KING MAHENDRA TRUST FOR NATURE COVSERVATION

Water Knowledge

Experiences from the Annapurna Conservation Area

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2003

F U N D E D B Y T H E F O R D F O U N D A T I O N

Foreword

WATER IS a vital resource for human sustenance as much as it is a source of perpetual clean energy. Water has a multitude of end uses. To name a few would include areas ranging from livestock rearing and agriculture to income generation from tea shops to reducing drudgery, particularly of women through the use of hydro-power. During the implementation of the Water Resources Use Project, focus was laid on improving the conditions of the local communities through better utilisation and conservation of water resources. To achieve these objectives, it was essential to first understand the dynamics of water resources and the issues pertaining to its uses.

With the generous financial support of the Ford Foundation, KMTNC/ ACAP was able to enhance the capacity of the locals in improving the management and utilisation of water resources. In addition, this project also allowed the opportunity for the KMTNC to learn from implementing the WRUP by undertaking action researches and its documentation. This publication, the first of its kind for the KMTNC, is an example of the documentation of lessons learnt from the ACAP. I would like to thank the Ford Foundation for their support, which has enabled us to come this far in learning from our experiences. Appreciation also goes to all the contributing authors for their effort in researching and synthesising their findings. The editors must also be commended for their perseverance in bring out with this publication in its present form.

This publication is a result of collaboration between different stakeholders: locals, community-based organisations, expert consultants, KMTNC/ACAP technical and field staff. This unique opportunity has enabled the KMTNC to reflect on and assess its own work as research institution. The research itself was valuable feedback to the KMTNC in improving conservation and development endeavours. Sharing it with the wider community will promote programmatic transparency and opportunities for replication of methodologies and technologies in and outside the working areas of KMTNC. We hope this publication will be of practical use to a wide range of stakeholders and government departments working in this sector.

Arup Rajouria
Member Secretary
King Mahendra Trust for Nature Conservation

Acknowledgements

THIS WORK is a collaborative effort of many researchers and a synergy of different perspectives to make this publication meet its purpose of helping build a better understanding of the uses of water resources in the Annapurna Conservation Area. In this process, first of all we would like to acknowledge the support extended by the Ford Foundation for the Water Resources Use Project 2000 to 2003 executed by the KMTNC. This publication has been possible with a Ford Foundation grant, and we are very thankful to the Ford Foundation for their generous support.

All the contributing researchers must be commended for their effort in documenting their researches. The remoteness and the varied landscape of the Annapurna Conservation Area result in huge gaps in information. The commitment of the researchers to explore and document their analyses and interpretations have contributed to shedding light and generating knowledge on water uses in this remote area.

During the various research studies, enumerators, ACAP field staff, local people, Conservation Area Management Committee members and members of the Mothers' Group were mobilised or involved in one way or the other. We would like to extend our sincere appreciation of their assistance as well as the support provided by the ACAP field Unit Conservation Offices.

In ACAP, we are particularly indebted to the ACAP Project Director, Gehendra Bahadur Gurung, and the WRUP Coordinator, Prakash Dhamala, for the administrative support extended. At the ACAP headquarters, we thank all the technical staff who were involved in this project at some point or the other in the three-year period; their involvement and feedback have helped the quality of the studies.

The editors would like to dedicate this book to the local communities of the Annapurna Conservation Area in appreciation of the cooperation and the generosity extended by the local people towards the researchers.

Bhaskar Singh Karky
Ganga Jang Thapa

Glossary of Terms

ADB/N	Agricultural Development Bank of Nepal
ACA	Annapurna Conservation Area
ACAP	Annapurna Conservation Area Project
AEP	Alternative Energy Programme (of ACAP)
AEPC	Alternative Energy Promotion Centre
BYS	Balaju Yantra Shala
CAC	Conservation Awareness Camp
CAMC	Conservation Area Management Committee
CEDR	Community Electricity Distribution Regulation
CEEP	Conservation Education and Extension Programme
CRED	Community Rural Electrification Department
DCS	Development and Consulting Services
DO	Distributing Organisation
ECCU	Energy and Climate Change Unit
ITDG	Intermediate Technology Development Group
HMG/N	His Majesty's Government of Nepal
ICDP	Integrated Conservation and Development Programme
ICIMOD	International Centre for Integrated Mountain Development
KMTNC	King Mahendra Trust for Nature Conservation
kW	Kilowatt (1,000 watts)
MHP	Micro-Hydroelectric Plant
MW	Megawatt (1,000,000 watts)
NEA	Nepal Electricity Authority
NRs	Nepali Rupees (US$ 1 = approximately NRs. 76)
REDP	Rural Energy Development Programme
TAC	Tourism Awareness Camp
VDC	Village Development Committee
VEC	Village Electrification Committee
W	Watt
WRUP	Water Resources Use Project (implemented by ACAP)

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Introduction

THE WATER Resources Use Project (WRUP) implemented by the King Mahendra Trust for Nature Conservation (KMTNC) in the Annapurna Conservation Area (ACA) with the financial support of the Ford Foundation began in August 2000 and ended in July 2003. WRUP was implemented as an integral part of the KMTNC's Annapurna Conservation Area Project (ACAP), which covers the region around the Annapurna Range of the Himalaya in northwestern Nepal.

The specific objectives of the Water Resources Use Project were:

- To document water resources management in the ACA;
- Identify and initiate action research to improve the capacity of the locals in harnessing water resources;
- Establish an evolving internal learning mechanism within the organisation; and
- Build the capacity of the KMTNC staff to undertake action research.

These objectives supplement the broader Integrated Conservation and Development Programme (ICDP)-based goals of the KMTNC for the conservation of nature as well as overall development of local communities. In the ICDP paradigm, the local communities are the focal point, the stalwarts of conservation and the managers of natural resources.

The ACA is the largest conservation area in Nepal. Hamlets and habitats of rich diversity nestle in the ACA along with looming peaks and deep gorges. The majestic snow-capped Annapurna massif is one of the world's most spectacular amphitheatres and also a perpetual water tower. The Annapurna region is a unique amalgamation of ecological, cultural and economic diversity. Perpetual water sources have further enriched the region and they play a vital role in the life-support system of the resource-scarce mountain environment.

Harnessing usable water has always been a constraint, mainly because of the spread-out nature of settlements, a reality enforced by the steep mountain terrain. The mountains themselves may constitute a perpetual source of the water resource base that supports a large population in the lowlands, but usable water is a scarce commodity in the mountains.

With the financial support of the Ford Foundation, the KMTNC/ACAP implemented this project with a view to improving the capacity of locals to manage water resources properly. The locals benefited from the project immensely by way of improving the management of micro-hydro plants in the remote areas that are community owned and operated. A series of action researches were conducted by the project prior to intervention. Similarly, intervention was also undertaken to enhance the decision-making capacity of women, the major users of water, who are often marginalised by centrally planned water use projects.

Likewise, another intervention was rehabilitating drinking water schemes through social mobilisation. A thorough study of local conditions was done prior to undertaking community rehabilitation works. Research was also conducted to assess the management of water mills in order to identify areas for improving the efficiency of a technology in use in Nepal for centuries. KMTNC/ACAP has been improving traditional water mills by replacing wooden parts and retrofitting them with modern metal parts. In the same manner, action research was also carried out to improve the management of Safe Drinking Water Stations, a technology recently introduced to rural Nepal by the KMTNC.

During the three-year project, numerous researchers, both local and international, consultants and volunteers collaborated in the field with the KMTNC staff. Such collaboration led to a synergy that enhanced the understanding of the dynamics of resource management, and helped identify areas that required attention. This was because of the different perspectives provided by the multi-disciplinary approach, which also provided a unique opportunity to improve the research capacity of those involved.

Even with the end of the Water Resources Use Project, the KMTNC/ACAP is continuing to work in this sector since it has gathered and developed substantial experience and expertise. In addition, the KMTNC/ACAP has also developed a database for this sector and linked it with the GIS system to assist in working out an overall long-term plan for the management of the ACA till the year 2012. Another remarkable outcome of this project is the establishment of the Energy and Climate Change Unit (ECCU), a new thematic area that KMTNC and ACAP will be working on in the future. The new unit will be looking at climate change from the perspectives of both mitigation (in the global context) and adaptation (at the local level) in the mountain areas since mountains and their water resources are the most vulnerable to the effects of climate change.

This collection of 10 papers adds

to the existing knowledge by sharing experiences towards sustainable utilisation and management of water. The first introduces the KMTNC, highlighting brief its evolution and process of consolidation. This is followed by a paper that provides an overview of ACAP, its programmatic areas and management strategy. The third chapter deals with the documentation of water use policies and practices in the ACA. It highlights current water use practices and government and ACAP policies. The fourth presents experiences from ACAP to deal with the processes and costs involved in commissioning MHPs. The next chapter is also about MHPs and discusses some of the managerial issues faced by MHPs in Nepal, and using the case studies of the Sikles and Chhomrong MHPs, recommendations are made for both ACAP and the local community to improve the overall management performance of community-owned and -operated MHPs.

The sixth chapter is a synopsis of the government's latest policy for promoting rural electrification by mobilising local communities. This policy's assumptions, opportunity and implication for MHPs are discussed. Chapter Seven is a documentation of ACAP's Safe Drinking Water Project, which uses the ozonation process for water treatment, a recent introduction that is also owned and operated by the community. The following chapter discusses the Clean Energy Technology, taking examples from improved traditional mills and safe drinking water stations, both technologies widely disseminated throughout the ACA. Chapter Nine assesses the role of women in water resources use, detailing the results of a survey which generated numerous interesting results and which otherwise may have gone largely unnoticed. The tenth chapter deals with the paradox of an arid region like Upper Mustang; aridity is a constraining factor for the overall socio-economic development of the region but it is this climatic condition that has preserved the region's biodiversity, which has global significance, including some that are endangered.

This publication will hopefully add value to the development of water knowledge in this region and ultimately assist in enhancing the livelihood conditions of the local communities and lead to better management and conservation of water resources. This book can prove helpful while replicating the best practices mentioned in the papers. It will also fill in some of the gaps in information found in the water use sector.

KMTNC's Evolution and the Process of Consolidation in the Field of Nature Conservation in Nepal

Bhaskar Singh Karky

Institutional Background

The King Mahendra Trust for Nature Conservation (KMTNC) was established in 1982 through Legislative Act exclusively to contribute towards the country's efforts in the conservation of natural resources, biodiversity and cultural heritage. This national level non-government organisation has the honour of receiving the august patronage of His Majesty King Gyanendra Bir Bikram Shah Dev and the guidance of His Royal Highness Crown Prince Paras Bir Bikram Shah Dev in his capacity as its Chairman. KMTNC was set up with the belief that nature conservation cannot be sustainable unless the motivation, goals and welfare of the local communities are first taken into account. Based on this guiding principle, KMTNC's conservation activities put the benefit on the local communities and their surrounding environment above everything else.

At present, KMTNC has five ongoing projects in Nepal, which encompass areas from the subtropical Tarai region bordering India up to the temperate-alpine regions of the Himalaya and beyond to the semi-arid trans-Himalayan region bordering the Tibetan plateau. The activities of KMTNC cover biodiversity and natural resource conservation as well as management, research and training of local communities to help them enhance their capacity for sustainable resource management and community development. It is also engaged in cultural heritage conservation and restoration work in areas with a significantly important heritage and culture such as Lo Manthang in upper Mustang.

KMTNC's Evolution

With over two decades of experiences and lessons learnt, KMTNC has evolved as one of Nepal's leading organisations in the area of environment, biodiversity and heritage conservation, while internationally, it has become an icon for showcase Integrated Conservation and Development Projects (ICDPs) since it was KMTNC that first implemented the ICDP paradigm, something that has been replicated in many parts of the world.

The ICDP approach was first implemented in Ghandruk in 1986 as part of a thousand-square-mile experiment called the Annapurna Conservation Area Project (ACAP). It was based on a revolutionary idea that fees paid by trekkers would be ploughed back for conservation and development to ultimately benefit the local communities. ACAP, which has now expanded to a landscape level project around the Annapurna range of the Himalaya, covering an area of 7,629 km^2 that encompasses 56 village development committees (VDCs), was a grand experiment in building the capacity of locals to empower themselves to initiate and make their own collective decisions—decisions that balance short-term benefits against long-term gains.

The Annapurna region has always drawn large numbers of trekking tourists, and in the years prior to 1986, the negative impacts of the growing tourist population were already clear. Deforestation and the subsequent loss of wildlife habitat as well as pollution from garbage and sewage were evident throughout the trekking trails. With ACAP's intervention, a holistic package was designed so that the region's carrying capacity of tourists would increase even as it enabled the community members to benefit from the trickle-down effect of tourism revenue, while pressure on forests would be reduced with the introduction of alternative energy programmes, and thus, preserve wildlife habitat. Today, the Annapurna region receives over 60 per cent of all trekkers in Nepal, but its natural heritage has remained intact.

Among the activities initiated for its success, ACAP formed Conservation Area Management Committees (CAMCs)—a local body in each VDC to coordinate conservation and development activities by the locals themselves with technical support from the project—at the grassroots level. And to ensure people's participation, ACAP raised the awareness level of the local communities by stressing the importance of biodiversity conservation. The project has run environmental studies programmes in secondary schools throughout the Annapurna Conservation Area (ACA) in order to mould the next generation as champions of conservation.

By 1993, ACAP was running seven Unit Conservation Offices throughout the Conservation Area, including on in the controlled-tourism area of the upper Mustang region which was brought under ACAP in 1992. Following this, in 1996, Conservation Area Management Regulation was notified in the Gazette by His Majesty's Government of Nepal. ACAP is currently involved in implementing the Upper Mustang Biodiversity Conservation Project (UMBCP) which aims to link biodiversity and cultural heritage conservation with tourism management.

Consolidation Process

The experiences from the successful intervention through ACAP did not remain confined to the Annapurna area but were applied further in the Tarai. In 1989, KMTNC established the Nepal Conservation Research and Training Centre (NCTRC) just outside the Royal Chitwan National Park (RCNP). After the RCNP was declared a National Park in 1973, the Smithsonian Institute of USA launched the Tiger Project the same year with the sole purpose of conserving the tiger—the flagship species in the park. This project was later renamed the Nepal Tarai Ecology Project in 1984 to further broaden its research to encompass the study of grassland ecology and included the conservation of rhinos and their habitat. The NCTRC was established after the Smithsonian Institute handed over the Project to KMTNC in 1989. NCRTC has since been developed as a national level training centre to provide a diverse range of training with a view to enhancing the managerial capacity of people involved in protected area management of the country. Drawing from the ACAP experience, NCTRC also introduced the twin objectives of providing alternative resources and promoting local guardianship of endangered species and their habitat for the communities living in the buffer zone area adjacent to the national park.

The successful conservation efforts, both inside and outside the park, resulted in qualitative and quantitative changes in vegetation, wildlife population and people's attitudes. But increase in the wildlife population also brought a host of related issues such as crop and livestock depredation. This subsequently caused a conflict between the park and the people which posed a threat to the sustainability of the conservation efforts. To mitigate such conflicts, NCRTC added community development to its roster of activities in 1993.

NCRTC is helping local communities build their capacity to manage resources. Forested areas which were severely degraded prior to the late 1980s have been regenerated and converted again to forests for local use and serve as an extension for wildlife habitat. Foreign visitors now pay the local communities to enter the community-managed forests such as the Baghmara Community Forest to view wildlife. NCRTC has also been playing an instrumental role in the translocation of rhinos since 1986 from the RCNP to the Royal Bardia National Park (RBNP).

With the addition of community development activities, NCRTC was renamed the Biodiversity Conservation Centre (BCC) in 2001 with the mandate to carry out conservation of the overall biodiversity in the region. Currently, BCC is implementing the Tiger Rhino Conservation Project (TRCP) as a pilot project for the first corridor conservation project of the country, linking the Siwalik range with the foot-hills of the Mahabharata range through the Barandabhar corridor. This corridor is a prime habitat for large animals such as the greater one-horned rhinoceroses and tigers, and also includes wetland ecosystems important for migratory birds.

In 1994, the Bardia Conservation Programme (BCP) was launched with activities focusing on research and community development based on the experience learnt in Chitwan. Although KMTNC had been involved in a number of conservation activities in Bardia since the first rhinos were translocated in 1986, BCP emerged from a satellite programme for monitoring the translocated rhinos and ultimately developed into a full-fledged project. BCP has been involved in the buffer zone area of the Royal Bardia National Park (RBNP), working with communities to mitigate park-people conflicts. It has also recently taken up scientific studies on prey and predators in RBNP and is also experimenting with electric fencing technology in high impact areas for the first time in the country. In 2003, KMTNC extended conservation activities to the Royal Shukla Phanta Wildlife Reserve (RSPWR) under the supervision of BCP.

Given its substantial institutional capacity and human resources in wildlife management, the Ministry of Forest and Soil Conservation (MOFSC) entrusted KMTNC with the management of the Central Zoo (CZ) in Kathmandu in 1996. Since then, the CZ has undergone a tremendous facelift and management restructuring. As the only zoo in the country, KMTNC has been working to establish it as a learning centre with a wide outreach for school-going children. The primary focus areas for the zoo are conservation and wildlife education, physical improvement of the zoo infrastructure and animal health management. It has also added a variety of species to the zoo's collection.

In 1997, KMTNC started field operations in the Manaslu region with the concept of replicating the ACAP model for conservation and development. In 1998, the Manaslu Conservation Area was declared and the government handed over its management to KMTNC. Subsequently, this project was named the Manaslu Conservation Area Project (MCAP). The major thrust area of MCAP is the Manaslu Eco-tourism Development Project. This project draws on the lessons learnt from past KMTNC projects, primarily from ACAP since there are many ecological and cultural similarities between the two regions. However, given the current downward spiral in tourism numbers, revenue plough-back and other activities that would have otherwise catered to the demands of the local environment and the population have been limited for now.

KMTNC is now taking its

conservation activities a step further by establishing linkages with communities beyond its borders to work together for the conservation of the global environment. In response to the growing global concern about climate change, KMTNC established an Energy and Climate Change Unit (ECCU) in 2003, linking energy, climate change and forests to develop projects on climate change measures with the involvement of local communities. This initiative has come as a follow up of the Bishkek Global Mountain Summit 2002, illustrating KMTNC's commitment to the protection of mountain environments. ECCU is expected to develop project activities in areas such as carbon sequestration in community forests, renewable energy, fossil fuel switching and household alternate/minimising technologies for fuelwood. In addition, it is also expected to anchor the vulnerability and adaptation assessment of climate change in Nepal with regard to local communities, forest and water resources, glacial lakes and biodiversity. Earlier, KMTNC activities focused solely on conservation and were limited to non-climate purposes. The new ECCU, in principle, proposes multiple benefits. At the local level, it will assist in enhancing the living conditions of the rural communities and their surrounding environment, including wildlife habitat for biodiversity conservation, and at the global level, it will be beneficial to the world climate in a number of ways.

Conclusion

KMTNC's endeavours across the different ecological regions of Nepal have brought about positive changes in regions that are home to many significant animals such as tigers, rhinos, snow leopards and lynxes. The institution has developed and produced qualitative and quantitative human resources with expertise in the kingdom's natural resources and biodiversity conservation fields. KMTNC's successful intervention processes have evolved over time and can be mainly attributed to two factors. First, local ownership of project activities, coupled with continuity and engagement in different regions with local communities over a long period has made the organisation a trusted 'household brand'. Secondly, its resilient project modality with the capacity to change, adopt and nurture the dynamics of environment and socio-economic perturbations/evolution has enabled KMTNC to cater to the diverse needs and demands of the local environment and its population.

In keeping with the dynamics of conservation, KMTNC is now moving ahead in gaining experience and expertise at a larger level. It has also added value to its existing conservation work by setting up an ECCU base to collaborate with partner agencies to link energy, climate change and forests, and to further complement the conservation work carried out by KMTNC in

Nepal. Being predominantly focused on conservation, KMTNC is expanding to develop an expertise in the field of climate change in order to meet the new challenges posed by national conservation and environmental issues in the new millennium.

An Overview of the Annapurna Conservation Area Project (ACAP)

Gehendra Bahadur Gurung

Sikles village in Annapurna Conservation Area

Introduction

Established in 1986, the Annapurna Conservation Area Project (ACAP) is the largest project of the King Mahendra Trust for Nature Conservation (KMTNC). ACAP was begun as a new approach to protected area management, with the underlying principle being the strengthening of linkages between ethics and the environment by taking local communities as both principal actors and beneficiaries of the conservation undertakings. Unlike the conventional protected area management approach where people are viewed as the undermining agents of environmental degradation, ACAP considers local people as the masters of environment conservation.

Annapurna Conservation Area

The Annapurna Conservation Area (ACA) is located in the north central part of Nepal. The ACA covers an area of 7,629 sq km. It is a land of extreme diversity, with altitudes ranging from about 1,000 to over 8,000 metres above sea level within a horizontal distance of less than 35 km. The result is a steep relief that has produced sudden changes in climate, vegetation and geo-ecology. The southern part of ACA is humid and warm with a subtropical climate, while the northern sector is cold and semi-arid.

The ACA is home to an extremely diverse range of flora and fauna in a variety of interrelated ecosystems from subtropical to alpine grasslands. The ACA harbours a recorded total of 1,226 species of plants, 38 species of orchids, 9 species of rhododendrons, 101 species of mammals, 474 species of birds, 39 species of reptiles and 22 species of amphibians.

A variety of population groups such as the Gurung, Thakali, Manange, Bhotia, ethnic Tibetan, Magar, Tamang, Bahun, Chhetri, Kami, Damai and Sarki inhabit the region. These groups follow Hinduism, Buddhism or Shamanism.

The primary source of livelihood of the people in the area is agriculture while raising livestock is a secondary occupation. The major crops grown are rice, maize, millet, wheat, potato, barley and buckwheat and livestock species include buffalo, cattle, sheep, goat, yak, horse and chicken. The main external cash income source for the people in the southern sector is military service, either in the British or the Indian army. On the other hand, in the northern sector, the main source of income is business. In recent years, tourism has become a good source of cash income for the people in the ACA. Also equally important in the last few years for source of cash income has been migrant labour jobs in the Gulf countries, Korea, Hong Kong and other parts of the world.

For centuries, people in the ACA have lived off the scarce natural resources by utilising their indigenous knowledge and practices. Problems of imbalance between ecology and economy are only a recent phenomenon. The problem intensified when the region was opened to international tourists whose entry in large numbers affected the local economy and resource utilisation. As a result, a vicious cycle of economic inflation and deterioration in tradition, culture and environment became evident. It was against this background that the KMTNC implemented the ACAP at the request of the Nepali government to achieve a balance between socio-economic development and resources conservation of the area in a sustainable manner.

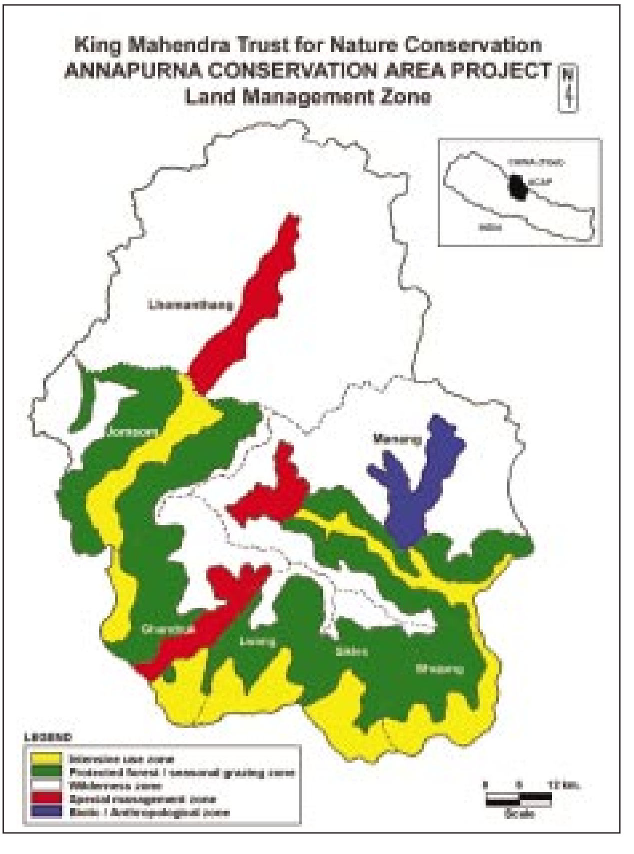
Management with Multiple Land Use Zones

ACAP recognises that natural resources within the ACA are at various levels of human impacts. Based on this fact, land use has been categorised into different zones. These zones satisfy different human and natural needs, which require different levels of conservation interventions. The land use zones are also interdependent on each other. The status of resources in one zone affects the resources in other zones. Thus, ACAP has adopted a multiple land use management approach that has adopted a holistic conservation of all the zones.

