Brahmaputra basin, it is estimated revenues from the sale of hydroelectric power will largely cover initial investments for construction of storage areas. High investment programmes for water resource development are required -- in the range of \$500 billion for 30 years -- emphasising awareness of natural resource limitation and technical skill for resource utilisation.

THE RELATIONS BETWEEN DRAINAGE CONTROL AND THE EXPLOITATION OF NATURAL RESOURCES

Wu Zheng Yi

Rational utilisation and exploitation of mountain region biological resources are the key links for development of agriculture and territorial/national economies for developing countries. Especially with urbanisation, the mountains, valleys and flood plains are interconnected, though unified planning cannot be easily achieved. Measures to improve relations between utilisation and conservation include: depending on green plants ecosystems, building vegetation cover management systems, strictly

protecting regeneration ability of biomass, and promoting multiple utilisation of resources for ecological, economic and social benefit. Human beings and Great Nature could and ought to gradually attain harmony.

Research and Technology for Watershed Management

ASSESSMENT OF A SMALL WATERSHED USING AERIAL PHOTOGRAPHY : AN EXAMPLE FROM A REMOTE HILL REGION IN NEPAL

Brian Carson

Land and human resources need to be considered concurrently ; use of aerial photography can achieve this. By integrating land inventory data, settlement infrastructure, land tenure, villager movement, and economic, political, social and religious spheres of the village on aerial photographs, the land manager is in an excellent position to suggest positive changes for successful and appropriate development at the village level. Also, within a few minutes, untrained villagers can pick out their own homes, farmland, and water sources. Once negatives are available, printing aerial photographs is cheaper and more rapid than making large scale topographic base maps.

RESEARCH AND TRAINING IN WATERSHED MANAGEMENT IN NEPAL

E. R. Sharma

The Seventh Plan (1985 - 90) highlights scarcity of forest products and soil erosion as research priorities. The main efforts of forest research at present are collection of data for a preliminary silviculture manual and species / provenance and elimination trials for fuelwood and timber. The Resources Conservation and Utilisation Project is monitoring hydrology and studying land use capabilities. The emphasis for future research activities must be on afforestation of marginal soil,

and the need for improved protection, production and management of forest. The major gaps identified in research at present include the impact and cost - benefit evaluation of erosion control measures.

GUIDELINES FOR THE FIRST - STAGE RESEARCH OF WATERSHED MANAGEMENT IN THE DRY VALLEYS OF THE HENGDUAN REGION

Zhang Rongzu, Sun Shangzhi and Wu Sugong

The dry valleys within the Hengduan Region are agriculturally important and have the most populated settlements of the area. All the dry valleys are semi - arid, and can be subdivided into hot - dry, warm - dry, and temperate - dry. Most are in rainshadow areas. Environmental deterioration has been brought about by expansion of cultivation, forest clearing, and promotion of goat pasture. Almost all ecosystems have had intensive and direct human influence. The first step of reforming the dry valleys should be conversion of misused land, especially steep slope farmland for greening. Integrated research for economic, social, and environmental data collection is emphasised and recommended.

Geo - ecological Conditions and Watershed Management

RIVER BASIN MANAGEMENT AND RESOURCE EXPLOITATION IN THE HENGDUAN MOUNTAINS

Cheng Hong and Ni Zubin

The Hengduan Mountains are sparsely populated with little economic development. A high proportion of the region has vegetational cover. Human activities have not affected the environment except in the east and south ; forests have been overcut and slopes cultivated, causing soil erosion and siltation in rivers. The most important measures to be taken are : rational cutting of forest, improvement of timber stocking and transportation, readjustment of the structure of the agricultural economy, and slope reform.

HINDU KUSH - HIMALAYAN EROSION AND SEDIMENTATION IN RELATION TO DAMS

Victor Galay

In planning for dams in the Hindu Kush - Himalaya Region, it is essential to know sediment yields to estimate reservoir life, but pertinent data related to erosion processes is lacking. One of the most dominant erosion processes results from glacier lake outburst floods which cause enormous sediment loads due to mass wasting. The management of watersheds to reduce erosion and extend reservoir life cannot be effective until more research related to quantifying erosion processes is carried out. It appears that water resource projects for power production or irrigation should utilise low level weirs instead of high dams.

THE PROBLEMS OF SOIL AND WATER CONSERVATION IN SOUTHWEST CHINA

Guan Junwei

Soil and water loss are defined as destruction of soil body (soil, subsoil, base rock) by water, gravity, wind, animals, plants and humans. The main forms of such loss occurring in southwest China are : plant food and leaching loss, squamose erosion, gravity erosion, torrential erosion, and debris flow. Debris flow can be forecast according to rainfall variance and rate of flow, after laying rain gauges, weir dams, pressure recorders for soil, recorders for dynamic water pressure and moisture for each layer of soil and trailing. The forecast mainly depends on over - saturation of solid load. The study of dynamic prediction of debris flow has advanced the system of long - term debris flow dynamic forecast.