Wilderness zone:
This is the area above the current upper elevation limits of seasonal grazing, roughly above 15,000 ft (approximately 4,600 m asl). The resources include high mountains, glaciers, rocks and pastures that have not been grazed or which have been abandoned for more than a decade. Management implications include full protection of the area with no provision for developmental activities.

Protected forest/Seasonal grazing zone:
This zone lies below the wilderness and just above the intensive use zones where villagers cannot go for one-day round-trip collection of fodder and fuelwood collection because of the distance. However, they use this zone seasonally for livestock grazing and timber collection for home use. The resources include alpine grazing pastures, pine forests and mixed broad-leaf temperate forests. The management focus is to restrict the use of the resources and allow only the local people to make use of the resources from this zone according to their traditional practices.

Intensive-use zone:
This zone generally comprises of human settlements which have seen a great impact on resources. Human



activities are intensive due to agriculture, livestock, and collection of fodder and fuelwood. Management implications include high and integrated interventions of plantation; improvement of natural forest management practices; restrictions on hunting; termination of commercial use of local resources; conservation education; and identification of alternative resources and income generation activities.

Special management zone: This zone includes selected and isolated areas that have been suffering acute environmental problems brought about directly or indirectly by tourism in the last three decades. These areas include Ghorepani-Chhomrong-Annapurna Sanctuary, Thorong Phendi, Tilicho Lake, Chame and Upper Mustang areas. This is a high priority zone in terms of conservation which takes the form of intensive monitoring of all aspects of environment and tourism, including a full spectrum of management and development efforts directed towards reversing the present trend.

Biotic/Anthropological zone:

This zone includes the natural areas which has not been significantly disturbed by modern technology and people or the intrusion of which has been absorbed by the traditional life of the inhabitants. Nar-Phoo valley of Manang district falls within this zone. The management implication for this zone is to implement integrated conservation area management programmes and activities.

Goals and Objectives of ACAP

The mission statement of the KMTNC directs ACAP. Under the framework of the mission statement the following are the goals and objectives of ACAP:

Goal

Achieve and sustain a balance between biodiversity conservation and socio-economic development of the Annapurna Conservation Area through community participation.

Objectives

- Mobilise the local communities for biodiversity conservation and socio-economic development,
- Help improve the socio-economic condition of local communities,
- Conserve biodiversity of the area, and
- Manage tourism for its maximum positive and minimum negative impacts on biodiversity conservation and socio-economic development of the area.

Guiding Principles of ACAP

ACAP has adopted the following principles to guide it towards achieving the KMTNC/ACAP goals. These include: 1) people's participation; 2) catalytic role of ACAP; and 3) sustainability of the programmes. These principles are prerequisites for ACAP-assisted projects.

People's participation:
Conservation necessitates accumulated knowledge of the local environment—something that local people have. Conservation is meant for human welfare with the local people as the primary beneficiaries. To ensure better success of conservation programmes, they must participate in it fully. In ACAP, locals are involved in the whole project cycle, from planning to evaluation.

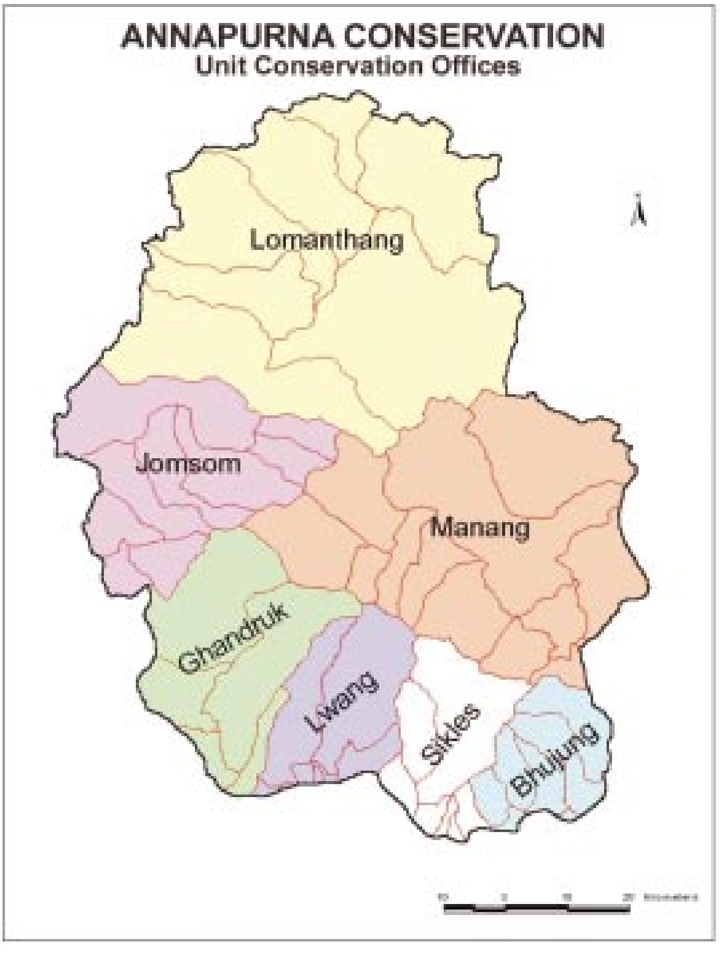
Catalytic role of ACAP:
While implementing conservation activities, local resources are not always adequate. And, traditional resource management practices alone can no longer effectively conserve these resources; some re-strengthening is required. Local people need new technologies to improve their managerial capabilities and financial support to invest for the future through conservation. But their access to such resources is limited, and that is where ACAP fills the gap between needs and unavailability of resources.

Sustainability of programmes:
Experience has shown that many externally assisted projects discontinue once the donors withdraw their support and the status of development and conservation reverts back to pre-project condition. ACAP emphasises the sustainability of projects by empowering the local people financially, technically and legally, and by improving their managerial capability through intensive trainings. ACAP prioritises projects that are considered within the managing capacities of local communities but without trying to discourage larger projects. The communities are encouraged to take up greater responsibilities with the ultimate aim that projects run successfully even after ACAP withdraws.

Unit Conservation Offices of ACAP

ACAP's activities are extended over an extremely diverse biophysical and socio-economic environment. To ensure a smooth implementation and monitoring of the programmes and activities, the ACA has been divided into seven Unit Conservation Offices, namely, 1) Ghandruk, 2) Lwang, 3) Sikles, 4) Bhujung, 5) Manang, 6) Jomsom, and 7) Lomanthang. The project headquarters is based in Pokhara, and it provides the technical and logistical support needed by the field stations. Each sector implements ACAP's core programmes independently.

Integrated conservation and development are the hallmark of ACAP and these two aspects complement and supplement each other. ACAP focuses on conservation of natural and cultural heritage as well socio-economic development of the conservation area. The area of priority regarding conservation and development varies from station to station, depending on the biophysical and socio-economic characteristics



of the sites. However, natural resources, mainly flora and fauna threatened by human activities, receive the highest priority at all stations. Cultural heritage conservation has been emphasised in the Lomanthang sector where medieval Tibetan Buddhism practices still survive. Socio-economic development through better tourism management is the focus in Ghandruk, Jomsom, Lomanthang and Manang sectors, while improvement of traditional agricultural practices are emphasised in the other sectors.

Mobilising communities

ACAP's programmes and activities are formulated and implemented with the active participation of the local people. ACAP encourages the incorporation of indigenous practices and knowledge into its management strategies and policies for resources conservation and socio-economic development. Conservation Area Management Committees (CAMCs) are formed at village development committee (VDC) level to look after the conservation and development programmes and activities within its boundaries. The committees formulate and implement conservation and development policies and strategies. The role of ACAP is limited to providing technical inputs if deemed necessary and endorsing the policies and strategies formed by the committees before implementation. The CAMCs may form different sub-CAMCs to monitor large areas or projects.

There are 55 CAMCs in the ACA with one in each VDC of the area. However, all the CAMCs are not equally strong in planning, implementing and managing projects since some have been working at conservation for more than 15 years while others have been set up more recently. Also, since conservation is a technical activity, the committees often seek support from ACAP. There is a need to explore the possibility of providing sustainable technical support to the CAMCs by building a pool of local technicians who will be responsible for assisting the CAMCs.

Awareness, training and education are very crucial factors that need to be considered while mobilising communities for conservation and development. ACAP executes a wide range of conservation education and extension activities. Among the major educational activities ACAP is involved in for community mobilisation are school education, mobile camps, street theatres, adult literacy, special days, fairs, etc.

Conserving the Biodiversity of the ACA

The ACA is the meeting point of the eastern and western Himalaya and is therefore enriched by the biodiversity from both sides. The large of number of species endemic to the area is a result of physiological and climatic diversity of ACA. As mentioned above, the lowlands of the southern ACA consists of subtropical broadleaf evergreen vegetation, which is gradually replaced by temperate deciduous forest that has some of the oldest rhododendron forests in the world. Pine, fir and then birch gradually dominate in the higher regions before vegetation ends in high alpine grasslands. ACA harbours a number of endangered species of both national and global significance.

The primary objective of ACAP is to conserve the natural and cultural resources of the ACA. Natural conservation activities include management of natural forest, tree seedling production and plantation and alternative energy activities. Wildlife conservation is also a part of wildlife habitat protection and a great deal of attention is given to soil and water conservation as well.

The easy access to seedlings and saplings raised in the field nurseries motivates villagers to carry out plantation and hasten re-forestation. The project nurseries also serve as demonstration and training sites for the villagers. These nurseries, which are supported by ACAP, be owned by the project, the community or by private individuals.

Project-owned nurseries are solely run by ACAP's resources. All expenses are borne by the project itself. Seedlings are distributed free of cost to both communities and individuals, with priority given to community plantations. On the other hand, in project-supported community nurseries, the community manages daily nursery activities. They generally hire a nursery in charge, whose nominal salary is determined by the community and paid by ACAP. ACAP also supports the community in terms of technical input and by providing material that is not locally available. The primary benefit to villagers from these community nurseries is that they get the seedlings free of cost whereas people from elsewhere have to pay.

Under the technical supervision of ACAP, private nurseries produce seedlings and sell them to individuals, communities and the project. The nursery owner has to contribute land and labour for the management of the nursery, while ACAP may provide locally unavailable materials and technical support.

The impact of ACAP on forest conservation has already been observed. Forest cover in some of the watersheds within the ACA, which had decreased by 10.7 per cent between 1960 and 1978, went up by 15.4 per cent between 1978 and 1999 (Poudel, 2001).

Another conservation programme, the Alternative Energy Programme, has been initiated to help reduce the pressure on forests caused by fuelwood extraction. Diverse activities have been designed for this programme to either replace the fuelwood or minimise its consumption, including the promotion of improved cook-stoves, back-boilers, smoke water-heaters, solar water heaters and micro-hydro electricity, and the opening of kerosene depots, promotion of bio-briquettes, photovoltaic technology, biogas plants, and so on.

Apart from micro-hydro and kerosene depots, which only community groups can operate, all promotion activities can be targeted either to individual households or community groups. At the community level, the communities have to contribute for locally available materials and unskilled labour and are also required to take over the management after the completion of the project. ACAP provides them with technical support, skilled labour and expenses for materials that need to be purchased. At the individual household level, the participating households have to contribute the material cost, and ACAP's support is limited only to transportation and paying for skilled labour.

The promotion of alternative energy has helped reduce the use of firewood considerably. A survey in the ACA showed that approximately in 2001, only 50 per cent of the hotels reported fuelwood as their main source of energy compared to 77 per cent in 1996, indicating that the number of hotels using firewood has gone down (Ryan and Gurung 2001). Firewood has been replaced by the different alternative energy sources and devices mentioned earlier.

ACAP is also helping communities in the conservation of cultural heritage of the ACA. The Annapurna Conservation Area is home to more than 10 ethnic groups and has a number of holy sites common to both Hindus and Buddhists. ACA is also a civilisation centre for Gurungs and Thakalis. The oldest Gurung settlement of Gol Somdhun in Namarjung VDC also lies within the ACA. The Thakali traditional historical artefacts Chokho Pani of Tukuche VDC are displayed in Mustang Museum in Jomsom managed by ACAP. Among ACAP's conservation efforts are restoration of monasteries and cultural practices. The communities are supported with technical knowhow, skills and funds for materials that need to be purchased.

Improving Socio-economic Conditions

Socio-economic status and resource conservation are directly related. Unaware and economically poor people may depend heavily on natural resources. ACAP has been putting considerable effort to uplift the socio-economic conditions of the people with the ACA since its inception.

The socio-economic development activities of ACAP consist basically of income generation and infrastructure development. The project has been successful in introducing micro-finance institutions aimed at reducing poverty. Micro-finance schemes were first initiated in Bhujung, and in 2001, micro-finance institutions were established in the Upper Mustang region. This project provided the people of Upper Mustang with a formal financial service mechanism in an area where the nearest bank is more than three days' walk away. ACAP has also been involved in integrated agriculture development, agroforestry development and construction of trails, bridges, school buildings, health posts, etc, in order to help support the socio-economic development of the area.

The majority of the people in the ACA depend on farming. Farming, however, is still subsistence-based and heavily dependent on natural resources for its sustainability. The agroforestry and integrated agriculture development focuses on developing agriculture as a means to conserve resources as well as generate income for the farming community. In addition to horticulture and cereal crops, cash crops like tea, broom grass and cardamom are being promoted.

Another characteristic of the agriculture development in the ACA is to promote organic agriculture. Chemical fertilisers, insecticides and fungicides are not promoted by ACAP. Farmers are encouraged to make use of traditional knowledge of making compost out of farm waste. Locals are also trained in compost-making from various plant materials. Indigenous knowhow on the control of plant diseases and harmful insects is explored, and knowledge of successful experiments disseminated among farmers.

Managing Tourism in the ACA

The Annapurna area is the most popular trekking destination in Nepal. In the year 2000, over 70,000 tourists visited the area. Tourism, however, has had diverse impacts on the local environment, economy and society, whether directly or indirectly.

S.N.	Facility	1996	2001
1	Soak pit	34%	42%
2	Toilet with septic tanks	64%	72%
3	Access to waste disposal site	6%	20%

Tourism infrastructure improvements in the ACA

One of the objectives of ACAP is to manage tourism in the ACA to ensure minimum negative impacts as well as maximum positive impacts. ACAP is making local people aware of the impacts of tourism through different educational activities such as Tourism Awareness Camps, Sign Posting, Clean-up Camps, Mobile Camps and Special Days related to tourism.

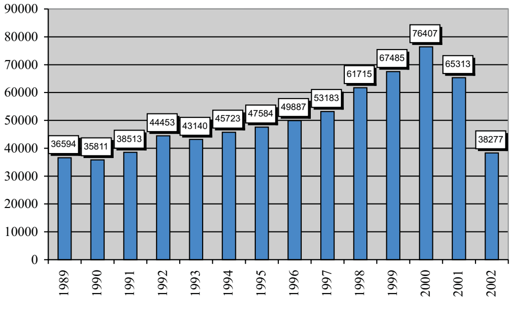
Managing tourism also includes infrastructure development. Improvement of trails and bridges, re-location of lodges, hotels, teashops, etc, and waste management are all part of tourism management activities. Tourism Management Sub-committees (TMSCs) are formed under CAMCs to propose and implement programmes and activities within their respective areas. TMSCs collect solid waste at collection centres and separated. Reusable and recyclable waste is transported for reuse and recycling, while the remaining waste is disposed through incineration or burial. A study on tourism-related impacts (Ryan and Gurung, 2001) revealed that waste management in the ACA has actually improved (see following table). This indicates that tourism has induced villagers towards cleanliness. As the chairperson of the Ghandruk VDC said, 'The change is due to awareness that the villages should be kept clean if more tourists are to be attracted.' (Pradhan, 2001)

Within the ACA, there are three tourism management zones from the perspective of government policy. Upper Mustang, a restricted zone in which only special permit holders are allowed, was opened for tourists in January 1992. These special trekking permits are issued to only 1000 trekkers a year and the fee collected by the government is US$ 700 for the first 10 days per person and thereafter US$ 70 per person per day. The trekking groups are required to be self-sufficient in terms of equipment and other necessities and are required to be accompanied by a trekking agency and an environmental officer. However, the area still has only rudimentary tourism facilities and ACAP has been working to improve the facilities and increase the carrying capacity of the area so that the number of trekkers can be increased and they can travel without carrying basic things like food, tents, etc. There may also be no need for an environmental officer once the local communities become aware of the importance of conserving their culture and environment.

Nar and Phoo area in Manang district within the ACA is another special area that was opened in 2002. Trekkers have to pay US$ 90 per week during the autumn season and US$ 75 per week during winter, spring and summer. Here, too, the trekking groups are required to be self-sufficient and be accompanied by a trekking agency and an environmental officer.

The rest of the ACA is the general trekking area, where trekkers can go in as they please, with or without trekking gear, since teashops and lodges can be found everywhere. All foreign trekkers to ACA, including those going to Upper Mustang, Nar and Phoo areas, however, have to pay a Conservation Area Entry Fee of Rs 2,000 (Rs 200 for nationals of SAARC countries). This fee is collected by ACAP and is used for the integrated conservation and development of the ACA.

Figure1. Number of tourists in the Annapurna Conseration Area



Sources: ACAP, 2001

Conclusion

ACAP, the largest protected area and the first conservation area of Nepal has been managed with a new approach to protected area management. Community participation has now been reflected in the national policy of protected area management and the ACAP experience has gradually been replicated in other protected areas as well.

In addition to biodiversity conservation programmes, ACAP has incorporated socio-economic development as an integral part of its conservation efforts. This means that conservation is a dynamic process and cannot be executed without socio-economic development. Conservation and development are two sides of a coin that complement each other. Similarly, tourism management plays the most vital role in supporting conservation and development of the ACA and that has now become an integral part of the overall conservation and development of the area.

The existence of ACAP in the area for the last 17 years has been instrumental in preserving the biodiversity of the area. The project has played an important role at a critical time when the environment was undergoing rapid deterioration. ACAP has also played a key role in improving the basic facilities required by the people in the area to enhance their livelihoods. With these experiences behind it, ACAP now hopes to further strengthen the capacity of the local communities in their conservation and development efforts.

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Water Resources Usage Practices and Policies in the Annapurna Conservation Area

Gehendra Bahadur Gurung, Benktesh Das Sharma, Lok Prasad Bhattarai

Introduction

The Annapurna Conservation Area (ACA) has been endowed with an abundant wealth of water. Besides the everyday uses of water such as drinking, cooking and cleaning, water is also important to sustain the livelihood of people, for instance, in farming and livestock rearing. There are other uses of water as well, primary among them are rotating turbines for mills and power generation. The recent intervention of KMTNC's Annapurna Conservation Area Project (ACAP) with regard to water resources has made people aware and able to use water resources for lighting their houses, for cooking and for operating small machineries. Natural water sources have also been used in ACA for income generation and for providing trekkers and locals with ozonated drinking water under the Safe Drinking Water Project. The local people are thus using water resources in every possible way and possibilities exist for their socio-economic upliftment with the advanced technologies promoted by ACAP in the water resources sector.

This paper gives an overview of the policy adopted by ACAP for the use of water resources. It outlines HMG/N's policy related to water use in order to explain the consistency between policies of ACAP and HMG/N, wherever applicable. It also gives firsthand information on how ACAP has intervened and implemented various programmes related to water resource use for conservation and development in the ACA.

HMG/Nepal's Policy on Water Resources in Nepal

In Nepal, there is no single consolidated 'water resource policy' in existence although various sectoral water use policies are reflected in several legislations and regulations related to irrigation, hydropower and drinking water. These policies are revised and amended from time to time as per the needs and requirements and upon availability of a scientific basis. Based on the experiences gained in various sectors a Water Resource Strategy (WRS) of Nepal was formulated in 2001, in which some of the basic policy principles of water sector development are as follows:

- The overall water sector development and management policy will be guided by an integrated water resource management model;
- Delivery of water services shall be decentralised;
- Economic efficiency, social equity and environmental sustainability will be the prerequisite for the development of water resources;
- Participation of stakeholders;
- Riparian concerns;
- Resource conservation and environmental protection; and
- Adoption of new technologies and institution.

The WRS has envisaged different sets of priorities for economic, social and environmental aspects, hoping to make policy principles work at the implementation level as well. In terms of social aspects, improvement of health and living condition and long-term food security has been envisaged as the most important prerequisite for the development of the water sector. The WRS is also expected to contribute to balanced development in terms of gender, regional distribution of the output of development and integration with the overall social development.

The economic principle of water sector development stipulates that irrigation development should support food production whereas the hydropower should satisfy domestic power needs and promote micro-enterprises. Likewise, development of drinking water should support the economy of the rural poor by saving the time of women and children who would otherwise have been involved in fetching water from long distances. It also states that the cost of pollution should be borne by the polluter.

Environmental principles dictate that environmental and ecological considerations should be integrated at every level of project planning and implementation. The water sector development project should also focus on maintaining water quality and quantity apart from illustrating plans to pay for the total cost of environmental damages, if any.

The Water Resources Act 1992 is the sole regulatory authority in water resources with a legislative base. It guarantees the legal status of water users' associations (WUA) and envisages the WUA as a basic social organisation with regard to water utilisation. It also asserts the authority to award any licence regarding water utilisation at the district level to the District Water Resources Committee presided by the Chief District Officer. Other members of this committee are mainly representatives from various government offices at the district level. Thus, technical and administrative staff are represented in this committee whereas it has been mandated to take decisions on the utilisation of water resources that are political in nature.

The Electricity Act 1992 is yet another legislation related to water resources. This Act provides for a regulatory structure and processes for the study, production and development of hydroelectricity and extension of its services as well as royalty, taxation and measures to be adopted for the conservation of the environment.

Practices and Policy of Water Resource Use within Annapurna Conservation Area

ACAP currently has five programmes underway that are related to water resources—drinking water, micro-hydro, safe drinking water, irrigation and water mills—and different practices have been adopted in each of these areas to be consistent with the policy framework of the Nepali government. The overall objective of ACAP's policy on water resource use is to promote socio-economic development and biodiversity conservation within the ACA, and which translates as follows in specific terms:

- To support economic development;
- To support social development;
- To support biodiversity conservation in wetland and aquatic ecosystems;
- To manage water pollution and water-induced problems; and
- To improve community participation in management, conservation and the efficient use of water through the use of improved technologies.

The policy on the usage of water resources within ACA follows the Conservation Area Management Regulations (CAMR) of 1996. This policy is guided by the principle of building on the traditional skills, knowledge and systems of the communities. All activities related to water resource usage and management involve the contribution of local people both as unskilled labourers and as suppliers of local materials, while ACAP contributes technical know-how and any external equipment and supplies that may be required. In this way, the policy serves to liaise between the benefit of community and biodiversity conservation.

Policy on Drinking Water Scheme

ACAP's sustainable community development programme is active in formulating policies that aim to provide communities with access to drinking water. The policy objectives are to provide clean drinking water to the community as well as to improve sanitation in the area. In general, ACAP seeks a 50 per cent contribution from the locals in its drinking water schemes and which can be in any form, labour or materials. ACAP provides a subsidy for non-local materials and skilled labour, including the transportation of such material up to the nearest road access. ACAP encourages local bodies to take up the responsibility for local materials, unskilled (local) labourers and transportation of materials from the road to the construction site.

Since ACAP includes a human resources development component, it provides technical and managerial training to the locals so that they can manage the schemes independently. For the sustainability of the drinking water schemes, an endowment fund is created in which ACAP may contribute up to NRs 1,000 per tap stand and, depending on the requirements of the scheme, individual households are also expected to contribute some small amount. The management responsibility is handed over to the sub-committees under the umbrella of CAMC. In providing access to drinking water, ACAP focuses on gravity water sources and the policy is to build on, strengthen and/or revive traditional systems.

In March 1998, HMG/N introduced the Drinking Water Supply Policy and Strategy (DWSPS). This document assumes a full recovery of initial investment and operation and maintenance cost for urban drinking water supply schemes, whereas for rural drinking water supply schemes, only the recovery of the costs associated with operation and maintenance has been sought. This policy is oriented towards the development of drinking water schemes along with health and sanitation programmes which together appear as an expression of government's commitment to provide access to safe drinking water for all people. Likewise, the policy assumes to save the labour of women and children that is otherwise expended in fetching drinking water and use such labour in other more productive areas. The policy also emphasises the reduction of the government's involvement in all stages of project development and encourages the involvement of different CBOs, NGOs, municipalities and the private sector in this area.

The DWSPS outlines the activities of each water resource policy in a clear and substantive manner. It promotes the integration of drinking water schemes in district development plans, which envisaging such a system design to be manageable independently by local communities. The strategy portion of the same document emphasises the utilisation of different modes of technology for collection of water such as gravity flow, shallow and deep handpump (in the tarai), rainwater harvesting and hydrams in the mid-hills.

Policy on Irrigation

ACAP's policy on irrigation is to build on, strengthen and/or revive traditional irrigation systems that focus on gravity sources of water. The policy prioritises irrigation for cash crop production. Community-owned irrigation schemes are also given preference so that the benefit trickles down to a wider population. ACAP provides technical and financial assistance for the repair and maintenance of the existing and small irrigation schemes, with priority given to small landholders.

The Irrigation Policy 1992 of HMG/N is clear that the participation of users is a key issue in irrigation development and emphasises strengthening WUAs and reducing the government's involvement. Towards this end, user groups are given the right to charge a small amount to pay for the operation and management of the irrigation systems. Similarly, it calls for irrigation projects to be demand driven and to seek a substantial level of cost sharing with users. The policy also advocates social justice and equitable gender roles at all stages of developing an irrigation project. Users' associations are encouraged to develop a federation as well. The policy also assumes devolution of power at levels of irrigation governance, from the centre to grassroots agencies, and emphasises coordinated action among programmes working in the irrigation sector and for agricultural development.

Policy on Micro-Hydro

ACAP's alternative energy programme carries out activities aimed at reducing stress on forest resources through wider use of electricity and other alternative energy sources. The focus of the programme is two-fold: promotion of technology that minimises fuelwood consumption and promotion of technology that substitutes fuelwood itself.

Although ACAP also supports the extension of the national grid, it focuses on community-owned micro-hydro schemes of less than 100 kW capacity. It emphasises that micro-hydro plants support micro-enterprise development as well as provide an alternative to wood fuel. Communities are expected to plough back the revenue earned from electricity in the local area itself. ACAP's policy is that at least 15 per cent of the micro-hydro project cost be borne by the local community, and for the remaining 85 per cent, it looks for funds from donors (80%) and meets it through its own internal sources (5%).

The contribution of the community can come in any form, labour, direct financial contribution or any other arrangement. In the past, ACAP provided soft loans to poor communities that could not manage their share of the finances. The loan helped ensure a built-in interest of the people to run the scheme successfully. This provision has since been discontinued and communities are now required to contribute the whole portion of their share.

Ownership of micro-hydros remains with the community, with its management supervised by the Micro-Hydro Management Committee (MHMC). This committee is formed under the umbrella of Conservation Area Management Committee (CAMC), the unit directly responsible for overseeing activities in each sector of the ACA.

The hydropower policy of HMG/N was revised in 2001 with the objective of developing a hydropower system that generated low-cost power. Cheap electricity would thus integrate hydropower development with other economic activities and boost the rural economy by fulfilling the domestic electricity demand both at the household and the industrial level. The policy has also given priority to the private sector's involvement in power development while joint involvement of the public and private sectors has been considered both viable and essential. A provision has also been made to attract the private sector to develop of new hydropower schemes under the scheme of BOOT (build, operation, ownership, transfer). Involvement of communities, local governments and private agencies has been encouraged at all the stages of hydropower development—production, extension and distribution. Above all, the policy emphasises safeguarding the interest of the users at the local level, while remaining concerned about the environment and the need to minimise downstream risk as well.

Attention has been given to the promotion of rural electrification by providing a substantial subsidy package for the development of micro-hydropower schemes in remote areas. Similarly, provisions have been made to provide grants through the Alternative Energy Promotion Centre (AEPC) to any domestic agency that develops a micro-hydro power scheme smaller than 100 kW. Furthermore, micro-hydro schemes smaller than 1 MW need not acquire government permission for study/survey, production, extension or distribution; the only requirement is registration with the District Water Resource Committee (DWRC). Such micro-hydro schemes have the liberty to decide the tariffs on their own and are authorised to expand the service and introduce differential rates for different times of the day, seasons, etc.

Policy on Safe Drinking Water

In order to provide safe drinking water to the thousands of tourists and to the local population, ACAP has introduced ozonated drinking water in the ACA. Beginning with reducing environmental pollution caused by empty water bottles, the policy hopes to ultimately replace bottled water in ACA altogether with ozonated water. The treated water is sold to visitors at a rate which is always lower than the cost of bottled water; locals can buy the water for an even cheaper price. Apart from the objective of promoting better health through safe drinking water and helping create a healthy environment, the ozonated water project is also intended to help mainly Mothers' Groups generate income through the sale of water.

The initial investment for the ozonation plant in terms of equipment and installation is provided by ACAP in collaboration with partner donors on an interest-free loan basis to the community, and the management is given to local community-based organisations (CBOs). Among the CBOs, ACAP gives priority to the Mothers' Group in line with its focus on gender development. Until the full cost of the plant has been paid, it remains the property of ACAP and can be removed if installments are not paid. ACAP may also provide post-installation support as required. The amount paid back is used to instal other plants in the ACA region. ACAP plans to have such plants at half day's walking distance around the Annapurna Circuit trek.

Policy on Water Mills and Sanitation

Traditional water mills (*ghattas*) can be found throughout the settlements of the ACA. It is a form of an important and sustainable technology that contributes to saving the manual drudgery, especially of women, in mountain settlements. *Ghattas* can either be owned privately or by the community. Private water mills are owned and managed by an individual and others are charged for services provided, while community owned mills are either free or a very small amount is levied, generally to recover the running cost. ACAP has a policy to improve the traditional water mills for better efficiency, and sometimes provides financial incentives for this type of improvement. Its priority, however, is community-owned mills wherever possible.

Conclusion

ACAP's policies on the use of water resources are implemented in the field by its various field-level institutions, and coordinated by the related sections at ACAP headquarters. ACAP aims to make efficient use of water resources by way of safe drinking water schemes, irrigation schemes, drinking water schemes, water mills and microhydro management. The judicious use of water has also opened up employment opportunities to the local community, and improved water mills and drinking water schemes have reduced the workload of the community. Access to safe drinking water has helped keep the environment clean by discouraging the use of bottled water by trekkers. Similarly, micro-hydro has been encouraged to provide clean energy and reduce deforestation.

In line with its policy, ACAP has provided several technical and managerial trainings to the communities to enable them to handle the various water resource-related projects efficiently. All these efforts have shown that communities are willing and able to use and manage water resources wisely. All activities in the ACA related to water resources are managed through local-level committees formed under the CAMCs and these committees are very well aware of their roles and rights regarding the use of natural resources. This is the key to sustainable resource management. ▯

Micro-hydro project cycle and project cost based on the KMTNC model in the Annapurna Conservation Area

Deepak Thapa Bhaskar Singh Karky

Introduction

The development of micro-hydropower is one of the major components of the Alternative Energy Programme of KMTNC/ACAP. Ever since the initiation of the first community based micro-hydro project (MHP) in the Annapurna Conservation Area (ACA), the Ghandruk Micro-Hydro Project in 1990, KMTNC has been involved in hydropower development on the micro scale. Eleven micro-hydro projects, with a total power generating capacity of 453 kW, have been installed so far in the ACA.

The KMTNC micro-hydro projects are implemented to address the dual principal philosophies of KMTNC of conservation of natural resources and development of community infrastructure. Like other micro-hydro projects established in other parts of the nation by different agencies, KMTNC's MHPs also fulfill the rural energy demands for lighting, cooking/heating and income generation. But unlike most of the others, KMTNC's MHPs differ in terms of concept, cost involved and application since they are focused on conservation as well.

Table 1 provides a list of MHPs constructed by KMTNC in the ACA. The financial details discussed therein are based on the actual cost at the commissioning of the MHPs.

Implementation process of micro-hydro project

The micro-hydro projects undertaken by KMTNC are purely community-based projects in which the local people are directly involved from the phase of project initiation to its completion, and the communities are given the responsibility for the operation, maintenance and management of the projects. KMTNC provides technical assistance and helps acquire grants for the project from donors. Active participation is sought from the community from the very beginning to ensure their input, contribution (cash or labour) and commitment so that a real sense of ownership is engendered within the community. A typical micro-hydro project supported by the KMTNC normally goes through the following stages.

Project planning

The planning phase involves identifying potential MHP sites while taking into consideration

Table1. **Micro-hydro power projects undertaken by KMTNC in the Annapurna Conservation Area.**

Name of MHP	MHP capacity and commissioning year	Total project cost (NRs)	Cost/kW (NRs)	Location (dictrict/ VDC)	No of households connected	Electricity tariff paid by user
Ghandruk	50 kW (1992)	34,00,000	68,000	Kaski/ Ghandruk	262	HH: Rs.0.50/W/month Lodges: Rs.0.75/W/month Micro-enterprise: Rs.600/month (flat rate)
Sikles	100 kW (1994)	90,52,111	90,521	Kaski/ Parche	537	Rs.0.50/W/month Micro-enterprise: Rs.0.10/W/month
Tangting	27 kW (1996)	31,15,039	115,371	Kaski/ Namarjung	195	Rs.0.50/W/month
Ghalekharka	18 kW (1996)	50,32,893	279,605	Kaski/ Sardikhola	173	Rs.1.00/W/month
Lo-manthang	29 kW (1996)	9,273,871	319,778	Mustang/ Lomanthang	147	<50 W: Rs.1.00/W/month >50 W: Rs.2.00/W/month
Tikhedhunga Phase I	40 kW (1997)	49,77,822	124,445.	Kaski/ Dangsing	102	HH: Rs.0.60/W/month Lodge: Rs.0.90/W/month
Bhujung	64 kW (1999)	10,342,088	161,595	Lamjung/ Bhujung	340	Rs.0.85/W/month
Chhomorong	30 kW (2000)	78,24,873	260,829	Kaski/ Ghandruk	65	HH: Rs.0.45/W/month Lodges: Rs.1.20/W/month
Tikhedhunga Phase II (Ulleri)	40 kW (2000)	54,39,879	135,996	Kaski/ Dangsing	149	HH & lodge: Rs.0.80/W/month Micro-enterprise: Rs.480/month (flat rate)
Thorong Phedi	20 kW (2000)	65,43,413	327,170	Manang/ Thorong	4 Lodges	Rs.0.80/W/month
Landruk	35 kW (2001)	6,541,249	186,892	Kaski/ Lumle	117	Rs.0.75/W/month Micro-enterprise: Rs.500/month (flat rate)

(76 NRs. = 1USD)

Source: Alternative Energy Programme, ACAP HQ, 2003.

the availability of a perennial source, the unlikelihood of the national grid being extended to the area within the next five years, the interest of the local community and availability potential donors.

Project initiation

Preliminary study

The request for a micro-hydro project comes from the community and a pre-feasibility survey is carried out by the technical personnel of the KMTNC/ ACAP to assess the power potential as well as the demand and socio-economic conditions of the settlements.

Detailed design

After discussing the feasibility study, project size, expected total cost, possible contribution sought from the community, and the tentative cost of electricity for the community and its willingness to acquire it, a detailed survey is carried out with the help of external micro-hydro experts.

Project funding

After completing the detailed survey, financial support is sought by KMTNC on behalf of the community from various potential donors by means of a financial proposal describing project parameters like costs, benefits, technical aspects, financial structure and management, etc. The total project cost is borne by KMTNC through donors and the local community. The local contribution comes both in the form of cash (bank loan, donations, etc) and kind (labour, materials, etc).

Project execution

Formation of management committee

After completing the detailed designing and upon securing funds for the project, the project is discussed with the villagers and an executive body of the local community called the Micro-Hydro Management Committee (MHMC) is formed through a democratic process. The committee is responsible for the construction, execution and management of the project.

Contract award for project construction

KMTNC then selects a micro-hydro installer (a contractor) through public tender and awards the contract for the construction of the project on the basis of cost and quality. A contract document that basically includes technical specifications, work responsibilities of various parties and payment procedures is then prepared and signed by KMTNC on behalf of the community and the contractor.

Construction/Installation

A Project Document, outlining the project features, financing structures, village responsibilities, including labour/cash contribution, loan, collateral, land acquisition, water rights, future management, pricing of electricity and electricity rules and regulations, etc, which serves as a morally binding document both for the community and ACAP is then prepared and duly approved and signed by the MHMC before the construction starts.

Monitoring construction works
KMTNC/ACAP is responsible for maintaining the quality of the construction works and equipment installed. It deputes the Alternative Energy Officer as the project engineer and an overseer as the site in-charge on behalf of the community. Together, the engineer and the overseer are responsible for the coordination and supervision of the construction work of the project and also for assisting the community with their work responsibilities as laid out in the Project Document. The MHMC also monitors the progress of the project.

Project completion
After the construction of the project is over, testing and commissioning is carried out along with power verification before it is handed over to the community.

Ownership and management
Once the project is handed over, it becomes the property of the community and the whole village owns the scheme, since everyone will have contributed to it either in cash or labour. The MHMC becomes solely responsible for the operation, maintenance and management of the scheme.

Policy behind project funding

Micro-hydro projects are the single most expensive project of the KMTNC. The financial resources required for the implementation of the micro-hydro projects is managed through various sources. The KMTNC acts as a facilitator and arranges for the major portion of the funds required either from donors or through its own internal sources. The remainder of the project cost is borne by the local community in the form of cash or labour.

Project design
The cost associated with the project design phase, comprising of the pre-feasibility study and detailed design survey, is taken care of by the KMTNC/ACAP, and the community has no liability as far as related costs are concerned. KMTNC/ACAP itself mobilises its in-house technical personnel to carry out the pre-feasibility study and bears the cost of the related expenses.

For the detailed design survey, generally the expenses are borne by the KMTNC itself. However, the KMTNC also approaches various donors right after the pre-feasibility study for possible funding and utilises that as far as possible.

Installation/Construction
The financial resources for the construction/installation of the MHP is jointly mobilised by the KMTNC through donors and the local community. The funding policy for all the projects constructed till date has been that 70 per cent of the total project cost is provided as subsidy by the KMTNC using donor funds, while the remaining 30 per cent is covered by the community. With the change in the national subsidy policy of

HMG/N in 2000, the subsidy policy of KMTNC has also been reviewed as it was felt that the communities are not benefiting from the current government subsidy, especially in remote mountainous regions. KMTNC now provides 85 per cent of the total project cost as subsidy (in the form of 80 per cent from donors and 5 per cent from KMTNC's own sources); the remaining 15 per cent is borne by the community.

The community manages up to 50 per cent of its share in the form of unskilled labour, locally available construction materials, transportation of equipment from nearest roadhead and cash donations received from various sources. The rest comes in the form of a bank loan taken by the MHMC.

IN terms of distance, the current government subsidy stands at Rs 150,000 per kW for projects that lie within two days' walking distance from the nearest road head; Rs 158,750 per kW for two to five days' walking distance; and Rs 171,500 per kW beyond five days'. This rate, however, does not suffice for the MHPs in the ACA, where the average cost is between Rs 180,000 to Rs 200,000 per kW in the southern sector and more than Rs 300,000 per kW in the north. Since the KMTNC MHPs do not qualify for government subsidy, it was found necessary to develop its own MHP subsidy policy.

The previous policy of KMTNC was to provide soft loans at a very low interest rate as a form of assistance to financially weak communities. This kind of loan was geared towards helping those communities meet their share of contribution. That way they needed to borrow only a minimum amount of loan from the banks. The soft loan was to be paid back to KMTNC within a certain number of years after the bank loan had been cleared. This support, however, has now been discontinued to avoid undue dependency on KMTNC. Communities are now responsible for coming up their share of financial contribution on their own.

Micro-hydro plant cost details

Project design costs

The pre-feasibility study of a MHP costs around Rs 10,000 on average while the expenses for a detailed study range between Rs 80,000 to Rs 120,000; however, these could can be much higher for MHPs installed in the northern regions of Manang and Mustang given their remoteness.

Construction/Installation costs

The construction and installation cost of an MHP, excluding design, represents the total project cost. The construction cost depends mainly on the capacity of the MHP, remoteness of the project site, transportation costs, quality of construction, equipment and materials used, transmission/distribution costs, length of headrace, and slope and the length of penstock pipe. A cost analysis of MHPs constructed after 1996 in the southern ACA reveals that the average cost of an MHP is approximately Rs 180,000 per kilowatt.

Running costs

The cost involved in the operation, repair/maintenance and administration cannot be predicted with any degree of accuracy. On an average, however, they range between an annual Rs 100,000 to Rs 175,000, which includes the salaries of the plant manager and operators, repair and maintenance, stationery, expenses for arranging meetings, etc. Occasional landslides and floods significantly increase the repair and maintenance cost as the experience from the Sikles MHP has shown.

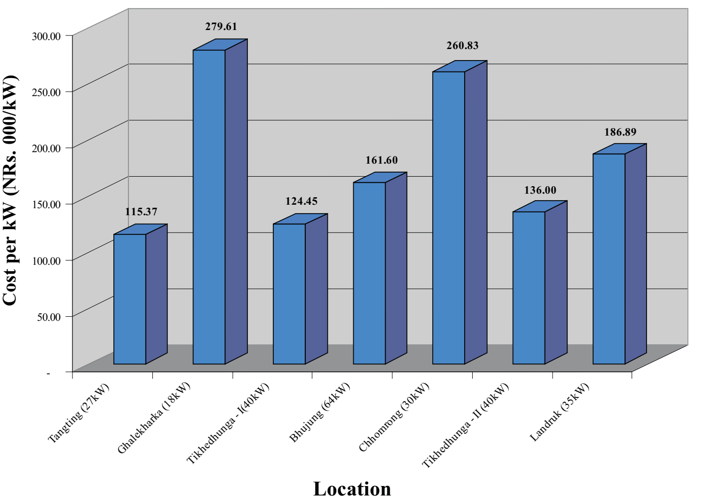
Higher cost than national average

One of the purposes for installing an MHP is because of the comparative low cost for decentralised energy systems, making it an ideal provider of clean energy to settlements spread over the rugged mountainous terrain. Even though the costs are relatively low for MHPs compared to more expensive larger hydro projects, due to various reasons the KMTNC MHPs in the ACA have a higher project cost than many other low-budget MHPs elsewhere. In Nepal, about 83% of the peltric sets are less than 1.5 kW and about 2/3rd of the installed MHPs are less than 15 kW with most being around 10 kW capacity, mainly catering lighting requirements and clearly limiting productive end-uses. But, it is perhaps because of this high cost for the larger scale that the community-owned and -operated MHPs in the ACA are running successfully whereas more than 50 per cent of the MHPs installed in other parts of Nepal are now non-functional.

Average cost per kilowatt

The average per kilowatt cost of the electricity generated from past KMTNC MHPs in the ACA stands at Rs 180,000 to Rs 200,000, while the average for non-KMTNC MHPs varies between Rs 100,000 to Rs 150,000. The quality of construction and the equipment/materials used in KMTNC-supported projects lead to a

Graph 1. MHP cost (NRs.) per kW in the ACA



Source: Alternative Energy Programme, ACAP HQ, 2003.

high initial cost. Construction by an external contractor on a turn-key basis, including the civil works, cement-lined or HDPE headrace canals and quality of other structures to avoid frequent maintenance push up the cost for MHPs in the ACAP. Similarly, to avoid logging for wooden poles that also require frequent replacement, use of galvanized or mild steel (MS) poles with a much longer life span contribute to the project cost.

In order to ensure a wide and equitable outreach by connecting all the households of a settlement to the power source, even scattered households in the area of the MHP end up getting connected. Ghalekharka MHP, which services four scattered villages, is one such example of cost escalation due to lengthy transmission lines; at Rs 280,000 per kilowatt this is the highest in the southern sector of the ACA.

The remoteness of a project site is another important factor that adds to the cost of an MHP. Projects in the northern parts of the ACA such as Lomanthang and Thorong Phedi are very expensive because of the transportation cost and the cost of labour. The per kilowatt cost of Thorong Phedi MHP, the second highest project in the world, is a whopping Rs 327,000—more than double the normal per kilowatt cost in other parts of the country.

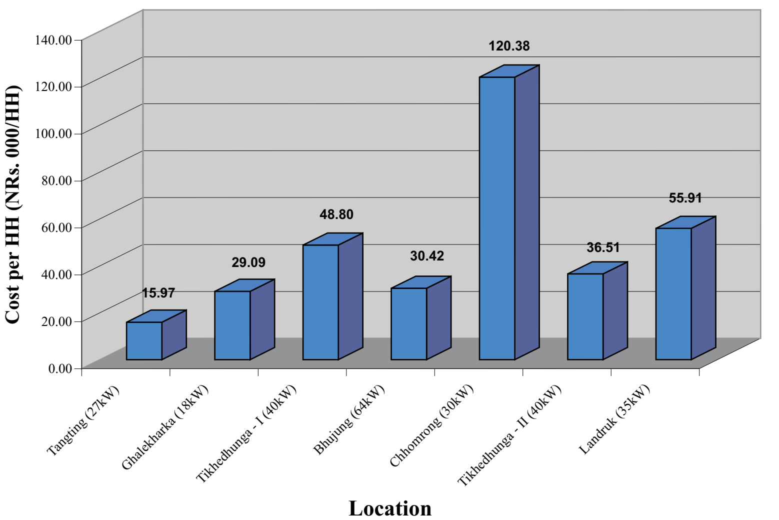
Average cost per household

The electricity generated from MHPs is expected to fulfill energy needs of the households, particularly for cooking and lighting, thereby minimising the consumption of fuelwood and simultaneously enhancing the livelihood conditions of the rural communities. The average power generation capacity of MHPs in the ACA is generally higher than typical low-budget lighting-

only schemes implemented in other parts of the country for the same number of households.

The average power subscription per household in the ACA MHP is around 264 watts unlike in other parts

Graph 2. **MHP cost per number of households in the ACA**



Source: Alternative Energy Programme, ACAP HQ, 2003.

of the country where average consumption is around 100 watts per household or even lower. The high subscription makes it possible to diversify the end uses of electricity such as through the use of low-wattage cookers *(bijuli dekchi)*, electric rice cookers and immersion rods as well as to power micro-enterprises in the ACA.

A larger micro-hydro project also increases the average cost of electricity per household compared to other low-cost, small micro-hydro projects that are meant for lighting only. A typical example is the Chhomrong MHP where a 30 kW plant serves only 65 households, i.e. around Rs 120,000 per household. The average cost per household in the ACA, however, hovers around Rs 48,000, of which the net average cost borne by each household after deducting the subsidy is only Rs 14,400. In this way, KMTNC subsidies play a vital role in making rural electricity affordable.

Economic viability of KMTNC/ ACAP MHPs

The economic viability of a micro-hydro project depends mainly on the capacity of the community to bear its part of the contribution, to generate enough revenue to pay back loans if any and to retain adequate funds for operation, repair and maintenance. The rule of thumb is that subsidies make possible a lower contribution from the communities and keep their loans within repayment capacity, thus making the project economically viable.

Given the high average capital cost in the case of KMTNC-supported micro-hydro projects because of reasons explained earlier, the support or subsidy provided is also comparatively higher than those in projects throughout the country. As MHPs are capital-intensive, the subsidy policy increment from 70 per cent to 85 per cent is thought necessary for the economic viability as well as sustainability of the projects. The subsidy also decreases the financial burden on the community and helps lower the price of electricity to within the paying capacity of the local people.