EXPLOITATION AND UTILISATION OF NATURAL RESOURCES IN THE HENGDUAN MOUNTAINS

Li Mingsen and Sun Shangzhi

To improve the economy and ecological environment of the Hengduan Mountains, the following measures should be considered : stabilise grain productivity and redistribute surplus, return

crop land with low productivity to forest or grazing land, cut forests rationally -- selection versus clear cutting -- and increase afforestation, establish artificial grasslands and improve animal community structure, develop cash crops (sugar, tobacco) and fruit orchards in valleys, conserve wild biological resources, develop artificial cultivation of medicinal herbs, flowers and wild animals, exploit ferrous and nonferrous metal and other mineral resources, develop diversified energy sources, advance processing and tourist industries, expand highway and education networks, and train local people.

DEBRIS FLOWS AND THEIR PREVENTION AND CONTROL IN JIUZHAIGOU SCENIC SPOTS OF THE HENGDUAN MOUNTAIN REGION

Liu Suqing, Tang Bangxing, Tan Wanpei and Liu Shijian

Most debris flows in Jiuzhaigou area originate in rocky mountains and steep hillsides above forest line (2,000 - 3,000 m), with distribution primarily over forest cutting area. Aims for the area are protection of natural ecological environment and promotion of tourism. To combine prevention with control, engineering works such as blocking, sandpocket and gully stabilisation projects must be carried out consecutively with vegetation measures such as plantation and afforestation of cultivated areas. Closure of forest areas, and restriction of tree felling and livestock grazing, are further suggestions.

ECONOMIC PLANTS OF THE HENGDUAN MOUNTAIN REGION

Liu Zhaoguang

The Hengduan Mountain Region has the richest collection of alpine plants in the world, with over 4,000 species of economic plants. Important among these are medicinal plants (over 1,500 species). Essential oil plants containing volatile oils in their roots, stems, leaves and flowers, have many uses in light industry, food industry, chemical

industry and medicine (over 400 species). Other oil plants, widely used in food industry, machinery, light industry, chemical industry and exploration, include 250 species, with over 100 having an oil content of more than 39 per cent. Other economic plants include starch and gelatinous starch plants, fibre plants, tannin plants, germplasm resources, wild fruit and flower resources, and the host plants of lac and white - wax insects.

WATERSHED DEGRADATION IN NEPAL

K. B. Malla

As many authors have stated, watershed degradation in Nepal is rated as high or very critical. Erosion is probably the most serious problem. Topsoil loss induced by grazing needs immediate attention. The most serious deforestation has occurred in Nepal's southern plains through conversion for agricultural land. Programmes to increase sustained agricultural production are necessary to improve watershed conditions. Priority in formulating land use planning and policy making should go to ministries connected with natural resource management.

PROBLEMS OF SEDIMENT LOAD IN WATER RESOURCE DEVELOPMENT OF NEPAL

C. K. Sharma

The main cause of heavy sediment load and decrease of lean flow in Nepal are weak geology, heavy and intensive rainfall, glacial lake bursts, deforestation, seismicity, and human factors. The most conspicuous human factor is the cutting of river banks for roads and canals. While partially responsible for sediment load, human factors are the main cause of the reduction of low flow and increase in high flow. To control sediment in rivers of the region, special techniques of WSM for stabilisation of slides and lake bursts are necessary, with regional and international cooperation.

RECENT DEBRIS FLOW ACTIVITY IN THE HENGDUAN MOUNTAINS

Tang Bangxing, Liu Suging, Tan Wanpei
and Liu Shijian

In recent years, debris flows in the Hengduan Mountains have become frequent and destructive mainly due to excessive exploitation of biological energy. The debris flows are concentrated in river valley zones, with densely populated urban areas. Active periods occur in relation with change of atmospheric circulation, earthquakes and human activity. The most serious problems are siltation, breach of natural dams, and upward movement of debris flow. Debris flow countermeasures include: prevention through ecosystem protection and rational development of agriculture, forestry and animal husbandry ; avoidance of debris flow hazard zones; and engineering measures with emphasis on checking, discharging and stabilising for the short term and closing mountains to livestock grazing and fuel gathering for the long term.

GEOHERMAL ENERGY AS A KEY TO COMPREHENSIVE DEVELOPMENT OF ENERGY SOURCES IN TENGCHONG COUNTY OF WEST YUNNAN

Tong Wei and Zhang Mingtao

Tengchong County in the southern Hengduan Mountains is without coal or oil, but is rich in hydropower reserve, with 85 minihydro stations in operation. Hydropower currently conflicts with water conservancy ; irrigation must take priority. Areas of water conservation forest have dropped sharply as forest fuels are primarily used for household and industry. Consumption of energy resources is increasing rapidly. Water loss and soil erosion have intensified. Comprehensive solution to energy source problems is urgent. Rapid development of forest and geothermal resources are suggested to allow rehabilitation of hydropower and water resources.