The ACA is one of the major tourist destinations of the country. Out of the 11 projects implemented, seven are in areas that see a maximum influx of tourists, and so the average power subscription and paying capacity are also higher in these regions. However, the possibility establishing small scale agro-processing industries and diversifying end uses is also higher due to the higher power generation. These factors also help the graded tariff setting and revenue generation comparatively easier and result in a financially strong community-owned project.

Another reason for the initial high cost is the quality maintained during the construction of the project. The repair / maintenance cost of KMTNC MHPs is comparatively low (except in the repeated landslide case of Sikles

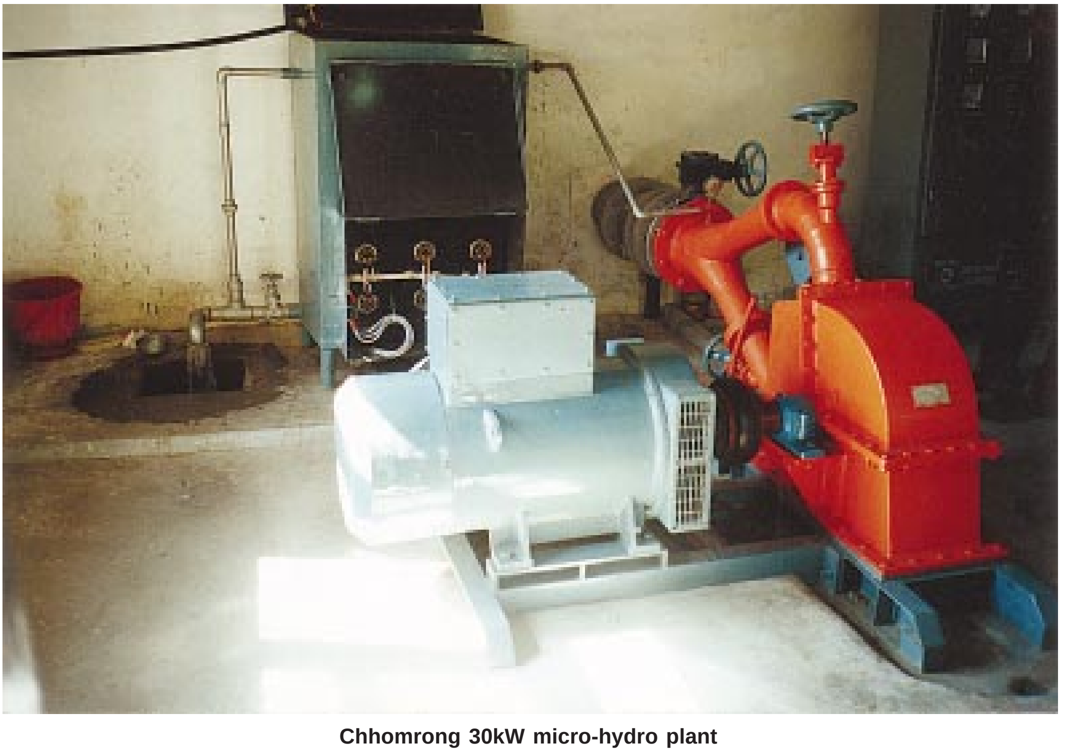
MHP) and hence the community can manage them with ease. The subsidy scheme has also allowed the MHPs to make repayments to the banks.

Conclusion

Though following an unconventional approach, the micro-hydro projects implemented by the KMTNC in the ACA have contributed significantly in meeting the energy demands of the rural populace. By providing a renewable source of energy, this has assisted to some extent in reducing dependency on fuelwood. In the long run, MHPs have proved successful in meeting its intended goals of: 1) assisting in conservation by protection of wildlife habitat; and 2) enhancing the livelihood conditions of rural communities by providing an alternative source of energy.

Rural communities that lie scattered in mountainous environments like in the ACA and which do not benefit from the national grid also find it difficult to take advantage of the national micro-hydro subsidy policy. Having managed the government subsidy and topping it some more for the communities, KMTNC has succeeded in continuing with the implementation of these MHPs even though they prove to be more expensive. The comparatively better performance of the KMTNC projects in the national micro-hydro scenario in terms of sustainability reflects the commendable efforts put in by both the KMTNC/ACAP and the local communities of the ACA.

So far, a cost-benefit analysis, sensitivity analysis and net present value exercise have not yet been incorporated in the development of KMTNC micro-hydro projects. This process should be undertaken in the future so that MHPs become economically more viable to the local communities and justifiable to the donors as well. Since the KMTNC MHPs are mainly conservation and development oriented, environmental and social gains must be calculated with as much caution and precision as possible. Similarly, in the project cycle, more emphasis has to be placed on the handing-over process of the MHP to the local communities. □



Chhomrong 30kW micro-hydro plant

Lessons learnt from ACAP in Micro-Hydropower Management

Esther Kim
Bhaskar Singh Karky

Fuelwood is still a major source of energy in rural households

Introduction: Micro-hydroelectricity in ACAP

Development requires energy. In the Annapurna Conservation Area (ACA), the traditional source of energy has been biomass fuels such as firewood. But continued use of firewood puts increasing pressure on the natural environment since it leads directly to deforestation. It is recognising this fundamental reality that one of the goals stated in the ACA Management Plan is to ‘reduce stress on critical resources, primarily forests, through wider use of electricity and other alternative energy programmes’ (KMTNC, 1997).

The Alternative Energy Programme (AEP), which is one of the nine core programmes administered by the Conservation Area Management Committee (CAMC), was established to meet this objective. It is run by an Alternative Energy Officer and two Alternative Energy Assistants. The AEP has two primary approaches to reducing pressure on forest resources:

1. *Promotion of fuelwood-minimising technologies* such as back-boilers, smoke and solar water heating systems, thermos flasks, pressure cookers, low-wattage electric cookers, kerosene stoves and improved cook stoves.
2. *Promotion of fuelwood alternatives* such as micro-hydroelectricity, solar technology (heating and lighting), biogas, kerosene and liquefied petroleum gas (LPG).

One of AEP's main programme areas is micro-hydroelectricity. Micro-hydroelectric plants, or MHPs (defined as 100 kW or less of generating capacity), convert the mechanical energy of water flowing downhill into electricity. Since most of the villages in the ACA, particularly in the high-hill region, are located on hillsides near water sources, micro-hydro is an ideal source of alternative energy for these villages. In addition, micro-hydro provides a local source of electricity for remote villages in the ACA that are not likely to gain access to the national electricity grid in the near future.

Till now, ACAP has built 11 MHPs, totalling an output of 453 kW. Ever since the first plant was constructed in Ghandruk in 1990, ACAP has assisted in the construction, operation and maintenance of these plants, all of which are owned and operated by local communities. Besides these, five MHPs in the ACA that were not originally built by ACAP now receive technical and financial support from ACAP.

Development of hydropower in Nepal

Hydropower is used in two forms in Nepal: mechanical and electrical. Mechanical hydropower, in the form of *ghatta* or traditional water mill, has been used in Nepal for hundreds of years. But the use of hydropower to generate electricity began only in 1911, when the first hydroelectric power plant—with a capacity of 500 kW—was established in Pharping (Thapa, 1995). Estimates of Nepal's theoretical hydroelectric potential range from 43,000 MW (Rana-Deuba, 2001) to over 80,000 MW (Amatya and Shrestha, 1998). At present, Nepal produces around 540 MW of clean energy. Of this, 514 MW is connected through national grid (NWCF, 2003) and an additional 1,956 MHPs generate 13,064 kW only (AEPC, 2002).

Most of the hydropower units in Nepal were initially not used to generate electricity, but rather for mechanical agro-processing. Later, the concept of attaching a generator to the turbine for electricity generation caught on. The year 1962 was the first time a modern MHP was installed in the country. By 1985, the Agricultural Development Bank of Nepal (ADB/N) devised a 75per cent subsidy for the cost electrical components for remote areas, and a 50 per cent subsidy for non-remote areas to encourage the development of these 'add-on' electric schemes as well as new MHPs. Though so many MHPs are installed, uncertainties about government subsidy policies have been a constrain for their promotion. In 1997, Alternative Energy Promotion Centre (AEPC) was established for the reformation of the 2000 government subsidy policy.

Issues pertaining to micro-hydropower development

Financial and Regulatory

MHPs are financed in a number of ways, depending on who initiates the project. Because MHPs require capital investment, and many remote communities do not have ready cash to pay the upfront cost, subsidies and loans are often required. Until 2000, the ADB/N had been the primary source of subsidies and loans for MHPs in Nepal. In September of that year, HMG/N changed the subsidy rules and created the AEPC with support from the Danish government to administer the new subsidy plan (AEPC, 2000b). As a result, all new MHPs wishing to apply for a subsidy must now apply through the AEPC. The current MHP subsidy scheme is graduated according to the distance from the nearest road, and includes transportation and materials costs. It does not, however, provide for continuing operation/maintenance costs (AEPC, 2000a).

A major problem with the government's subsidy scheme is that it has changed so frequently that planning for future projects becomes difficult (REDP, 2000). Many contractors, private parties and NGOs have expressed frustration at not being able to rely on a consistent subsidy policy or a long-term government policy regarding micro-hydro development (Adhikari, 2001; Junejo, 1995). With Nepal's MHP market being relatively small both in volume and revenue generation, this inconsistency is enough to make otherwise capable engineering firms and suppliers hesitate about making substantial investments in this sector.

Another issue with the one-time subsidy scheme is that operation and maintenance costs are often underestimated or not planned for.

FINANCIAL and REGULATORY ISSUES

- *Inconsistent subsidy policies*
- *Dependence on subsidies*
- *Small market for MHP in Nepal*
- *No planning for long-term costs*
- *Lack of micro-enterprises means no long-term financial sustainability*
- *National grid as disincentive for MHP Water use policy is ambiguous*

Over 50 per cent of the MHPs installed in Nepal till now are currently nonfunctional (Rijal, 2001). If commonly occurring technical problems (mentioned below) are not taken into account, a plant can easily be put out of business. If concurrent income-generating activities are not in place, or savings are not allocated for operation, maintenance and capital replacement, the community or private owners can find themselves unable to pay for repairs once a problem does occur.

Lack of micro-enterprises means no productive end use of electricity. And that is again related to poverty since the purchase of electric micro-enterprise machinery requires upfront payment as well. MHPs also face stiff competition from diesel and mechanical-powered, agro-processing mills (Junejo, 1995).

One disincentive for building an MHP at a given site is the possibility of the extension of the national grid to that site in the near future. Knowing that the government could easily extend the grid to an area even with an installed MHP, prospective entrepreneurs may opt instead to wait or use expensive diesel generators in the meantime.

Another policy issue is that of water rights and conflicts over water resource use. The Water Resources Act of 1996 prioritises the use of water resources in Nepal in the following order: drinking water, irrigation, agriculture, hydroelectricity. Since the law does not specify any prior right of water use for MHPs it has caused several existing MHPs in Nepal to shut down because the water was subsequently diverted for other uses (Amatya and Shrestha, 1998).

To encourage the widespread adoption of MHP projects, ACAP has developed its own community-friendly policy for financing subsidy for the installation of MHPs. ACAP also assists in seeking donors as the current government policy is insufficient for installation of MHP in remote areas. As most MHP sites in the ACA are remote, the cost is substantially higher and hence require greater subsidy. Besides, as ACAP's MHP promotion is oriented towards conservation of natural resources, it makes it substantially different from the objectives of other MHP projects.

Technical

Lack of sufficient local technical expertise and capacity has been the single biggest drawback cited for previous MHPs. In Nepal, contractors such as Balaju Yantra Shala (BYS), Development and Consulting Services (DCS), Intermediate Technology Development Group (ITDG) and others have been instrumental in the growth of MHPs (Shrestha and Amatya, 1998). However, without a district-level capacity for repair and maintenance, breakdowns become costly both in terms of money and time, as technicians and equipment have to be sent in from Kathmandu or further. But now, even this level of support is in jeopardy, as DCS is now no longer involved in the MHP

TECHNICAL ISSUES

- *Lack of local technical expertise for operation and repair*
- *High relative prices for equipment*
- *Quality of local equipment*
- *Landslides and natural disasters*
- *Quality of feasibility studies*
- *Unrealistic project expectations*
- *Low load factors*
- *Lack of management training*

industry and ITDG no longer manufactures low-wattage electric cookers.

Lack of local technical capacity also means that the price of equipment becomes two to three times higher compared to India, Pakistan and China (Rijal, 2001; Junejo, 1995). Maintenance cost is also more expensive given the transportation costs for equipment and the travel costs for technicians. In many cases, locally manufactured equipment is also inferior in quality apart from being more prone to breakdowns (Junejo, 1995, Rijal, 1997a).

Unrealistic project feasibility studies in terms of design, maintenance expectations and demand projections often lead to plant failure (Shrestha and Amatya, 1998), which is all the more reason why close collaboration with the target community is essential from the very beginning of the project cycle.

It is the steep topography and high rainfall that make the mid-hills of Nepal so suitable for hydropower development, but these same factors can also lead to landslides and floods (Goel, 1995). Even with proper feasibility studies and design surveys conducted, unexpected landslides and other natural disasters frequently claim the civil structures of the MHP, or even the plant itself. There is also the case of a general lack of quality control on the civil works of the MHP. Potential solutions to this costly issue include insurance for MHPs, as well as extended warranty periods for contractors, but they have yet to be implemented in Nepal so far (Rijal, 1997b).

Low load factor is also a recurring issue with MHPs. The average load factor range from 10 to 20 per cent, and goes down further to 5 per cent with some plants (Arya, 1995; Thapar, 1995). Since the power from many of the MHP schemes are used mainly for evening lighting, peak load only occurs from 6 pm to 9 pm, with low utilisation at other times. Such low load factors are a sign that the capacity of the plant is not being used efficiently. Experience has shown that the long-term economic viability of such plants is not satisfactory (Shrestha and Amatya, 1998; Junejo, 1995).

Owners and managers of private MHPs are often not qualified to manage them properly, leading in frequent plant failures (Shrestha and Amatya, 1998; Junejo, 1995). Lack of training, record-keeping and/or managerial skills often disable an otherwise technically sound MHP scheme. Currently, there are no national standards for MHP management or operation, nor are there any coordinated programmes for training or certification (Rijal, 1997b). However, MHPs that have had assistance through a technical or management intermediary, such as ACAP, generally have had higher success rates than fully private or individually run plants, presumably because of the capacity building through training and guidance has occurred (Shrestha and Bajracharya, 1998).

During the period 2001 to 2003, several action researches were undertaken by KMTNC/ACAP under the Water Resources Use Project to improve the management of MHPs in the ACA. As a follow up to the recommendations of the action research, numerous workshops, trainings for operators and preventive maintenance procedures were developed for the 11 MHPs within the ACA (WRUP 2001/2002, WRUP 2002/2003).

Social and Gender Issues

In Nepal, biomass fuel, particularly firewood, is the predominant energy source (Figure 1). Electricity accounts for a mere 1 per cent of energy consumption. And, in rural areas, only five per cent of the people have access to electricity. Reducing the heavy reliance on biomass energy in rural areas, particularly in the mid-hills, has varying social impacts.

Typically, energy in rural communities is used for the following purposes (Goel, 1995):

- Domestic and commercial lighting;
- Cooking, water heating and space heating;
- Small and cottage industries such as agro-processing and weaving;
- Medium-sized industries based on local raw material; and
- Irrigation and drinking water.

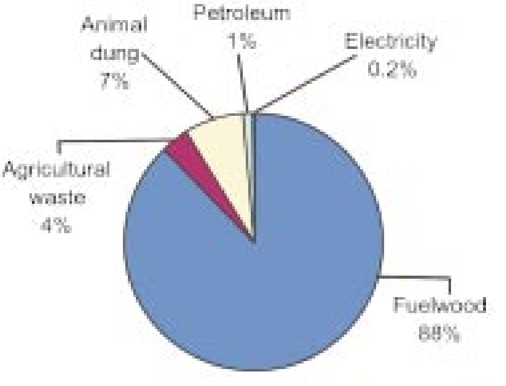


Figure 1. Energy consumption in rural Nepal by fuel type, 1994-95 (Amatya and Shrestha 1998, from WECS, 1997)

Electricity can perform many of these functions, but only if there are proper tools and the people have been educated on the use of electricity. For instance, the purchase of an electric cooking appliance is necessary to substitute firewood with electricity. This in turn requires people to understand the value of an electric cooking appliance, money for its purchase and the willingness to use it (Junejo, 1997a).

Substituting biomass and other

fuels with electricity has a number of benefits (Shrestha and Amatya, 1998; Thapa, 1995; UCS, 2000; Rijal, 1997b; Junejo, 1997b). Removing the smoke from traditional cooking fires or the fumes from kerosene improves indoor air quality and, therefore, health. Using electricity to power mills, oil presses, husking machines and other agro-processing units reduces drudgery and saves time. Time and drudgery are also saved by not having to collect firewood, which takes even longer with increased deforestation. Good-quality lighting allows later working hours and increased study time for children. Radio and television allow access to information.

In mountain villages, women traditionally bear the burden of energy collection and use, so any change in energy source and usage affect women disproportionately (Rana-Deuba, 2001). In particular, the health, drudgery and time benefits of electricity noted above have a greater impact on women than on men. Even so, there is no documented study of women's participation in MHP planning or management, and no gender-specific policies exist for the development of MHPs (Shrestha and Amatya, 1998).

Availability of electricity itself as well as the free time it allows, also enables income generation opportunities, especially for women (Rana-Deuba, 2001). In one example, a village couple started a poultry farm with the free time and hot water generated through electricity. Another example cites a woman who took a small loan for an incense-rolling machine. She has already repaid her loan and now generates a 50 per cent profit through the sticks she sells through a distributor in Kathmandu. Further study is required to fully understand the social impact of MHPs. However, the benefits of MHP seen so far look encouraging.

The gender analysis in ACA of benefit from MHPs that is depicted in Table 1 shows that women derive more benefit from the use of MHP electricity.

As shown above, the highest proportion of respondents (42 per cent) stated that electricity from the

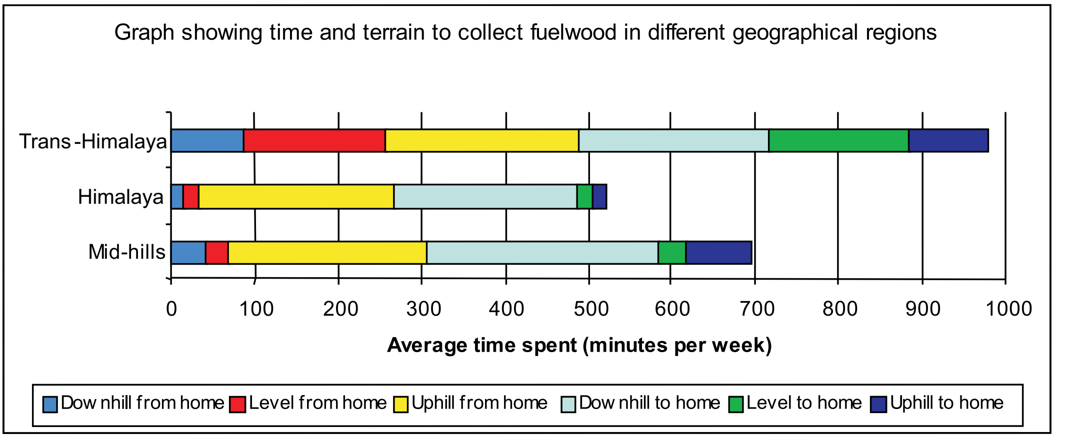
SOCIAL/GENDER ISSUES

- *Replacing fuelwood with electricity requires education and end uses*
- *Women bear burden of energy use, but have little input in MHP mgmt*
- *Improvements in health, drudgery, time saved through MHP*
- *Income generation through MHP improves livelihoods*

Table 1. **Gender analysis of benefit from MHP (Bhadra & Karky, 2002)**

	Male	Female	Total
Improved living standard	46	44	90 (42%)
Reduced drudgery	8	12	20 (9%)
Improved health	35	43	78 (36%)
Raised social status	0	3	3 (1%)
Increased income generation opportunity	12	13	25 (12%)
Total responses	101	115	216

Graph 1. Drudgery graph for fetching fuelwood in the different ecological regions within ACA (Bhadra & Karky, 2002)



MHP has raised their living standards. Next came improved health, reported by (36 per cent). MHP has also contributed to increased income generation as reported by 12 per cent of the respondents and subsequently reduced drudgery, which is more evident amongst women (eight men against 12 women). Interestingly, three women also feel that access to the benefits of MHP has raised their social status.

Graph 1 clearly indicates the drudgery involved in fetching fuelwood in terms of time taken and slope climbed or descended. Decreasing the frequency of fuelwood collection by developing an energy mix by adding electricity from MHP to households can reduce the scale of drudgery. It is for this reason that access to MHP electricity plays an important role in improving the livelihood and health conditions and in reducing drudgery.

Lessons learnt

With support from the Ford Foundation's Water Resources Use Project, a case study assessed the management of the MHPs at Sikles and Chhomrong (Kim and Karky, 2001), two Gurung villages in the southern ACA region. Field visits and interviews with local residents, village leaders, MHP staff and ACAP staff revealed many positive aspects of MHP management as well as areas that could do with some improvement. As lessons learnt, the following recommendations were made from the case study.

Two levels of recommendations stem from the summary of findings:

1. Short-term: recommendations that can be implemented in the near future with current resources.
2. Long-term: recommendations that require institutional rethinking over a period of time and that has a wider scope.

1. Short-term

Technical
Sikles urgently requires police switches to monitor their electricity usage, so that low-wattage electric cookers can once again be used. In addition, since DCS will no longer provide them with technical support, the Micro-Hydro Management Committee (MHMC) should begin building working relationships with other existing micro-hydro service providers (a list of whom can be provided by ACAP). In this way, they will be prepared for any major technical problems that may occur in future.

Also, ACAP has the technical human resources in the form of the AEP staff—the Alternative Energy Officer, two Alternative Energy Assistants and several Alternative Energy Helpers. However, when even minor technical problems occur, the MHMCs tend to ask ACAP to call a technician, often at great expense of time and money, and then ask ACAP to subsidise the costs. Frequent turnover of the AEP staff has also left gaps in ACAP's knowledge base of its own MHPs.

Rather than hiring more staff, the existing staff should be more efficiently utilised to handle technical issues as well as to identify and prevent problems before they occur. Local technical capacity should also be increased. This can be accomplished through:

- Regular and thorough hands-on training of staff, who can then train plant operators / managers;
- Regular preventive maintenance visits by ACAP staff (these have planned but not yet implemented);
- More mobility of ACAP staff for troubleshooting;
- Incentives for long-term retention of both ACAP and plant staff;
- Proper handover between outgoing and incoming staff; and
- Proper handover of the MHP to the community.

Financial
Electricity generation should not just be for consumption, but also for production. Income generation from electricity is important for continued financial sustainability of MHPs. Compared to Chhomrong, where over half of the electricity is used to generate income through tourist lodges, Sikles has only three mills and one wood-finishing machine. Considering that Sikles has very little money saved after seven years of operation, electricity end uses should be expanded to include more productive, income-generating activities.

Though their financial situation is better, Chhomrong should still consider diversifying their income-generating activities to reduce their dependency on only one sector, especially given that tourism has decreased significantly in the past few years. Electricity is currently not allocated for agro-processing, even though agriculture is the other major economic activity in Chhomrong.

Both Sikles and Chhomrong should start setting aside separate funds for capital replacement and maintenance repair.

Budgeting for new plants should take into account the total life-cycle cost of a similar plant. The only way to do this is to be aware of what this life-cycle cost might be. ACAP should keep better financial records, especially of its own total annual expenditures on each plant, in order to plan for future MHP budgeting and prepare the current MHPs for financial independence. The budget should make provisions for spare parts, full operation and maintenance, capital replacement, police switches and other enforcement as well as provision for end uses (such as a subsidy for low-wattage cookers) and gradual reduction of ACAP assistance in the planning stage itself.

Management

Keeping proper records, both technical and financial, is essential for long-term management and preventative maintenance of MHPs. In Sikles, the plant manager keeps financial records, but these need to be audited more regularly. A technical log book should also be maintained by the Sikles plant operators as they do in Chhomrong.

Careful record-keeping is of no value if the information is not shared or utilised. There were several significant communication gaps among the MHMC, plant operators and ACAP in both villages. More frequent communication among plant operators, the plant manager, ACAP field offices and the ACAP head office is necessary for all parties to learn from each other's experiences.

Communication can be facilitated through:

- Regular visits by ACAP AEP staff (for technical purposes, as suggested above);
- Regular workshops in Pokhara and / or in MHP sites;
- Accountability of one staff member in each ACAP field office for collecting and maintaining information about the MHPs in its sector (this staff doesn't have to be an AEP staff); and
- Regular accountability of this field staff member to the AEO in Pokhara to report about the MHPs in its sector.

Social

The advantage of both Sikles and Chhomrong from the perspective of MHP management is that both villages are almost entirely Gurung, and share a strong sense of community. In this study, very few problems were noted in terms of equitable distribution of electricity, water resource conflicts and so on. However, both villages could use more representation from women and lower-income groups in decision-making regarding electricity.

Before this can occur in a meaningful way, education is necessary. Without being aware of the uses and advantages of electricity in terms of reducing drudgery, increasing income generation and resource conservation, those who may be affected will not even realise, much less articulate, their needs and wishes vis-à-vis electricity.

Education on energy use should go hand-in-hand with education on energy efficiency. Once energy efficiency is given priority, villages with MHP will be able to do much more with the electricity they are allotted instead of limiting important uses like low-wattage electric cookers as in Sikles, or a continued reliance on firewood for cooking as in Chhomrong.

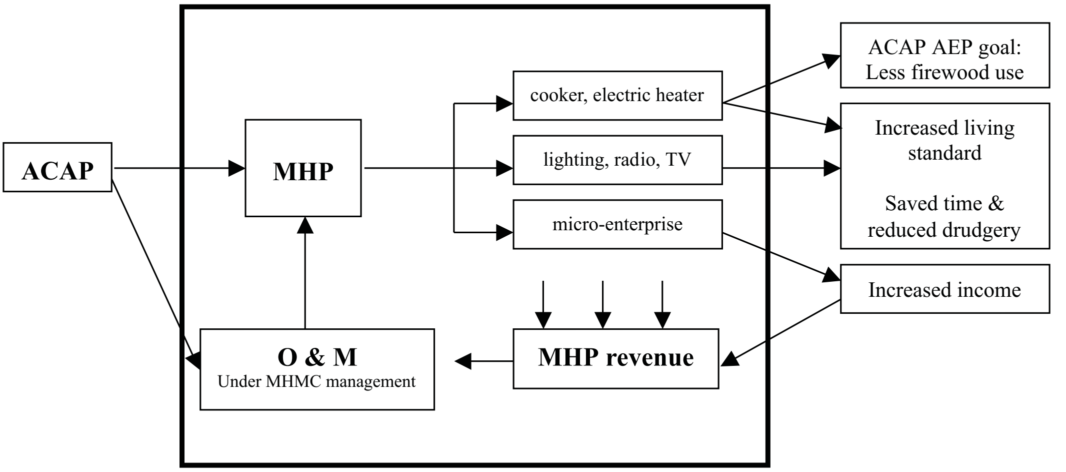
Besides education, ACAP should also continue to encourage end uses, such as low-wattage electric cookers and water-heating immersion rods that support the conservation goal. For the short term, ACAP can solicit or support other organisations or companies that develop these types of technologies, and then provide incentives to the communities for their use.

2. Long-term

ACAP's investment in micro-hydro plants should not be viewed in isolation, but as part of an integrated system. If MHPs are to truly support ACAP's goals of natural resource conservation and sustainable development, each new MHP project should be considered holistically: from construction to production, from ACAP input to community use. Without such a outlook towards MHP management, the desired objectives often remain unrealised. Such as, for instance, why are the households in both Sikles and Chhomrong still using firewood to cook?

Figure 4 below illustrates the MHP system. ACAP provides technical and financial support for the construction of the MHP as well as its

Figure 2. MHP system, with ACAP input and current AEP goals



operation and management. The MHP in turn provides electricity to power devices for cooking, lighting, leisure and micro-enterprise. Revenue is generated from device use through tariffs, which pay for operation and maintenance. The result is lessened firewood use, increased living standard, more free time, reduced drudgery and higher income.

As things stand, only cooking appliances and electric heaters, neither of which is used very widely in Sikles or Chhomrong, contribute directly towards the AEP goal.

Figure 2 shows that investment in MHP construction alone does not necessarily lead to firewood conservation nor to sustainable development, especially if electric cookers and heaters are not used. To that end, each new project should include not only construction and basic maintenance, but also provide for:

- Diverse end uses that support conservation and improved living standards;
- Education regarding electricity use (for community) and maintenance (for staff); and
- Income-generating activities.

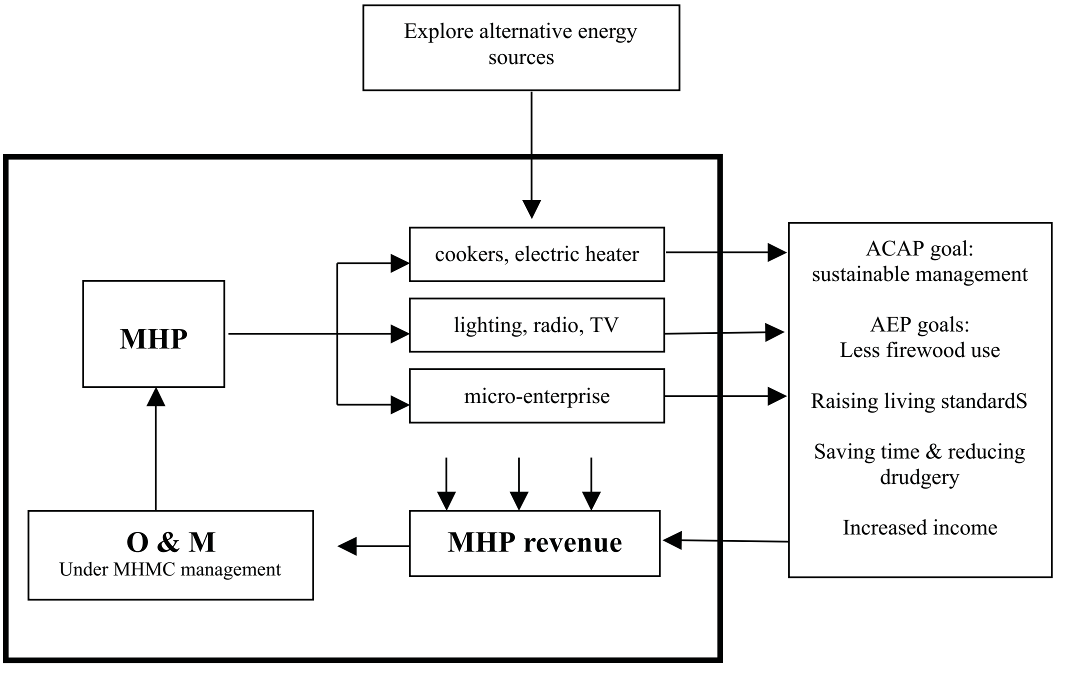
The AEP cannot do this alone since, at the moment, its focus is strictly on conservation. But Figure 2 shows that MHP directly contributes to other positive benefits for the communities. Changing the AEP's goals to broaden them means that ACAP will also need to become broader in its general approach. ACAP has a rich array of programmes and institutions already in place, such as Ama Toli, Lodge Management Committee, Savings and Credit Group, etc, that are connected directly to the MHP and its effects. However, the current tendency is for each group to work separately and autonomously. Working together across disciplines will enable the AEP to approach each MHP project in a holistic manner, thereby ensuring its long-term success and sustainability.

The eventual goal is for the management of the Annapurna Conservation Area to be fully handed over to the local communities, including their MHPs. Long-term self-sufficiency means that communities have to reduce the ACAP input into the MHP system shown in Figure 2 through a combination of the following:

- Appropriate alternative energy sources, such as solar and biogas, to reduce pressure on MHP;
- More efficient electricity use through energy-efficient appliances, insulated buildings, and demand management; and
- More attention to income generation from electricity, so that MHP maintenance is funded entirely locally.

The end result, as shown in Figure 3, is a self-sufficient, community-owned and -managed MHP system with many positive benefits for years to come.

Figure 3. MHP system without ACAP dependence, focused on new ACAP goals.



Conclusion

The goal of ACAP's Alternative Energy Programme is to conserve forest resources in the ACA by reducing the consumption of firewood. Financially, the single largest activity for AEP and ACAP is micro-hydroelectricity. The justification for this investment is that micro-hydro brings the AEP closer to its conservation goal by providing communities that use firewood with a clean, local alternative energy source.

ACAP's micro-hydro projects differ in many ways from the rest of the projects being implemented in the country, as it is predominantly focused on conservation. To overcome numerous issues pertaining to the micro-hydro sector, ACAP has developed its own policy especially with regard to subsidy so that MHP electricity becomes more accessible to the local poor. Regular trainings and workshops for operators and management committees have also become routine project activities to help make the community-owned and -operated undertakings sustainable. Socially, access to MHP electricity has brought numerous changes, primarily that of raising the living standards of the people. It also seems apparent that women have benefited more from MHP electricity than men; one reason is from reduced drudgery.

Learning from ACAP's experiences in micro-hydro projects, one key reason for all 11 plants to be functioning compared to the low national average could be due to ACAP's long-term in engagement in the area and its continued support for the development of the MHP sector at the community level. Action research to pinpoint problem areas, to recommend ways to enhance efficient management systems and to develop appropriate human resources at community and project levels are some measures taken by ACAP to make micro-hydro projects self-sustaining. The case study focusing on the MHPs in Sikles and Chhomrong have provided ACAP with insights to improve its approach to current and future micro-hydro projects. Comparing the overall MHP management in Sikles and Chhomrong, some progress has been made in the six years separating the two plants. However, there is still some room for improvement.

For Sikles and Chhomrong, as well as for ACAP, some short-term suggestions for technical, financial, managerial and social improvement have been made. These recommendations can be implemented with existing resources, and the improvements can be seen in the near future. However, further improvement for MHP sustainability requires a more holistic view towards MHP management over the long term. ACAP's AEP goal may include improving livelihood conditions in addition to conservation of forests.

These recommendations can also be applied to other ACAP micro-hydro projects as well as to other water resource usage projects such as safe drinking water and irrigation. Continued self-assessment and management improvement ensures that ACAP's programmes meet the project's goal of balanced conservation and sustainable development.

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Community Electricity Distribution Regulation 2003: Implications on Micro-Hydro Plants

Ngamindra Dahal

IT HAS been 90 years since Nepal's first hydropower plant was built and four decades after the country's immense hydropower potential was first recognised. Yet the number of people with access to electricity in the country stands at a mere 18 per cent. The existing national gridlines have a power surplus but the Nepal Electricity Authority (NEA) has not been able to distribute the excess power to the rural communities that have so far remained without access to electricity.

The completion of the 144 MW Kali Gandaki Hydropwer Project in 2002 helped add a surplus to the national gridlines, putting an end to nearly ten years of electricity shortage. But the surplus power has been of little use. After the addition of the new source of electricity into national grid, peoples' anticipation for electricity had increased. Rural communities without access to electricity have approached the NEA for the extension of the grid to their areas, but until recently, NEA gave very little priority to extending its power lines to the rural areas because of high administrative and operation cost involved compared to the quantity of electricity consumption in the villages. Lately, however, NEA has realised that unless immediate steps are taken to cater to the power needs of rural households, it would continue to incur further losses through the surplus power—already over 80 MW—being unused. The losses are likely to increase further with new power plants that are presently under construction come online.[1] In this regard, the enactment of the 'Community Electricity Distribution Regulation 2060 (CEDR)'[2] may be viewed as an appropriate step taken by

[1] Speaking on the 18th anniversary day of Nepal Electricity Authority (NEA) executive director, Janak Lal Karmacharya, disclosed that NEA incurred a net loss of Rs 650 million in fiscal year 2002/03. 'Though the loss has decreased as compared to last year, the financial condition of NEA is worsening day by day,' Karmacharya said. The loss in the previous year was Rs 710 million. *Source*: Kathmandu Post *Aug 20, 2003*.

[2] NEA framed the CEDR by exercising its power conferred it by section 35 of the NEA Act, 2041 (1982).

NEA to utilise the surplus power for the electrification of Nepali villages.

The CEDR may be only a tentative step towards NEA's present power distribution policy that aims to allow prospective customers from rural areas to buy electricity. But it has opened up new possibilities in the hydropower sector while seeking investments in partnership with Nepali rural communities. The most important aspect of this initiative is that the CEDR has paved the way for integrating rural communities into the mainstream national economy since it allows community-based organisations to purchase electricity from NEA's national grid in bulk and sell it to local people at a reasonable price. This approach can be expected to gradually gain popularity among rural communities who are desperately seeking access to electricity. Furthermore, local communities can also invest in electricity distribution infrastructures in their locality and recover the cost by selling by electricity supplied by the NEA. In this respect, this paper provides a synopsis of the CEDR and analyses its role in rural electrification with reference to the roles of MHPs.

Overview of the Community Electricity Distribution Regulation 2003

Objective: The aim of the CEDR, which came into effect on 17 July, 2003, is to involve communities in the expansion of electricity distribution in the rural and sub-urban areas that currently lie outside NEA's existing gridlines. The more specific objectives of the CEDR are as follows:

- To promote public participation in the present distribution arrangement in order to make it more effective by reducing theft and conducting maintenance and distribution at the community level through distributing organisations (DOs).
- To encourage community management in the extension of distribution lines, and the protection and promotion of electricity distribution system through the distributing institutions.
- To attract private investment to meet the needs of the people in rural electrification since the pace of rural electrification at present has been very slow.
- To promote technical and managerial capability of rural communities in electricity distribution through distributing institutions.

Provision for Partnership: According to the provisions of the CEDR, NEA plans to supply electricity through a DO to all households that utilise power from grids with capacities less than 50 KVA. The CEDR defines a DO as any organisation registered as per Clause 5 of the Regulation with the objective of providing electricity distribution service through a community-based approach in rural areas. The consumers of local electricity are first required to establish a DO and register it as per any of the following regulations: Company Act, 2053 (1996), Cooperatives Act, 2048 (1991), Association Registration Act, 2034 (1977), Social Welfare Act, 2049 (1992) or any existing users' association or institution registered according to prevailing laws, provided such an organisation amends its constitution to ensure the inclusion of provisions required for community electricity distribution.

NEA will treat DOs as *community bulk consumers* and provide them with electricity in *bulk amounts* through *bulk meters*. Only the DO would be permitted to supply electricity to customers called c*ommunity bulk consumers* by having a meter fixed in one point in the respective rural area. Based on the size and requirements of consumers in the *distribution area* and as specified by the DOs, NEA shall arrange for power supply through its *distribution network.* Only those customers receiving or are to receive a supply of 50 KVA or above within the distribution area shall also be the customer of the NEA. The DO will be responsible for the construction, management and collection of the tariff of the *distribution line*, which is the distribution infrastructure necessary in the distribution area after the bulk meter is installed for the supply of electricity.

Thus any DOs interested in distributing electricity within the area of the NEA can apply to the Community Rural Electrification Department (CRED) through the local NEA branch in the specified format. The CRED will issue letter of intent to the DOs to enter into an agreement 60 days after the date of application and upon necessary investigations of the application.

Repair and Maintenance: It is the primary responsibility of the DOs to build and manage the distribution system. DOs need to establish a separate repair and maintenance fund every month for the regular repair and maintenance of distribution lines by depositing at least 10 per cent of monthly sales income in such a fund. NEA will also establish a separate 'Community Rural Electrification Fund' for rural electrification, extension of distribution lines and strengthening of the system. Regarding the construction and maintenance of the power supply, NEA's liability is limited to its *distribution network*, which includes infrastructure to supply electricity from the electricity generation plant or sub-plant up to the bulk meter. The NEA provides technical and managerial training to the employees of the DOs free of cost for the first year from the date of agreement.

Provision of electricity tariff and leasing distribution line: NEA and the DO will fix the tariff for bulk community customers through mutual agreement while keeping in mind the quantity of distribution, geographical location, participation in investment, and other investment and technical aspects. The DO shall collect the tariff and other charges from its customers as per the Electricity Tariff

Realisation Regulation, 2050, and as directed by Tariff Fixation Commission. NEA can give the electricity distribution lines on lease or rent to DOs while the DOs need to pay the lease or rent amount to the NEA. In case of partial investment made by DO, there shall be a concession on lease amount depending on the proportion of investment. In the case of damage to distribution lines due to natural calamities and failure to get it repaired from the Repair and Maintenance Fund of the DO, the NEA will repair the distribution lines upon request from the DO.

Implications and Impacts of CEDR

Nepali hill communities have tried to construct electricity generating units, or MHPs, where possible. However, these MHPs of various scales have been built in villages and townships where extending the central power system are not economically feasible. Since people view electricity as a basic amenity for modern life, they have even built tiny MHPs of 1 KW using a 'peltric set'—a low-cost technology promoted by Nepali technicians which is used widely in Nepal. This may be taken as a unique case of the people's desire for electrification of rural households using small and locally modified technology. In this context, the MHPs[3] promoted in Nepal by various organisations may be seen as a significant step towards rural electrification. Similarly, the CEDR may also be viewed as a new thrust towards empowering communities through decentralized rural electrification initiative. Some key issues related to the roles of the CEDR and the MHPs in the rural electrification sector are discussed below.

Focus Areas of CEDR and MHP: The CEDR is framed neither to help build new MHPs nor to support existing MHPs. Its primary objective is to extend its market into rural areas in collaboration with community organisations and operational partnerships with local customers. Initially, NEA may find it attractive to enter areas that have growing marketplaces and those that are accessible by roads. Areas covered by existing MHPs may not be the priority areas of NEA for obvious reasons— they are built in remote parts where extension of gridlines would be costly. Wherever possible, NEA may wish to collaborate with the MHP managing organisations such as the Micro-Hydro Management Committee in the Annapurna Conservation Area as a DO and help the latter expand coverage areas, maintain adequate supply or to enhance the reliability of power supply. Such a partnership would be

[3] With a total installed capacity of over 6 MW from 1246 units by the end of 2002, micro-hydro plants (MHPs) are the major alternative source of power to meet the electricity demand in isolated rural areas.

beneficial to both parties.

The potential intervention zones of the CEDR and the MHPs are nearly exclusive of each other. MHPs are built in regions where grid extension is not feasible and as such MHPs would continue to be the best option for an alternative source of energy for inaccessible rural households in Nepal. This fact is bolstered by the fact that local knowledge and skills to build small hydropower plants are easily available and also because MHPs can be developed through community initiative and investment. NEA will give priority to providing electricity to areas close to highways with gridlines and subsequently to areas near the gridlines where alternative sources of hydropower source are not available.

CEDR in ACAP: With 11 MHPs, the Annapurna Conservation Area Project (ACAP) is a leading micro-hydro promoter in the country. Together, these plants produce 453 KW electricity. Because they are situated in the tourist zone, ACAP-promoted MHPs have different characteristics in terms of energy-use patterns than many other MHPs built elsewhere in the country. Besides lighting, most of the electricity produced by ACAP through MHPs are used for cooking and heating. There are several areas where power produced by existing MHPs have not met the demand and upgrading the MHP is not always feasible. Extension of the central grid through the CEDR approach would be beneficial to some of the communities that operate MHPs, particularly those that have a high demand of electricity for non-lighting purposes and which cannot be met through their own generation. However, it becomes essential to take adequate precautions before connecting the national grid to communities with MHPs in order to avoid undesired effects such as the end of MHP operation that may arise from conflicts among users over tariffs or on the question of extending coverage areas that will require additional investment to strengthen distribution systems.

Assumptions of CEDR: Success of the CEDR depends on several underlying assumptions; the most important being that communities will buy electricity at the present market price, which is one of the highest in the world. The next is that the DO will be able to raise enough funds to operate and maintain the distribution system through the sale of electricity and yet retain a good profit margin.

Opportunities and Constraints: Lack of adequate financial sources and technical capacity has been the most common excuse for the poor development of Nepal's hydropower potential. But this is only partially true when taking into consideration cases of existing medium and large hydropower plants that were built with foreign aid, mostly loan assistance. A major flaw of this practice is that Nepali local capital has not been properly mobilised, and Nepali technologies and skills are underutilised. Centrally planned hydroelectric projects have often led to high production costs, making Nepal's electricity one of the most expensive in the world.

On the other hand, the MHPs have been instrumental in electrifying rural sectors, and in mobilising Nepali capital, skills and institutions in the renewable energy sector. This is a decentralised approach whereby the MHPs are promoted for the development of alternative energy sources. The CEDR helps shift centralised electricity development towards decentralisation, with the possibility that it will become more sustainable. Though NEA has introduced the CEDR in different contexts, it can potentially play a positive role in the electricity development sector. The underlying goal of the CEDR and MHPs are the same: to promote rural electrification. If NEA used the CEDR only to share the responsibility of distributions with community-based organisations but without enough support to the latter, little can be expected from this new approach.

The CEDR seeks a one-way partnership with the community-based organisations. That is, its aim is to supply electricity to the users but not to buy from them. Therefore, it is difficult to resolve the issue of partnership with those communities that operate MHPs which intend to sell excess electricity to NEA or buy electricity from NEA to augment power supply to the existing MHP grid. Also, if the NEA's partner DOs manage to generate cheap electricity locally by mobilising their own funds, then the existing partnership between NEA and DOs will not work.

Possibility of Broader NEA-Community Partnership: A broader partnership between communities and NEA is possible if NEA could amend the CEDR to include a provision of buying electricity from the community-based partner organisations. This would play the role of a catalyst in mobilising local resources through community organisations, which they can invest in producing electricity and selling the same to NEA when they experience a surplus. The new provision would help not only the community organisations in mobilising local funds for producing electricity from feasible sites, but it would also add power to NEA's national grid. This initiative, however, would require support in terms of policy from the government in integrating it with the alternative energy programme.

The most important advantage of this approach is that the scattered and idle capital will be collectively mobilised to generate and distribute hydropower locally. It will further help electrify remote villages and towns by using local human resource and materials and generate employment, hence stimulating the local economy. It will also help empower the local organizations including DDCs, VDCs and CAMCs. However, a possible threat of the arrangement is conflict between the neighbouring communities over the sites of electricity generations. This issue, however, needs extended discussions before a definite conclusion can be drawn.

Conclusion

One of the major objectives of hydropower development is to supply electricity at an affordable price. Reasonable tariff is possible only when the cheapest projects are implemented. The key to cheap and sustainable hydropower development is to build up local capability in production, management and distribution. This will require the creation of mechanisms for mobilising local finance, providing support to local industries, and giving opportunities to the locals to develop their technical and non-technical skills. In a sense, the NEA has taken a step towards this goal by implementing the CEDR even though it is primarily designed to expand the local market for distributing its surplus electricity. But since it helps NEA build partnerships with community organisations, that can serve as an opportunity for both parties. That can happen is NEA broadens this cooperation by amending the CEDR to include a provision for buying electricity from the local organisations.

For the time being, however, a proper implementation of the CEDR would be an effective measure not only for electrifying electricity-deprived rural communities but also in expanding the market for electricity, thereby strengthening NEA's institutional base through partnership with community-based organisations. In this regard, the CEDR should be seen not merely as a competitor of the MHPs but as a facilitator to strengthen these local units, but only if it incorporates a buyback policy as well. ▯

Many micro-hydro Management Committees still lack women representative

Safe Drinking Water Project Using Ozone Treatment in the Annapurna Circuit Trek

Bikash Serchan

Introduction

Management Committee Members of the Safe Drinking Water Project

The Annapurna Conservation Area (ACA) is the most popular trekking destination in Nepal, with more than 50,000 trekkers visiting it every year. In order to provide safe drinking water to the trekkers, lodges and tea-shops along the trekking trails have been transporting bottled drinking water all the way from Pokhara or Beshisahar, a distance that sometimes takes more than a week to cover. By making bottled water available, trekkers may have benefited, but since the local people can hardly afford to buy it, their health is still at risk. There are also the associated problems of waste management created by empty bottles and the visual eyesore they prove in the otherwise pristine environment of the region.