THE RAINSTORM AND ITS RUNOFF OVER THE HIMALAYA AND THE TRANSVERSE MOUNTAINS

Wu Xiangding, Lin Zhenyao, Zhang Yiguang,
and Guan Zhuhua

In China, a rainstorm is defined as over 50 mm of rainfall in 24 hours. In the plateau and mountain areas, major weather systems are shear line, vortex, and Bengal storm. June, July, and August are the rainiest months throughout the region. The rainstorms are concentrated on the eastern and southeastern parts of the Himalaya - Transverse Mountain area. Approaches for preventing or weakening rainstorm runoff damage are : afforestation, construction or reconstruction of flood control installation, and more research on rainstorm and runoff.

A GENERAL INTRODUCTION TO DEBRIS FLOWS AND THEIR COMPREHENSIVE CONTROL IN HEISHA RIVER, LIANGSHAN, SICHUAN

Wu Jishan, Tian Lianquan and Zhang Youfu

The Heisha River is a catastrophic debris flow gully in the mountainous region of southwest China. A control programme was devised according to the formative mechanism, activity laws, and damaging patterns of debris flow. Measures include: a flood - control reservoir, conservation forest on the upper reaches to regulate floods, silt arrest dams, check dams, revetments and longitudinal dikes, and soil and water conservation forest on the middle reaches. On the lower reaches, dikes, drain ditches and protection forest belts have been established. Since 1978, when these measures were completed, the hazards of debris flow have been controlled. However, current reservoir and dike siltation calls for strengthened management to close the mountains and facilitate afforestation.

INTEGRATED DEVELOPMENT OF THE ERHAI REGION

Zhang Mingtao and Chen Chuanyou

The Erhai Region consists of a series of parallel mountain ranges and large, flat valleys. Although cultivable land area is available, spring drought constitutes a great threat to agricultural production in the region. Even water supply for human and livestock consumption is problematic. Inefficient utilisation of water resources is hindering growth in production. Hydroelectric potential is facing investment constraints and rising costs of production. The only way to solve the water shortage in Erhai Region and its effects is cross basin diversion. By tapping new water sources, irrigation, regular functioning of power stations, maintenance of the Erhai Lake water level, and agricultural and industrial production needs may be met. Various government departments have put forward designs for the project. The most reasonable plan is diverting Yangbi River water to Erhai Lake, either by a converging or a diverging plan.

A COMPARATIVE STUDY OF THE GEO-ECOLOGICAL CONDITIONS AND ENVIRONMENTAL PROBLEMS BETWEEN HIMALAYA AND THE HENGDUAN MOUNTAINS

Zheng Du

The tropical fringe and subtropical zone of the middle and low altitudes of both the Himalaya and the Hengduan Mountains are characterised by monsoon climate though the precipitation ranges are distinct. Yak and sheep are grazed in the alpine belt, croplands are located in the valley belt, and the montane forest belt is used for grazing and cultivation in both mountain areas. Population growth, increasing economic development and related changes have brought about environmental problems such as slope instability, accelerated soil erosion, and expansion of scrub belt of dry valleys. Landslides, slope - slip, mud - flows and debris flows are frequent problems shared by the regions.

Annex 5.

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Secretary, Ministry of Education and Culture
His Majesty's Government of Nepal

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Vice-Director
Directorate of Cooperation and Humanitarian Aid

UNESCO
Dr. Gisbert Glaser
Division of Ecological Sciences

Director (ex - officio)
Dr. Colin Rosser

Founding of ICIMOD

The fundamental motivation for the founding of this first International Centre in the field of mountain area development was widespread recognition of the alarming environmental degradation of mountain habitats, and consequent increasing impoverishment of mountain communities. A coordinated and systematic effort on an international scale was deemed essential to design and implement more effective development responses to promote the sustained well-being of mountain communities.

The establishment of the Centre is based upon an agreement between His Majesty's Government of Nepal and the United Nations Educational, Scientific and Cultural Organisation (UNESCO) signed in 1981. The Centre was inaugurated by the Prime Minister of Nepal in December 1983, and began its professional activities in September 1984.

The Centre, located in Kathmandu, the capital of the Kingdom of Nepal, enjoys the status of an autonomous international organisation.

Director : Dr. K. C. Rosser

Deputy Director : Dr. R. P. Yadav

Participating Countries of the Hindu Kush - Himalaya Region

- | | |
|---------------|--------------|
| o Afghanistan | o Bangladesh |
| o Bhutan | o Burma |
| o China | o India |
| o Nepal | o Pakistan |



**INTERNATIONAL CENTRE FOR INTEGRATED
MOUNTAIN DEVELOPMENT (ICIMOD)**

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