It was recognising these issues that ACAP initiated the Safe Drinking Water Project (SDWP) with the primary goal of establishing a chain of Safe Drinking Water Stations (SDWS) along the Annapurna Circuit Trek. Though this project was conceived some years back, it came into existence only in 2000 with financial assistance from NZAID and the technical support from NZ Empower Consultants Ltd. A total of 18 SDWSs have been established by the end of third phase of this project and only two more stations are needed to complete the chain.

Objective

The three main objectives of the Safe Drinking Water Project are:

- Better health—to provide safe drinking water to the local people and trekkers;
- Better environment—to reduce visual pollution created by empty mineral water bottles; and
- Better income—to provide sustainable income generating opportunity to the local women's groups.

Apart from these three basic objectives, the project has been providing employment opportunities to the local youth (particularly women), contributed to reduced fuelwood consumption that results from boiling water for drinking and enhanced the image of the ACA as a healthy tourism destination. Unlike bottled water, profits from the sale of water from the SWDSs stay within the community and is used for environment conservation and other community development work in the locality of these stations.

Technology

Although there are a number of technologies available for water treatment, the ozonation process was selected because of its efficiency and reliability. Other reasons for choosing this technology are its low energy consumption, compact size, lightweight, cost effectiveness and simple operation.

Ozonation is a much better alternative to boiling, using filters, chlorination or iodisation, and UV treatment. Boiling water requires a lot of energy in the first place, and is only effective if the water is boiled for a long period. But then water boils at a lower temperature at high altitudes, which would be the natural condition in most of the ACA, rendering the water unsafe to drink. Moreover, certain species of viruses are resistant to boiling water for as long as 10 hours.

The normal filters available in the market are not effective for removing water-borne pathogens. The ones that could possibly do that are both expensive to purchase and install. Cryptosporidium and Giardia are often chlorine resistant. Iodine tablets or drops are effective disinfectants but they affect the taste and accumulate in the body over time. UV is effective only if the water to be treated is completely clean and free of turbidity in order to allow all the bacteria to be irradiated by the UV rays. On the other hand, there is no known bacteria or viruses resistant to ozone and neither is ozone disinfection dependent on temperature for efficacy.

Ozone has been used in Europe to purify drinking water for more than a century, and in recent years its use in the United States has increased dramatically as well. When chlorine reacts with organic matter in water, it produces carcinogenic agents like trihalomethanes (THMs) or dioxins, which are proscribed by the EPA. Unlike chlorine, ozone does not produce carcinogens and therefore, in 1991, the EPA granted approval for the use of ozone to treat drinking water. This process is also being used by bottled water companies in Pokhara and Kathmandu.

Cost of Equipment

The initial investment for this technology is high. The cost of establishing the SDWS involves the cost of equipment, cost of transportation and room preparation. Since the equipment has to be imported from overseas, an ozonation plant is more expensive than other methods. In the long run, however, this technology proves cost effective since it involves less maintenance, consumes less electricity and can be operated very easily.

Room preparation and connection of facilities like electricity and water are the responsibilities of the local participating community-based organisations (CBOs). The cost of transportation varies according to the distance from the nearest roadhead. And, the cost of equipment differs on changes in design. However, in general, the cost of establishing a SDWS amounts to approximately NRs 350,000, the details of which are presented in the table below.

Alternative energy source requires additional cost as shown in the table 1 **next page**:

Management and Operation

Management System

The overall management of the SDWS is given to a local CBO. ACAP's priority is to work with the local Mothers' Group (an all-women group), thereby addressing gender concerns wherever possible. In some cases, it is the Tourism Management Sub-Committee (TMSC) and/or Conservation Area management Committee (CAMC) that are in charge of the stations, but these are generally in the most remote areas.

Distribution of Revenue

Fixed Amount:

- Repayment of capital to ACAP
- Administrative fee
- Operation and maintenance Expenses
- Annual maintenance cost
- Savings for parts replacement

Variable Amount:

- Profit to CAMC for Conservation and Community Development Projects
- Profit for Local MGs' projects

The New Zealand government provided funding for this project through NZAID by offering the equipment and installation costs to ACAP as a grant (16 stations for the first and second phases of the project). The equipment is then handed over to the local CBOs in the form of an interest-free loan to be paid back with

Table 1. **Detail Cost of establishing one unit of SDWS**

Items	Quantity	Unit	Rate (NRs)	Amount (NRs)
1. Ozone Water Treatment System*	1	set	3,15,000	3,15,000#
WATER COMPONENTS				
2. 200-litre poly tank	1	no.	880	1,760
3. 15 mm HDP pipe	50	m.	9	450
4. Water tap	1	no.	57	57
5. 90 degree bends	3	nos.	37	111
6. Pipe connectors	3	nos.	44	132
7. 10-litre plastic buckets	3	nos.	120	360
8. Tools for water connections	1	set	3,125	3,125
9. Teflon thread tape	3	rolls.	17	51
10. Stainless steel hose clamps	10	nos.	250	2,500
11. Silicon sealant	1	tube	563	563
POWER COMPONENTS				
12. Twin strand 240 volt power cable	25	m.	63	1,575
13. Compact fluorescent bulb (240 volt)	2	nos.	1,238	2,476
14. Wall power socket (240 volt)	2	nos.	275	550
15. Wall mounting box for the socket	2	nos.	57	114
16. 240 volt 3-pin plug	2	nos.	94	188
17. Light switch	2	nos.	125	250
18. Power meter	1	no.	725	725
19. Voltage stabiliser	1	no.	4,000	4,000
20. Electrical tools	1	set	13,750	13,750
21. Toolbox for both water and power tools	1	no.	5,625	5,625
22. Cable clamps (cable clips)	25	nos.	3	75
23. Stainless steel screws	40	nos.	3	120
MISCELLANEOUS				
24. Accounts cash book	1	no.	126	126
25. Sales Record Book	2	nos.	116	232
26. Simple Calculator	1	no.	726	726
27. Cash Box with lock	1	no.	2,000	2,000
28. 12 mm ply board (4'x4') for mounting equipment	1	no.	432	432
Grand Total				**3,57,073**

* Available at Lotus Energy Pvt Ltd, Kathmandu.

Local participating group shall refund this capital to ACAP as agreed in the MOU.

Source: Community Development Programme, ACAP Pokhara.

Table 2. Cost of alternative energy sources

Energy Source	Cost per unit (NRs)	Remarks
Peltric Set	100,000.	Including penstock pipe, intake structure and PH
(1 kW) Solar PV Module 3 x 75 Wp	180,000.	
Pico Set (250 watts)	25,000.	

Source: Community Development Programme, ACAP Pokhara.

revenue generated from the operation of the plants. Until the full cost of the plants is paid, the stations remain the property of ACAP and it retains the right to removal if payments are not made. Once the full repayment has been made the plant is handed over to the community.

By following a revolving credit scheme, ACAP also plans to make us of the repaid capital of the completed installations to fund additional SDWS. The collection from the first two phases is expected to meet all the costs associated with Phase 3 of the project. Therefore, no external funding source will be required to ensure the long-term sustainability and replication of this project in other parts of the ACA, which are thus far without SDWS such as the Annapurna Base Camp trail or the Upper Mustang trail.

It is important to note that the SDWS is established only at about half a day walking distances around the Annapurna Circuit Trek. This means some villages will miss out on the opportunity for a profitable enterprise. However, ACAP had devised a profit-distribution mechanism through mobilisation of the profits for community work so that a larger population benefits from this scheme as well.

Operation

The operation of an SDWS is extremely simple. The system consists of a 200-litre polytank seated on a bench into which water is piped from a nearby source. When the tank is filled to a desired level, the treatment unit is turned on. The pump sucks water from the tank and sends it through the filter and venturi (ozone injector) and back into the tank. In the meantime, the ozone generator sucks air and converts oxygen in the air to ozone. The venturi, which is connected with the ozone pipe, sucks ozone produced in the ozone generator and mixes it with the water. The ozone then kills all the microorganisms in the water.

When the display in the control panel reads 750 mV, the unit is left operating for about 5 minutes to ensure complete disinfection. The water inside the tank is then safe to drink and can be used to refill the trekkers' water bottles for a fixed price. (The price of water at various locations is shown in the Table 3.)

It takes 30 to 90 minutes to treat one lot of water (i.e. 200 litres). The treated water will remain safe as long as it can be protected from recontamination. Caution is therefore of the utmost necessity. Even a single droplet of untreated water or a single particle of dust can destroy the safety of the water and has to be treated again to avoid health risks to consumers.

The power requirement of the system is only 200 watts for about an hour a day. Wherever available, the SDWSs are powered by the national grid electricity; elsewhere power is supplied either by micro-hydro, a peltric set or solar panels.

Maintenance

All the operators receive an on-the-spot training regarding operation, maintenance and book keeping during the installation of the station. In this way, the operators become fully capable for daily operations as well as for handling minor maintenance problems. ACAP also provides a copy of the operation and maintenance manual in Nepali to all the operators and field stations. This has decreased the reliance on external support for minor repair and maintenance.

For routine maintenance, ACAP has signed a contract with Lotus Energy Pvt Ltd in Kathmandu. Their technicians visit each station every six months just prior to the start of each trekking season to inspect the system thoroughly and conduct the necessary repair and maintenance work. They also provide refresher training to each operator during their maintenance trip.

The cost of routine maintenance is about Rs 90,000/- per trip with each station paying around Rs. 12,000/- per annum apart from any spare parts which may have to be replaced. (This amount will be reduced with more installations around the circuit.) Unscheduled maintenance, however, is charged as per the actual cost incurred for the concerned station. Minor repairs are also done by ACAP under its Community Development Programme.

Table 3. Price List of Safe Drinking Water* (Rs./ltr)

Settlement	Price	Power Source	Settlement	Price	Power Source
Birethanti	25/-	NEA grid	Jagat	30/-	Peltric set
Ghasa	35/-	NEA grid	Tal	35/-	Solar
Lete	35/-	NEA grid	Bagarchaap	35/-	Solar
Larjung	35/-	NEA grid	Chame	35/-	NEA MH
Tukuche	35/-	NEA grid	Pisang	40/-	Solar
Marpha	35/-	NEA grid	Humde	40/-	Solar
Jomsom	35/-	NEA grid	Manang	40/-	Solar
Kagbeni	35/-	NEA grid	Churi Letdar	50/-	Peltric set
Muktinath	40/-	NEA MH	Thorong Phedi	60/-	ACAP MH

* Local customers can purchase the water at a reduced price.

Source: Community Development Programme, ACAP Pokhara.

Table 4: Financial status of SDWS, Manang

Description	Amount (NRs)	Remarks
Gross income	2,60,361	Sale of water, water bottles, bottle carriers, etc
Expenditure	1,24,580	Salary, room rent, loan repayment, stationery; maintenance fee not included
Net income	1,35,781	as of March 2003

Current Situation

So far, 18 SDWS have been installed around the Annapurna Circuit Trek. In the first and second phases, the donor had supported the installation of 16 plants. In order to promote the SDWS, ACAP has mounted a serious marketing campaign to inform the trekkers about the project asking them to support the schemes. The campaign includes brochures handed to all trekkers upon entry into the ACA, signboards, health and environment-related posters and stickers. To target and promote the stations at the local village levels, ACAP field offices conduct awareness campaigns, health education, conservation education and extension programmes tied to the SDWS.

With the establishment of SDWS, local people have benefited from employment and the income generated from the tourism business which would otherwise have gone to bottled water companies in urban centres. Though the impact assessment of SDWS is yet to be conducted, the Mothers' Groups have claimed a significant reduction of empty plastic water bottles as waste during their routine monthly clean-up campaigns.

The health of the local people has also improved with this project since the locals have also started to consume treated water. After the establishment of SDWSs, diarrhoea has dropped from the most common to the second most common cause of disease reported in Jomsom Hospital. This project is also much appreciated by most trekkers except for a few who complain about the price, which is usually still half of what bottled water costs.

The project should have by now been commercially viable and able to fund at least four stations to close the circuit as expected in the initial plan. Unfortunately, almost all the stations have suffered from low sales of water and lack of revenue generation to repay the loan as agreed in the MOU with ACAP. This has mainly to do with the sharp decrease in the number of tourists during the last quarter of 2001 and the whole of 2002 and 2003—a trend globally witnessed and more so in Nepal given the ongoing Maoist conflict.

The purchase rate too is not very encouraging. During the planning phase, it was envisioned that 20 per cent of all trekkers entering the ACA would buy two litres of water every day. But most of the stations have failed to achieve this target. The only station that did was Manang, which had a net savings of more than NRs 100,000 as of March 2003. The reasons behind the success of this particular station can be attributed to:

- Longer stay of trekkers (usually two nights) for acclimatisation;
- Wide promotion of safe drinking water by Himalayan Rescue Association (HRA); and
- Use of safe drinking water by local people during festivals.

Problems

ACAP has gained valuable expertise in disseminating this technology in rural Nepal. This has enabled the ACA in maintaining its standards as a healthy and eco-friendly trekking destination. However, sustainability of these schemes is still in question since ACAP and the SDWSs have been struggling with various problems from the very beginning, as listed below:

- Drop in the number of tourists coupled with low purchases is limiting revenue generation;
- Lack of reliability in supply of safe drinking water caused by freezing conditions at high altitudes and power breakdowns which limit service hours;
- Shortage of capable manpower to run the station in remote areas due to high turnover of operators;
- Limited information received by trekkers visiting the ACA about the availability of safe drinking water;
- Limited awareness among local people about water-borne diseases and environmental impact of empty water bottles and ultimately on the tourism industry;
- Lack of cooperation from hotels and lodges regarding promotion of SDWS; most hoteliers and lodge owners fear losing their individual profit earned from selling bottled mineral water; and
- Minor problem with guides buying water at local prices and passing it on to tourists.

Future Direction

ACAP is a pioneer of the SDWS technology in Nepal and it is continuously working to make the SDWSs environmentally, economically and socially viable. In the current context of decline in tourism, there is not much ACAP can do other than try marketing the safe water to the few that go trekking and to the locals. Increasing the rate of water through awareness generation is one strategy taken by ACAP.

Out of old habit, local people use direct tap water or stream water, which comes free. Such untreated water is the major cause of outbreak of water-borne diseases and infant mortality in many rural areas in Nepal. ACAP field offices have been conducting many awareness-raising programmes in the ACA through its Health and Sanitation Programme, Conservation Education Programme and Gender Development Programme.

ACAP also relies on mobilising the local health authorities to generate awareness in the villages.

Similarly, hoteliers and lodge owners need to be made aware of the negative impact of plastic water bottles to the environment and the tourism sector as a whole. ACAP needs to ensure that they are informing their guest about the community-owned and -operated SDWSs in the trekking route by displaying the brochures. ACAP also has to convince the hoteliers to perceive the SDWS as a local asset rather than a liability; and a key to preserving the environment for the future and also for initiating community development and conservation work with the income generated.

ACAP has also recently developed expertise in passive solar design of buildings. This may be linked with SDWSs by exploring the possibility of room heating and insulating the system to mitigating the freezing problems in higher altitudes. ACAP has also improved the signage for all SDWSs. Each station now has at least four signs: two at the station (one at a right angle to the trekking trail), and one at each end of the village indicating the walking distance to the SDWS. SDWS is also marked out in every location map.

For more effective marketing strategy, ACAP has also been liaising with HRA, TAAN, Guide Book and Map Publishers so that tourists can get information on safe drinking water before they start their trek. Regular updated information on the web is also available at http://www.kmtnc.org.np/acap.htm and http://www.mpwr.co.nz/acap_safe_drinking_water_update.htm.

Establishment of sub-stations is also under consideration to ensure a reliable supply of safe drinking water to those villages that are dispersed. Setting up an SDWS at the Entry Permit Counters at the Lakeside, Pokhara, and in Thamel, Kathmandu, could further advertise this project. ACAP needs to explore this further.

Once the circuit is completed with two more installations, ACAP can extend this project in other trekking destinations within the ACA as well and consider expansion into the Manaslu Conservation Area Project. Other potential sites for replication of this project are the major tourst areas of Nepal such as the Royal Chitwan National Park, Langtang National Park, Sagarmatha National Park, Royal Bardia National Park and Kanchanjunga Conservation Area. As this technology is equally effective for removing iron, hydrogen sulfide, manganese and arsenic, which are common in ground water, this technology could be disseminated widely for water treatment in the Tarai region of Nepal as well. Other applications of ozone are wastewater treatment, air purification, food processing, etc, which could be explored to target the urban areas.

Conclusion

Without doubt, this technology is an effective method of treating water that is slowly gaining popularity worldwide and is a much suited technology in the resource-scarce mountains. Good management, increased awareness and adequate promotion are the basic requirements for the success of this project. Regular and prompt maintenance are of utmost importance for maintaining a reliable supply to the trekkers who need safe drinking water.

When this project becomes financially sustainable with the acceptance of hoteliers, it could finally replace the use of bottled mineral water in the ACA, making the region free of empty water bottles. This would not only uplift the image of ACA as an eco-tourism destination, but also assist in better health, better environment and better income locally. ▯

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Clean Energy Technology: Improved Traditional Water Mills and Safe Drinking Water Stations disseminated by ACAP

Bhaskar Singh Karky Jonathan Cushing

Introduction

ACAP has been promoting the use of numerous clean energy technologies (CETs) in the Annapurna Conservation Area (ACA) with the objective of reducing pressure on the scarce mountain resources, improving the livelihood conditions of the rural population, and reducing drudgery, particularly of women. Improving traditional water mills by retrofitting them with modern equipment for increased efficiency and the introduction of ozonation plants to treat water are two examples of community owned and operated CETs currently in use in the ACA.

Water Mills in Nepal

Water mills, or ghattas as they are locally known, are used throughout Nepal to grind cereals and press mustard. Water mills been used in various forms for almost as long as civilisation itself. An example is the Buddhist prayer wheel seen throughout the Himalaya (Subba, 2001) which are also based on the same principle as the water mills. Using local materials and water as power, these mills are extremely simple and cheap to run. Shrestha and Amatya (1998) estimate there may be 25,000-40,000 water mills in Nepal that are used for grinding and hulling of grain crops. The majorities of these mills generate a minimal output (0.2-0.5kW), giving a grinding output of 10-20 kg an hour (Shrestha and Shrestha, 1998) and are located within the community. They are owned either jointly by the community, but more commonly it is the property of an individual within the community. The mills are generally simple and cheap to construct. Since all the parts can be made from locally available materials, they require very modest investments. However, such mills tap only a fraction of the energy of flowing water (Subba, 2001).

Water mills are normally set up by diverting a stream through stone and brushwood weirs into the mill house where a horizontal axle turns the grinding stone. At the centre of the mill house stands a large wooden boss, into which the turbine blades are fixed. These are made of wood, and provide the power to turn the grindstones. Grindstones are the most expensive component of mills and may have to be carried in from elsewhere if there is no one in the locality with the skill required to carve stones.

Private mills are generally owner operated, whereas community-owned mills are likely to have an operator who is paid to operate the mill, either in cash or kind. In recent years, however, a trend towards privatisation of mills has been observed. East Consult (1990) identified this change among both traditional and improved mills. Although the reasons for this shift are not entirely clear, it has been suggested that complications with cross-caste ownership may be partly responsible, while problems of finding staff and those associated with community management could also have played a role.

There are two kinds of water mills: i) Traditional Water Mills, and ii) Improved Traditional Water Mills, with the latter incorporating slight modifications for improved efficiency. ACAP has been promoting Improved Traditional Water Mills within the region, while advocating improvement of traditional ones by replacing plastic feed pipes and metal feeds and runners to improve their efficiency. Such improvements have been widely adopted throughout the area and now almost all water mills in the Jomsom region now transformed into Improved Traditional Water Mills.

Figure 1. Traditional Water Mill

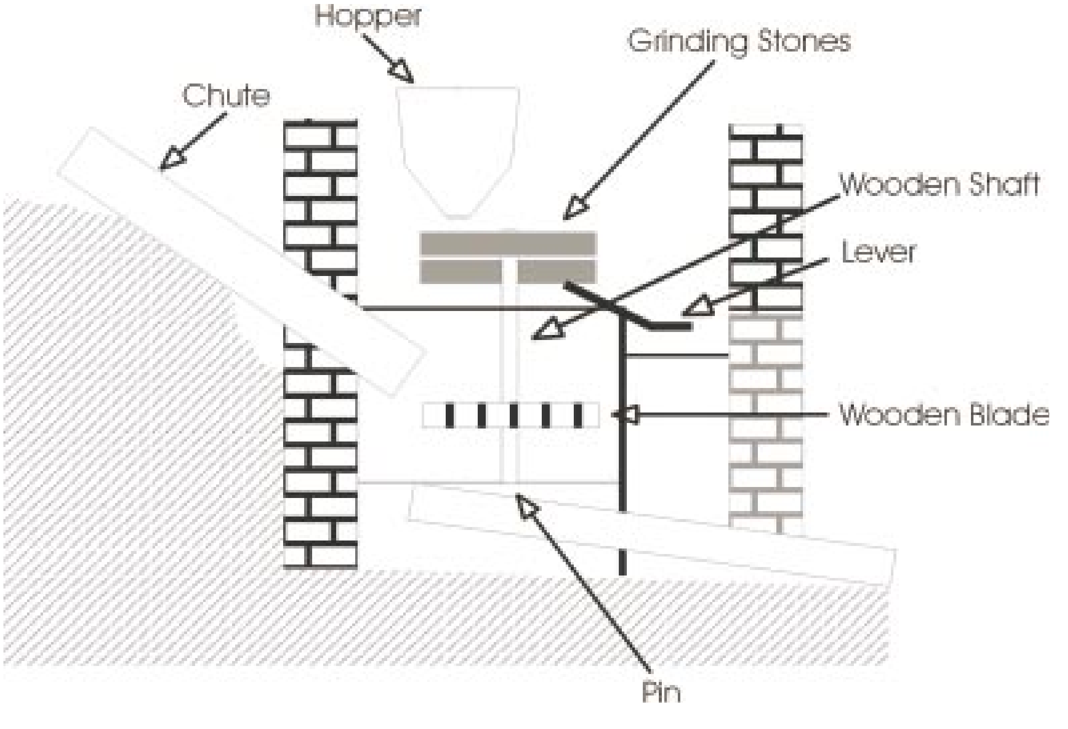
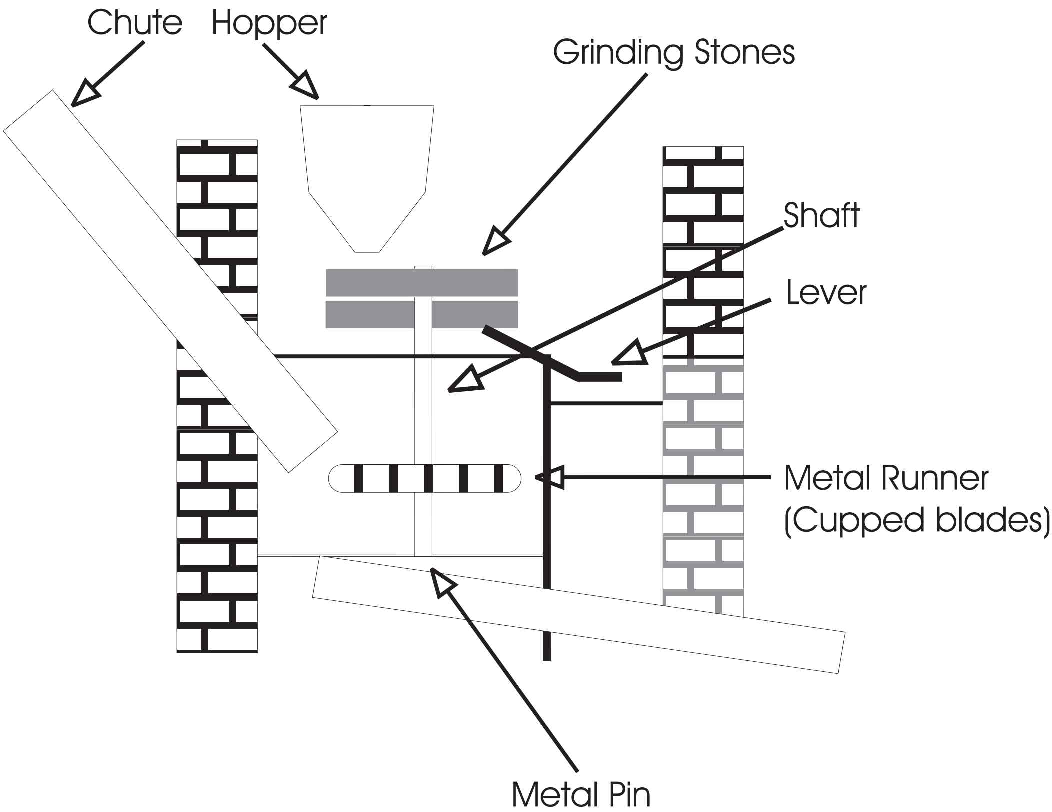


Figure 2. Improved Water Mill



TRADITIONAL WATER MILLS

The Traditional Water Mill, or ghatta, is based on the principle of the conversion of kinetic energy from downward flowing water into mechanical energy (Shrestha, 2002). This is achieved by diverting water downwards through an open channel onto a water wheel or turbine which then spins due to the force of the water bearing down on it. The centrepiece of the runner is a large wooden boss onto which turbine blades are fitted. Blades are driven into the boss and secured either with nails or by wedging. The boss is attached to a drive shaft that is then attached to the top millstone. The mill can be controlled by raising and lowering the shaft and by regulating the flow of water to the turbine. Such mills generally require all moving parts to be replaced every two to three years (Shrestha, 2002).

IMPROVED TRADITIONAL WATER MILLS

It is not known how many mills in Nepal have been modified. The Centre for Rural Technology (CRT, 1995) in Kathmandu estimates that it

Table 1. **Differences between traditional and improved mills.**

Traditional Mill	Improved Mill	Advantages of improved mills
10-20 kg per hr output	20-50 kg per hr output	Higher potential output
Wooden Runners	Metal Runners	Increased efficiency
Less water efficient	Increased Water efficiency	Mills can run throughout the year
	Shortened mill staff pole	Increased grinding capacity
Wooden blades	Shaped metal blades	Blades are more efficient and last longer

Table 2. Basic technical and functional features of traditional and improved water mills (Shrestha, 2002).

Comparison Parameters	Traditional Water Mill	Improved Water Mill
Length of Canal (in metres)	20-200	20-200
Working Head (H) (in metre)	3-7	2-7
Water Discharge (Q) (in lps)	40-100	20-100
Inclination to Chute (degree)	40-50	30-40
Speed, rpm	60-90	110-210
Output Power Capacity (kW)	0.2-0.5	0.5-3
Grinding Stone	Local	Local
Thickness of Grinding Stone (")	3-10	5-15
Diameter of Grinding Stone (")	24-34	24-34
Operational Efficiency (%)	Below 25	30-50
Functions and Capacity	– Grinding cereals only, 10-20 kg/hr	– Grinding cereals, 20-50 kg/hr - Dehusking of rice (50-70 kg/hr) - Expelling of oil from oilseeds (10-15 kg/hr) - Generation of electricity (12V-DC, 220-AC, 1-3 kW)
Repair/Maintenance	High	Low
Life Span	2 Years	10 Years

Table 3. Power outputs of mills (Shrestha and Shrestha, 1998).

	Power Output (kW)
Traditional Mill (*Ghatta*)	0.2-0.5
Improved Mill	0.5-2.5
Electric/Diesel Mill	1+

Table 4. Power requirement for various rural applications (Shrestha, 2002).

Mill Machinery	Required Power (kW)
Grinder (maximum 40 kg maize/hr)	0.7 - 1.4
Grinder (maximum 70 kg maize/hr)	1.75 - 3.0
Paddy Huller, No. 5 (maximum 70 kg paddy/hr)	1.75 - 3.0
Oil Expelling, 3 Bolt (maximum 25 kg mustard/hr)	2.1 – 3.0
Paddy Thresher (maximum 100 kg paddy/hr)	0.7 – 1.75
Circular Sawing Machine @ 350 mm	1.4
Pliar @ 150 mm	0.7
Dynamo, DC 12 Volt, 400 Watt	0.4
Induction Generator, AC 220 Volt, 1 kW	1.0
Lathe @ 300 mm	0.7

has installed 600 improved mills and is continues to install them at the rate of around 250 a year (Eagle and Olding, 2001). Modifications are generally simple, and often just involves replacing fragile parts with more durable metal parts. The open channel to the turbine is also replaced with a PVC feed pipe to maximise power. This results in substantial improvements to the output of mills and to the amount of 'down' time that mills experience when replacing parts. Basic modifications consist of replacing wooden mill runners with metal, and changing the wooden, handcrafted turbine blades for more efficient metal ones. Combined with a shorter staff pole, this results in an output of 20-50 kg an hour compared to 10-20 kg possible with traditional mills (Shrestha and Shrestha, 1998).

Parts for improved mills cannot be manufactured by local blacksmiths or craftspeople and have to be brought in from manufacturing centres. This increases the cost of improved mills and creates a dependence on external suppliers (www.panasia.org). The cost of the improvement kit is approximately USD 80 (Eagle and Olding, 2001) or NRs. 6,080. (76NRs. = 1USD). AEPC estimates that 465 improved mills were installed between 1995 to 2001 and prior to that, there were around 200 such improved mills in the country (AEPC, 2002).

Payment to commercial suppliers have to be made in cash, not in kind, meaning that mill owners may have to charge customers in cash, or take loans to finance the improvements (www.panasia.org). Shrestha and Shrestha (1998) however concluded that most mill-owners pay for improvements outright, rather than take loans to cover the cost of improvements. This would suggest that mill-owners or community user groups generally have sufficient funds to cover the cost of improvements. Additional end-uses such as dynamos or hulling units are generally more expensive (Shrestha, 2002) and these certainly require loans or financial support to install them. Improved mills connected to a huller can mill rice and those connected to an oil presser can expel mustard oil. Once installed they can be used to generate income for the owner or the local users' group, but taking loans means that cash will have to be generated from the system.

Mill-owners benefit from the improved mills in several ways, the principal one usually being increased income (East Consult, 1990) from the higher capacity of the mills. This greater processing capacity also translates into decreases in operating hours for improved mills. Shrestha and Shrestha (1998) and others note that increases in productivity have meant that improved mills now need to operate only for 6-12 hours a day, instead of up to 24 hours a day during festival seasons when demand exceeded production. This means that millers can spend more time at home or engage in alternative income generation activities such as farming. In the case of Melamchi (Shrestha, 2002), the increase in capacity from mill improvements has meant that a miller's need for foodgrains are now met through payments made for milling, whereas earlier the mill earned only 50-75 per cent of the required quantity, thereby resulting in the need to find alternative sources of income.

Advantages for Improved Mill Users

The implications of using an Improved Mills are perhaps not immediately obvious to mill users since processing charges generally do not appear to decrease when mills are modified (East Consult, 1990). However, since the time spent waiting for grain to be processed is reduced, customers (primarily women) have more free time in which to pursue other activities (Shrestha and Amatya, 1998). What is done during this saved time is a separate issue. East Consult (1990) found that there was a general consensus amongst users that life has become easier for women after the introduction of the improved mills. They also found a 'spirit of camaraderie' among mill users who used the time taken in waiting for grain to be processed to instead socialise with other village members, something they would otherwise not necessarily have a chance to do. But it is also possible that, although not discussed, opportunities to socialise have in fact been reduced with the introduction of improved mills.

Improved Mills offer an improved level of quality over traditional mills since grinding is more efficient (East Consult, 1990). Owners have also used the extra power generated to diversify the services offered and as a result find they have more customers now (East Consult, 1990). Oil presses and other services are also considerably more efficient when run from an improved mill, with *siddha* mill (East Consult, 1990) producing 50 per cent more oil than the traditional presses.

In terms of accessibility of improved services, it has been noted that these services generally do not appear to reach those commonly termed as the ‘poorest of the poor’. The poor either cannot afford to use the facilities or when they do use them, they are required to pay more (East Consult, 1990). This is due to their inability to make cash payments which therefore requires them to often pay in kind which is more expensive than paying by cash. Community-owned projects might also be controlled by the dominant caste in a community, making it difficult for others to participate in the management of mills (Synghal, 1994). It is also likely that men may dominate management groups. Rijal (1997) finds that women find ‘it difficult to become active participants in development activities because of poverty; illiteracy; [...] and traditionally conservative attitudes towards women’ (Rijal, 1997).

Similarly Whittington and Swarna (1994) note that in water projects worldwide it is often men who take the decisions regarding projects whereas in daily life they are mainly used by women. This can sometimes lead to projects being unsuited in practical terms. The gender imbalance may be worse in the Mustang region due to the high proportion of male migrant labour (ACAP/WRUP, 2002) who may lack appropriate knowledge of the region but still sit on many of the decision-making committees. Rijal concludes that project subsidies and funding agencies have failed to ‘address concerns regarding social equity in terms of class, gender, and ethnic groups’ (Rijal 1997).

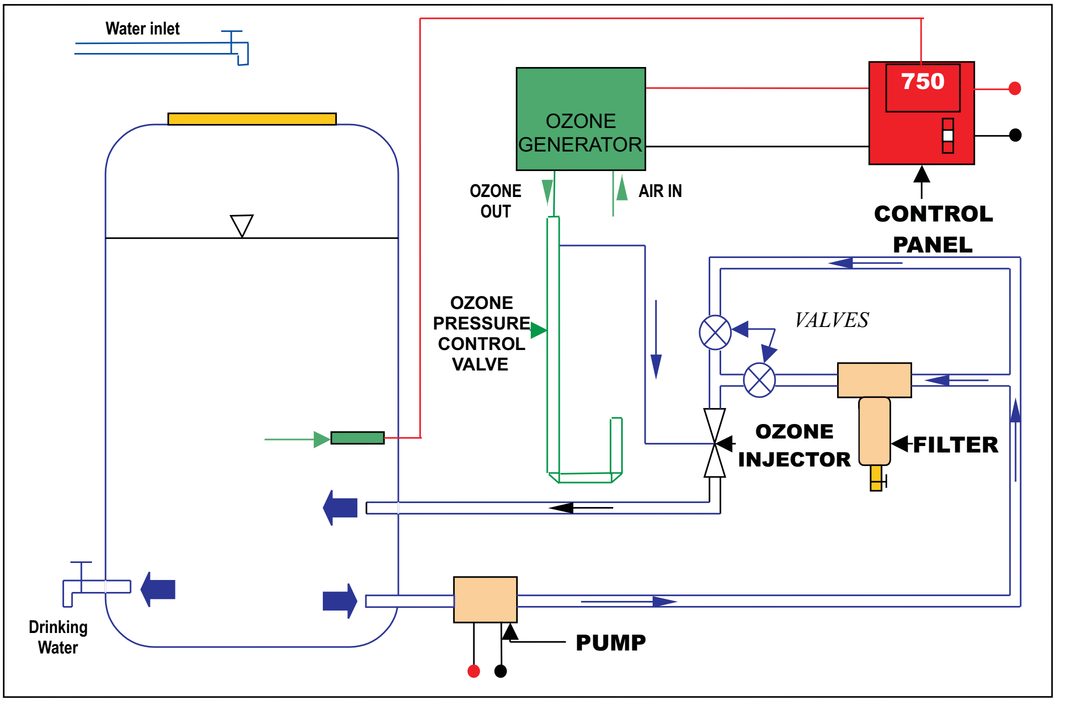
Government and other funding agencies do not take into account these factors when considering projects since funding tends to be on an ad-hoc basis (Rijal, personal communication, 2002), with little consideration given to factors that should be prioritised, (such as gender and caste issues). However, in the Muktinath area, improved mills were found to be community owned and operated with a 100 per cent outreach to households.

Safe Drinking Water Stations

The ACAP established a series of Safe Drinking Water Stations in the conservation area in 2000-2003. The stations were provided by a New Zealand-based environmental consulting company, Empower, which specialises in similar environmental projects. The company was set up to ‘combat poverty through addressing the infrastructure and social and economic development needs of such communities’ (Empower, 2002).

Since safe drinking water stations are not manufactured in Nepal, the cost of setting them up is rather steep. The various components have to be imported either from New Zealand or a third country. Given the need for a heavy initial investment required, the New Zealand ODA came through with the funding for the project (Empower, 2002), and also provided the equipment and installation training to ACAP. The equipment

Figure 3. Schematic diagram of water treatment through ozonation process.



was then supplied by ACAP to village groups, who bought it in under a ‘hire-purchase’ kind of arrangement. However, no interest was charged and the loan is to be paid off with revenue generated from the plants. Until the full cost of the plants have been paid off, the equipments remain as the property of ACAP and in that regard, ACAP retains the authority to remove the equipment from the area if repayments are not made (Empower 2002). In comparison with similar schemes under which micro-hydro plants are being operated (see Kim and Karky, 2001), in the case of the safe drinking water plants the advantage remains with ACAP in that they are easily transportable, and could, if necessary, be removed.

Operation of Safe Drinking Water Stations

The Safe Drinking Water Stations in the ACAP trekking circuit use solar power or electricity from a micro-hydro plant or the national grid. Safe drinking water stations purify water by using ozone. Treating the water with ozone leaves no taste or colour in the water; after the treatment is over, the ozone reverts back to carbon-dioxide and oxygen. Ozone destroys microorganisms and bacteria through a process known as ‘cellular lyses’, rupturing the cell walls and converting the remainder of the organism into CO_2 (www.mpwr.co.nz). Ozone is effective against a wide range of organisms, including bacillus spores which can survive chlorination as well water boiled for up to ten hours (www.mpwr.co.nz). Water is initially filtered through a cloth or ceramic filter to remove physical objects that may be present before being treated with ozone. Ozonation plants thus substitute both heat requirement for boiling water and iodine usage for chemical treatment

Renewable Energy Technology (RET) in Harnessing Water Resources

Given ACAP's integrated approach to the conservation of all forms of natural resources as well as the development of livelihood conditions, it was obvious that providing energy for development was as crucial as supplying energy that had no negative environmental impacts. But the scattered nature of mountain settlements in the region makes energy transfers expensive. It is for this reason that ACAP has promoted decentralised energy systems such as Improved Traditional Water Mills (*ghatta* improvement) and Safe Drinking Water Stations as a way to promote Renewable Energy Technology (RET) to lessen the impact on the resource-scarce mountain environment. There are other RETs disseminated by ACAP as well such as micro-hydro electricity, solar heating and lighting and bio-gas.

To retrace a bit, RET is the use of technology that enables energy

Table 5. **RET characteristic for water mill and safe drinking water plants.**

RET characteristics	Improved Water Mill	Safe Drinking Water Station	Technology implication
Modular in nature	Micro-enterprise for Agro-processing	Micro-enterprise for Mothers' Group	Community-owned and -managed micro-level enter prises for sparsely populated mountain settlements
High upfront payment	Traditional mills improved by ACAP subsidy	Donors subsidise the cost of the technology	TWM is relatively less expensive compared to SDW technology; both require subsidy
Intermittency in supplying energy	WM are individual location-specific plants where water is dependent on rain, irrigation usage, MHP usage, etc	SDW plants depend on electricity or solar energy; intermittency is an issue in the latter case	Energy cannot be stored or supplied in the case of WM
Lack of despatchability in distribution and storage	Operation is seasonal and is based mainly on the harvest season	Operation is seasonal and is based on tourist season	Location specific and well suited to the mountain environment

usage in a sustainable manner with the replenishment rate of energy being more than the extraction rate of bio fuels. In the case of solar, wind and hydro, these alternative sources of energy are of a non-depleting nature. Today, climate change has become a most controversial issue between the developing countries and the industrialised ones with policy and technology focusing on transition to low-carbon energy systems (The Economist, 2002). In this sense, the water mill and safe dinking water stations are ideal in a changing world since both carbon-free technology systems that use low-grade energy.

The characteristics of RET as described by Rijal (1998) can be discussed separately with regard to the water mill and the ozonation plant as follows:

In terms of technology, the Safe Drinking Water Station Technology and the Improved Traditional Water Mill provide location-specific comparative advantage in areas where settlements are sparsely populated and energy requirements are characterised by low load factor (water mill is dependent on the harvest season and ozonation plant depends on tourist season). A major advantage of small-scale decentralised energy systems like these which make use of indigenous knowledge for management is that they are more viable than larger projects managed from the centre (Rijal, 1998).

Conclusion

ACAP has promoted the efficient and rationale use of energy from water so that environmental resources are conserved. Similarly, sustainable economic development is taken care of through income generation from the technology and living conditions are improved through reduced human drudgery. With both the improvement in the Traditional Water Mill and the introduction of the Safe Drinking Water Project, ACAP has managed to introduce appropriate small-scale decentralised energy systems that use water resources and are managed locally.

The water use technologies examined here are unique from each other in many ways. While one relies on updating a centuries-old technology found in operation all over the country, the other introduces a modern method of purifying water for drinking. As these two RETs need to be looked at separately, a straightforward comparison of the two technologies is not quite appropriate. At the national level, there is a lack of such simple yet environmentally sustainable technologies; but these experiences from ACAP require further assessment before they can be considered for replication elsewhere.

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Role of Women in Water Resources Use: Study in ACAP

Chandra Bhadra Bhaskar Singh Karky

End-uses of micro-hydro electricity assisting in reducing women's drudgery

Background

The main users of water resources at the household and community levels are women. They use water for domestic purposes, for irrigation and for grinding cereals at water mills. They also use hydro-electricity obtained through flowing water for domestic usage and micro-enterprises. Given this reality, the Annapurna Conservation Area

Project (ACAP) has mandated that of the 15 members of the Conservation Area Management Committee (CAMC), three of the nominated members have to be women. This is to ensure that women's interests are represented and addressed in ACAP's programme activities. However, traditional conservative attitudes towards women still persist and thus provide constraints towards a better understanding of the role of women and their potential for water resources management and conservation and hence, the sustainability of projects. This quandary called for a systematic action-research with a gender perspective so that gender concerns were mainstreamed into ACAP's water resources development even as issues of gender-equity in the distribution of water resources benefits were ensured and women's rights and control over community water resources established.

Though the main objective of the research was to study patterns of water resources usage among women, a gender-analysis technique was used. This was felt necessary since it was premised that women's situation cannot be understood in isolation and without realising their position and condition vis-à-vis men within the family, in the community, in the larger society and the state. The study was based on the assumption that

- Due to the patriarchal socio-legal systems, women do not have equitable access to benefits of water resources development; and
- Enhancing their decision-making power on choice of project, and ensuring equal and active participation in the management and conservation of water resources result in more equitable benefit sharing and sustainability of projects.

The sampling frame for this study selected settlements in three geographic regions, purposefully and specifically to best represent the ecological, economic and social diversity within the ACA. Quantitative and qualitative surveys were conducted in Ghandruk, a renowned tourist destination in the south-west part of the ACA to represent the mid-hill region; Tachey, a non-tourist destination in mid-east ACA, to represent the Himalayan region; and finally, Lo Manthang and Tsarang, which lies in an area of controlled tourism in the far north of the ACA, to represent the trans-Himalayan region.

Research Findings from ACAP Study on Women

Sex Composition

The study (Bhadra and Karky, 2002) selected a near-equal proportion of male (48.2 per cent) and female (51.8 per cent) respondents from the three ecological regions, with a total sample size of 112.

Demographic Characteristics

The sample consisted of the Gurung (46.4 per cent) and the Loba (33 per cent) ethnicities in the majority. Other ethnic groups like the Magar (1.78 per cent) and the Lama (0.09 per cent) and various castes like Kami (4.46 per cent), Damai (1.78 per cent) and Chhetri (1.78 per cent) were small in number. Seventy-five percent of the respondents were married, 12.55 per cent were unmarried, 1.8 per cent widowed, 1.8 per cent divorced/ separated and 8.9 per cent remarried. The mean age during the first marriage for women was 20 years and for men, 24 years. Similarly, the mean age of first childbirth for women was 23 years and for men it was 29 years. Among the respondents, 64 per cent of women and 36 per cent of men were illiterate.

Adequacy of Water Resources in the Household

On the question of having adequate water for household needs, about 82 per cent percent of the respondents answered in the affirmative, while 18 per cent reported that they do not have access to adequate water supply. The latter comprised of respondents from Ghandruk (12) and Tachey (8). All respondents from Tsarang and Lo Manthang reported that they have adequate water supply. This could reflect better water resource management by the locals in the semi-arid regions where water is extremely scarce and stands as a limiting factor for agriculture and livestock rearing.

However, when a gender analysis was performed, more women (17 respondents) than men (3 respondents) reported not enough water supply for household purposes. This has implications on women, who have the primary responsibility of managing water at the household level. It may mean that women endure the inadequacy more intensely and/or it could well be that men are not even aware about the water scarcity in the household. That could explain why 94 per cent of the men reported that there is adequate water in the household, while that was true for only 70 per cent of the women.

Purposes of Water Resources Use

Respondents reported that they used water for drinking and sanitation (27 per cent), irrigation (25 per cent), livestock rearing (30 per cent) and income generation (18 per cent). Again, the results of the gender analysis showed differences in responses with regard to water use for irrigation and livestock rearing. More women (59 per cent) reported using water for irrigation, while more men (53 per cent) reported the same for livestock rearing. This implied that women are engaged in crop production, while men are in charge of in livestock rearing. The responses for income generation was also distinct between men and women. A larger proportion (61 per cent) of women reported that water is used for income generation as opposed to only 39 per cent men.

Assistance in Income Generation from Water Resources Use

A total of 81 respondents reported that water assists them in income generation. Twenty-three reported that it helps them in income generation from agriculture/ horticulture; 20 maintained that it helps them in income generation from livestock rearing; while another 20 reported that it assists them in running lodges/restaurants/tea shops. An additional 18 people reported that they use water for running watermills.

The gender analysis of these responses revealed that except for those respondents who used water for income generation from lodges/ restaurants/tea shops, the number of male respondents is higher in all the other categories. This indicated that more women are engaged in running lodges/restaurants/tea shops than men, while more men are engaged in income-generating activities through water mills, agriculture/horticulture and livestock rearing.

Existence, Access to and Benefits from Water Resources Projects

Existence of Water Resources Projects

In the four VDCs chosen for this research, the existing projects included drinking water and sanitation, irrigation, micro-hydro plant (MHP) and water mills. At the time of the research, these villages did not have Safe Drinking Water Stations (SDWS) that were introduced by ACAP in the Annapurna Trekking Circuit.

Access to Water Resources Project Outputs

All the respondents reported that they had access to water from the various drinking water and sanitation projects even though they reported not having access to ozone filter plants (Safe Drinking Water Station) projects. (It should be noted here that the SDWS is not the same as drinking water and sanitation projects. Refer to Karky and Cushing (2002) for Safe Drinking Water Stations in the ACA. While ozone filters are being installed in the ACA, none of the settlements in the research sample lie in the trekking circuit route.)

All the respondents except two reported having access to electricity from micro-hydro projects. Similarly, 96 per cent of the respondents stated that they had access to traditional water mills. Gender analysis of these results did not reveal any significant differences between males and females. However, analysing the reasons given for lack of access to irrigation showed that the main reason to be ‘no land to irrigate’. In this category, the number of women (23 responses) is almost double that of men (12 responses). This is indicative of the lack of women’s rights to land entitlement.

Benefits from Water Resources Project Outputs

Drinking Water and Sanitation Project

Thirty-three per cent of the respondents attributed improvement in their health to drinking water and sanitation projects. A further 32 per cent reported that the drinking water and sanitation projects had saved time for them and 28 per cent reported reduction in drudgery. The gender analysis did not show much difference in the responses of men and women, except for three women who reported having more leisure while none of the men reported the same.

Micro-Hydro Project

The highest proportion (42 per cent) of respondents reported that access to MHP electricity had improved their living standard. Thirty-six per cent reported that it has improved their health and 9 per cent reported that it had reduced drudgery. A substantial proportion (12 per cent) reported having benefited from income-generation opportunities. The gender analysis revealed that more female (55 responses) reported reduced drudgery and improved health as opposed to 43 men who gave the same response. This indicates that micro-hydro energy / electricity reduces women's workload, leading to their increased well-being. Interestingly, three women also felt that access to MHP raised their social status.

Water Mill

Water mills that were considered in the study also included improved traditional water mills apart from the new ones. Forty-four per cent of the respondents reported reduced drudgery while another 42 per cent reported of time saved by using water mills. Interestingly, gender analysis revealed that the number of men who reported that the water mills had saved their time was much higher than women (39 men as against 28 women). This result is indicative of men helping in the household food processing using water mills. What is not known is, had there been no water mill, whether women would be more engaged than men in grinding foodgrains manually. Other studies of the past have found men to share women's food-processing activities if mills had been installed in the village (Bhadra 1997).

Participation in Water Resources Development

A gender analysis of participation in MHP projects was not possible because the percentage female members in users' group committees was almost negligible. In both Tachey and Lo Manthang, the management committees were exclusively male, while in Tsarang there was one female member in the committee and who happened to be the chairperson of the committee as well. While a case study on her would have been an appropriate tool for the purposes of gender analysis, it was beyond the scope of the study at hand.

A study conducted on MHP management in ACAP (Kim and Karky 2001) revealed that there was no effort on the part of the locals to include women at the decision-making level of the village electrification projects. A woman was found to be an operator because her husband was an operator as well.

However, she had no visual influence in the decision-making and was singled out by the other male operators. The reason given for not involving women in the meetings and committees was that women are not educated and hence do not understand technical matters. Additionally, women were said to be too busy at home (Kim and Karky 2001). Further study on this is desirable.

Similarly, in terms of irrigation projects, in Lo Manthang, the irrigation committee had some female members but the field office reported that men made all the decisions. In Tachey, there was no irrigation project during the time of the study. However, contrary to MHPs and irrigation projects where women's participation was either negligible or non-existent, women's users' group participation was more evident in drinking water projects. A gender analysis of participation and decision-making was, therefore, done for drinking water projects. But despite the relatively higher participation of women in drinking water projects in comparison to other water resources projects, their participation in users' groups was found to be very low (8 per cent of the respondents). These findings coincided with the results from a survey conducted by UNDP, which revealed that most of the drinking water projects in rural areas were implemented by the state agency with minimal consultation and participation by the rural community, the supposed beneficiaries (UNDP, 2002).

Participation in Users' Group Activities

The gender analysis of the Drinking Water User Group membership revealed that in the sample population as a whole, only a few respondents held membership in this type of users' groups (just nine respondents), while three respondents reported that they had no drinking water project in their respective villages. Due to the small number of respondents who were members of drinking water users' groups, gender differentials were more difficult to assess.

When the majority (72 per cent) of the non-member respondents were asked why they were not a member in a users' group, most reported that membership was not mandatory for using the water supply while others had their own water sources. Among the other reasons cited, the men stated that they lived outside of the village or had only a temporary settlement in the village, while the women revealed that they had no time to participate in the committee because of their other responsibilities or their lack of education.

Of the nine respondents who were committee members, all five women were only general members while among the men, one man was a secretary of the committee and the other three were general members.

Out of the four men, only one

man reported that he participated in the meetings regularly while four of the five women said they participated in meetings regularly. This is indicative of women's commitment in the drinking water committees through their regular participation in meetings. In addition to attending the meetings regularly, the female committee members also confirmed that they expressed their opinions in meetings. On the contrary, only one man reported that he expressed his opinion and that too occasionally. This reflects men's irregularity in meetings and their reluctance to express their opinions. Male out-migration may also have had a role to play for this gender differential in attending meetings and expressing their views.

Ironically, although the men were irregular in the meetings and reluctant in expressing their opinions, the men's opinions were always considered and took precedence over those expressed by women. All the male members reported that their opinions were taken into account; only two women reported that to be the case. Similarly, when it came to actual implementation of opinions, it was revealed that men's opinions were implemented more often (as reported by the three men) than women's opinions (reported only by one). This indicated the devaluation of women's opinion by the committees.

Participation as Labourers

Around 70 per cent of the respondents reported that they worked as labourers in water resource projects, with nearly all of them (94 per cent) engaging as unpaid / voluntary labourers. The gender analysis showed that there was no difference in terms of labour participation. The maximum number of both men and women contributed in earth and stone works. In fact, women volunteered slightly more in both earth and stone works and pipefitting.

However, voluntary work in the administrative section was five times higher for men than that for women. This again speaks of the lack of education on the part of women to be eligible for administrative work. When the respondents were asked about the capacity in which they provided labour—skilled or unskilled—only seven were found to be involved in paid labour; three men were involved as skilled labourers while two women worked as skilled labourers and a further two as unskilled female labourers.

According to their own ranking of prevailing wages rates, skilled men were the highest paid. Unskilled men and skilled women were ranked almost equally and unskilled women were ranked the lowest. This gender differential in wage rate indicated the devaluation / under-valuation of women's work as a result of gender discrimination.

Participation in Operation, Maintenance and Repair (OMR)

The majority of the respondents (85 per cent) were not involved in plant operation. However, a relatively larger number of respondents were involved in maintenance and repair (15 per cent in operation as against 57 per cent in maintenance and repair). When a gender analysis was performed, of the 16 respondents involved in operation works, more than 81 per cent were men. In maintenance and repair, men and women were engaged in equal numbers. This again revealed the stereotypical division of men's work and women's work, where men get the high value training and hence get paid more than women.

The above fact is further supported by information about training in OMR, which was participated in only by men. This again reiterated the stereotypical division of labour where only men get paid in cash for OMR work and whatever maintenance and repair works women perform is mainly regarded as voluntary and/or is not paid in cash.

Agency in Water Resources Development

Agency in water resources development is measured by active involvement in project decision-making such as project selection, selection of project site and donation of land/natural resource. Only 22 per cent of respondents were actively involved in water resources projects. The gender analysis revealed that two time more men were involved than women (16 men as against 8 women). This is indicative of women's agency, which is lesser in comparison to that of men.

Since a majority of the respondents (78 per cent) were found not to be actively involved in the agency portion of water resource development, they were asked to give reasons. Sixty-four per cent stated that they had not been informed about the project while 21 per cent admitted that they were not interested. Gender analysis revealed that more women said that they were either not informed or they were not interested. One woman felt that she was socially excluded. Supporting the results that were evident in the earlier sections, men reported that they were out of the village or in a foreign country at the time.

A gender analysis of the capacity of involvement showed that the degree of men's agency was higher than that of women's. While sixteen men were involved in project selection as well as site selection, only six women were drawn in. Interestingly, the only respondent who had donated land/natural resource for a project was a woman.

In terms of type of involvement, the majority of the respondents were involved in projects as group members rather than individuals. Gender analysis revealed that men's involvement was twice that of women's as group members—indicative of women's exclusion from participation in public life.

Ownership of Enterprises and Work Inputs Related to Water Resources

It is important to analyse the ownership, rights and control of income to compare the relative empowerment status of women with that of men. In the study, 24 respondents reported that they owned enterprises related to water resources. The ownership of the enterprises was almost four times more for women than for men. Among the owners of enterprises, the highest number (10 respondents) reported of tourism-related enterprise, followed by alcohol making (7 respondents), livestock (5 respondents) and water mills (5 respondents). Although family ownership was found to be more common than respondents' self ownership, the gender analyses showed that women reported of their ownership more in all categories of enterprises more than men.

In terms of work input into the water resource-related enterprises, although the mean hours of work input by men were 9.29 per day as opposed to 8.05 hours by women, the difference was not very significant. However, the number of men who reported working in the enterprise (7 respondents) was almost three times lower than women (20 respondents). This indicates that more women actively work in enterprises than men, irrespective of whether it belong to themselves or their families.

Control Over Income

Regarding ownership of income from water resource-based enterprises, half the female respondents reported that they kept the money from their enterprise with themselves. In the case of male respondents, slightly more than a quarter claimed the same. But since keeping money does not automatically indicate control over income, decision-making on expenditure was tested to triangulate the control over income. For this, the respondents were asked for information related to decision-making on daily household expenditures from purchasing small daily items such as food to larger decisions such as purchasing/selling land, children's education, etc. The expenditure pattern revealed an egalitarian pattern between male and female. This confirms that those (women) who reported that they kept the income from the enterprises also had control over it. The result thus indicated that in the ACA area, unlike in many other parts of Nepal women have control over both enterprises and income.

Decision-Making Pattern

Although the majority of decisions in the household were made in consultation with other members of the household, there were many respondents who made decisions pertaining to self and other household activities by themselves. This type of decision-making pattern confirms the results from the Status of Women in Nepal (SOWN) study which had revealed that the Tibeto-Burman socio-cultural groups had more scope for females in household decision-making (Acharya and Bennett, 1982). In fact, Mustang was one of the sample districts in this landmark study on the status of women in Nepal.

In this ACAP study (Bhadra and Karky, 2002), fifty-two women as against 39 men reported making decisions by themselves for their own self. Similarly, 125 women as opposed to 95 men reported making decisions for the family. Interestingly, among those who reported that their spouses made decisions in family matters, the number of women was half that of men. This confirms decision-making patterns that favoured women.

In a study of a mid-hills village, the household decision pattern was more gendered. When the decisions were minor and did not involve money, woman made the decisions. On the other hand, when major household decisions were concerned, especially those involving large amount of money, men made the decisions (Bhadra, 1997). On the contrary, women in the study under discussion (Bhadra and Karky, 2002) were found to have decision-making power equal or even more in those cases where money and expenses are involved. Women were found to make decisions for medical expenses, children's education, purchase and selling of land, livestock and jewellery. On decision regarding the purchase of food and distribution of cooked food, women had more power than men. Additionally, women in this area had equal decision making power about personal/individual matters pertaining to their mobility, participating in meetings, training and study tour and personal matters like family planning and labour allocation.

This finding is in conformity with the second round of the SOWN Study (1993), in which Mustang women were found to have more decision-making power in terms of labour allocation, household expenditure and investment, clothing and household durables, and children's education than women in other districts (Strii Shakti, 1995). However, the current study deviates in the decision-making pattern in capital transactions (buying and selling of land, gold and silver and major animals). The SOWN study (1993) found that in capital transactions, men had more decision-making power than women, while the ACAP study (Bhadra and Karky, 2002) found women to have equal power even in purchase/sale of land, livestock and jewellery. This is indicative of the egalitarian intra-household gender relationship.

Ownership of Land and Livestock

The study found no gender differentials in family land ownership.

A majority (50 men and 52 women) reported that their families own land as against 3 men and 2 women whose families did not. However, when gender analysis of the land ownership by respondents was performed, only 20 per cent of men reported that they do not have land of their own as against 76 per cent of women who reported the same. This corresponds to the national situation of lack of land ownership titles amongst women. The preliminary results of the 2001 Census showed that households reporting women's ownership of land is just 11 per cent (CBS, 2002). In comparison to the national situation, the women in the ACA fared better in terms of land ownership. Despite the egalitarian familial and social milieu in terms of gender, the patriarchal statutory code on inheritance rights may have hindered ACA women from possessing land of their own.

It is noteworthy that it is not only that fewer women had access to landownership than men; the data revealed that the area of land owned by women was also smaller in size than that of men. The approximate average size of land owned by men was 10 *ropanis* while average size of women's land was mere 3 *ropanis*. These gender differentials in land ownership is indicative of the patriarchal nature of the state through which discrimination against women infiltrates even into gender egalitarian families/communities in the access and control over productive resources.

Livestock plays an integral part in the livelihood of the people living in the ACA (Karky, 2002). Although the gender differential of livestock ownership was intended as an indicator of wealth ownership, respondents expressed impossibility in distinguishing personal ownership of livestock as against familial ownership. Hence, women's personal ownership of livestock could not be captured.

In the sample population it was revealed that the majority of respondents had cattle in their families. The average number of cattle owned was found to be 5.27 per family. Families were also found to own goat/sheep with large herds (31 on average). Since there are no automobile access in the study area, quite a few households (33) had horses and donkeys as a mode of transportation. Additionally, families also owned poultry and rabbits for household consumption.

Mobility

Mobility is measured in terms of the respondents' frequency of travel, visit to the market, their travel time, place of visit for users' group activities and spending nights outside of home.

The data indicated that there is not much difference between men and women in terms of frequency of visits to shops and markets. Compared to other types of markets, the frequency as well as the number of visits to the village shop was higher. Respondents were found to visit nearby market places (local) more frequently than the district markets (district headquarters) and the regional markets (Pokhara). They generally visited these distant markets once a year. Interestingly, the number of respondents visiting regional market was more than those visiting district markets. This showed that among those who visited markets outside of their village go to Pokhara for their annual purchases rather than markets in their district headquarters.

As mentioned above, the number of respondents participating in users' group committees was found to be very low. Among those who were in such committees, only men were found to travel outside of the village for its activities. Despite the inability to substantiate the information with statistically significant results due to the very small number of respondents, the trend showed that women normally did not travel outside of villages for the users' group activities.

Participation in Monitoring and Evaluation (M&E) of ACAP Projects

The number of respondents participating in ACAP project monitoring involving any project was very small. Eight men and 15 women reported participating in the monitoring and evaluation of ACAP projects, which indicated that women are doubly involved in the M&E of ACAP projects. It was also revealed that that women are involved more in M&E not only in terms of number, but also in terms of the frequency of the M&E routine. One explanation for this could be the strong role played by the Mothers' Group in ACAP project activities.

Drudgery Graphing

Drudgery Graph

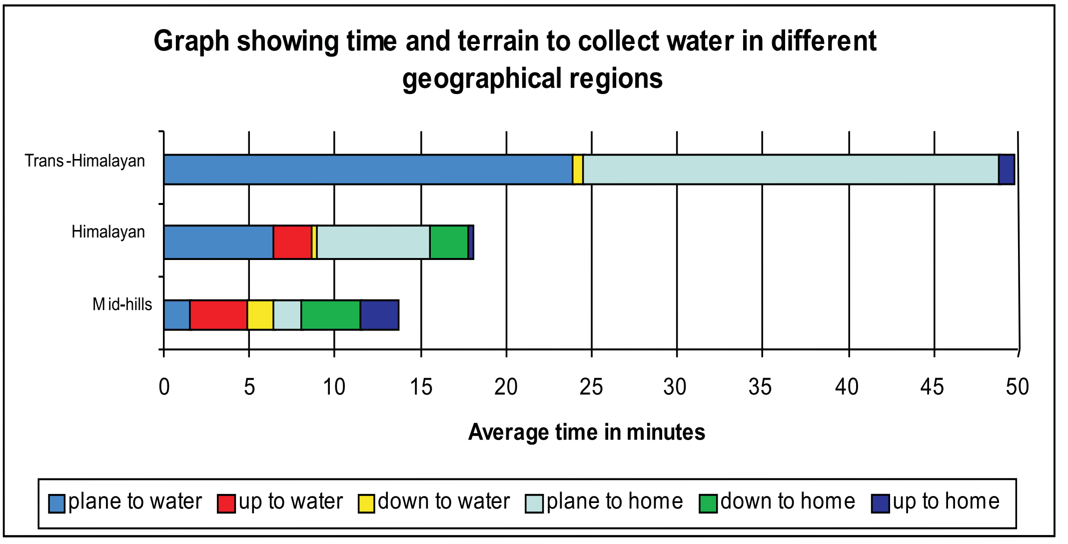
Shown below are drudgery graphs for collecting water on a daily basis in the different ecological regions. Return trips to fetch more water on the same day are added to calculate the average time taken to go to the source and back home again.

Graph 1 illustrates that the longest time taken to collect water is in the semi-arid trans-Himalayan region; almost three times longer than in the Himalayan region and nearly four times longer than in the mid-hills. The longest slopes to climb and descend are in the mid-hills, followed by the Himalayan region. The terrain covered in the trans-Himalayan region to fetch water is relatively flat.

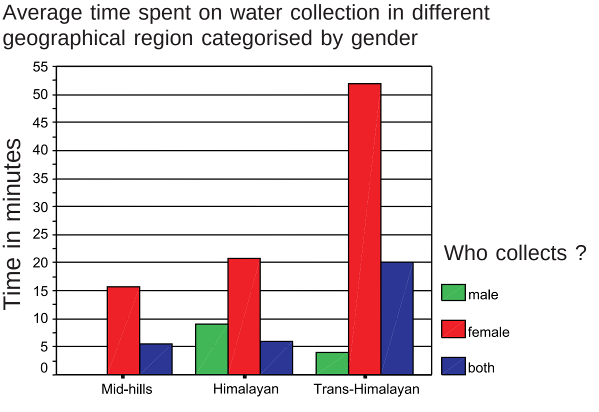
Gender Analysis in Drudgery

Graph 2 shows the work load shared by men and women in collecting water. In all three ecological regions, women spend more time at this task. In the semi-arid trans-Himalayan region where fetching water takes the longest, it is the women who do most of the work. In the mid-hills, where fetching water has to overcome the longest slopes, again men do the least.

Graph 1. **Drudgery graph for collecting water (Bhadra and Karky, 2002)**



Graph 2. Gender roles in fetching water in the different ecological regions (Bhadra and Karky, 2002)



Conclusion

Data analysis from the three ecological regions within the ACA, namely the mid-hills, the Himalaya and the trans-Himalaya, reveal that water resources, especially for drinking, is the most important factor for women and its scarcity concerns them the most. Fetching water in the mountainous terrain involves extreme drudgery and it is mostly up to the women to do the job. Despite the fact that women are more regular in attending meetings on drinking water projects and expressing opinions more regularly than men, they are marginalised by the male-dominated user's group members and their opinions are ignored. Frequently, water resource projects have been found to discriminate against women by mobilising more women as volunteers, and when they do get paid, the female wage rate is lower than that of men for the same job. Furthermore, only men receive training for cash paying jobs in water resources projects.

Women are also found to own and operate more income-generating enterprises based on water resources, and more women are found to engage in enterprises irrespective of whether it is self-owned or family owned. Decision-making on expenditure revealed an egalitarian pattern between males and females. Women who kept income from the enterprises also had control over its expenditure. This ACAP study on women also conforms to previous studies which showed women in this region to enjoy substantial decision-making powers within their households.

In terms of land ownership, fewer women own land and the land area they own is significantly small compared to owned by males. But considering the national data, women in this region fare far better in terms of land ownership. It is interesting to note that although women's representation is much less in number and their opinions are not heard / implemented that much, more women participated than men in monitoring and evaluating ACA projects.

Despite ACAP's realisation that women's role is crucial in water resources management and conservation in terms of sustainability of projects, actual representation of women was found to be nominal. The sheer number of male representation often overshadowed their roles. Even though, traditionally, women in this region enjoy gender-egalitarian familial relations and social milieu, projects and policies designed by the state are often counter-productive for them. Women reported that they are excluded from the participation in projects as state officials do not consult them about projects even though they have greater responsibilities than men in natural resources use and management, particularly due to male out-migration. Furthermore, the gender differential in land ownership is indicative of the patriarchal nature of the state where discrimination against women infiltrates even within gender-egalitarian families / communities on the question of access and control over productive resources.

Women in the ACA are involved in the process of social mobilisation for management and conservation of their natural resources and community development. Compared to the national scenario, the majority of familial and communal arrangements in the ACA is gender egalitarian and women have larger responsibility of household resource management than men due to male out-migration and a matri-local form of marriage system. This gender egalitarian arrangement of the communities and families need to be capitalised by outside agencies, both governmental and non-governmental, by building the capacity of women and involving them in natural resources conservation and development projects. Furthermore, women should be involved specifically in water resources development, management and conservation projects in order to create women-friendly projects that help women in income generation. ▯

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People, Flora and Fauna in the Semi-Arid Condition of Upper Mustang

Bhaskar Singh Karky, Benktesh Dash Sharma

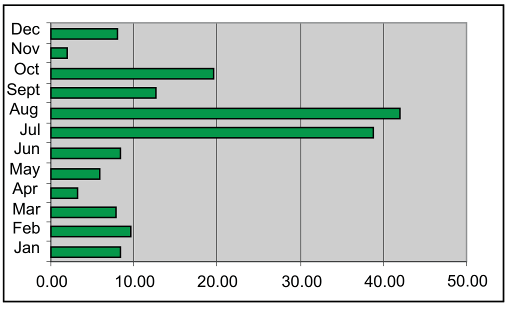
Tsarang: a settelment in Upper Mustang

General Overview

Mustang lies in the trans-Himalayan region, between the Annapurna and Dhaulagiri ranges in the south and the Tibetan Plateau in the north. The Tibetan highlands, which comprise the northern regions of Mustang together with the Himalayan ranges constitute part of the highest, youngest, and the largest structural land form in the world. This combination has given rise to the existence of a unique geo-ecosystem in the area.

Upper Mustang consists of seven VDCs and covers an area approximately of 2,562 sq km. The land

Figure 1: Mean annual rainfall (in mm) in Upper Mustang (HMG/N, 1999)



elevation ranges between 2,600 to over 6,000 m.a.s.l., with most of the settlements concentrated at 2,600-4,000 m.a.s.l. The region's landscape reflects its location in the rain shadow region of the Himalaya, and its subjection to strong winds blowing in from the north (Parajuli and Sharma, 2000). The Trans-Himalayan region is characterised by semi-arid physiological conditions, receiving only 250 to 500 mm of precipitation annually (KMTNC, 1997). The area receives most of its water supply from melting snow during the spring season, and from the limited precipitation in the summer months as depicted in Figure 1 (HMG/N, 1999). But as Figure 2 shows, the total annual evaporation far exceeds annual precipitation (Blamont, 1997). Water scarcity, therefore, is the limiting factor for agriculture and livestock rearing since the biophysical conditions of Mustang resemble those of a semi-arid temperate desert with strong winds.

Average temperature is low in Upper Mustang due to its high altitude. At the same time, the rarefied atmosphere increases the amount of solar radiation is 50 to 200 per cent received at lower elevations of comparable latitudes (Du *et al*, 2000). Thus, given the conditions of lack of moisture, infertility due to paucity of organic matter in the soil, and erodibility of soil, the majority of plant growth occurs due to intense solar radiation and heating (Du, *et al*, 2000).

Landuse Pattern

Much of the Mustang landscape is dominated by pastures. Various shrubs and grass species grow in these semi-arid landscapes. Almost all the land in the region is otherwise barren, and only 1.7 per cent is suitable for cultivation. This results in an average landholding of 0.35 ha per person,

Figure 2: Monthly precipitation and evaporation patterns in Mustang (Blamont, 1997)

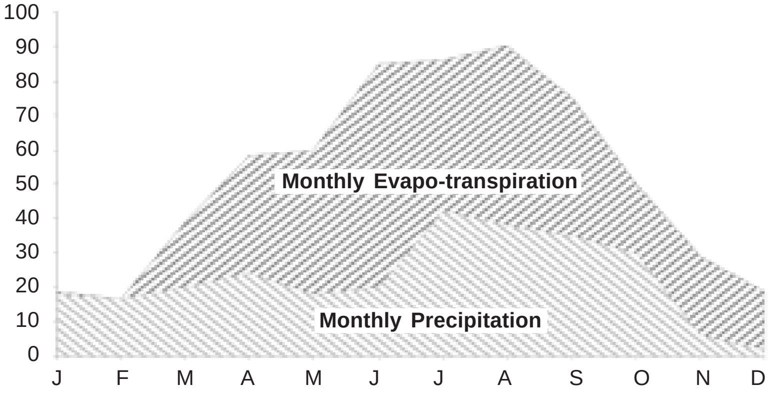


Table 1: Landuse pattern of Upper Mustang in 1978

Landuse	Area (km^2)	Percent
Forest	0.48	0.02
Agriculture	32.74	1.28
Barren	1434.66	55.98
Grazing	1066.27	41.61
Shrub	15.84	0.62
Waterbodies	12.78	0.50
Total	**2562.77**	**100**

Source: LRMP, 1986

Table 2: Landuse pattern of Surkhang VDC of Upper Mustang in 2002

Landuse	Area (km^2)	Percent
Forest	0.48	0.02
Agriculture and settlements	2.44	0.31
Bare land	158.31	20.19
Water body	14.25	1.82
Grass land	282.34	36.01
Shrub land	255.38	32.57
Snow cover	71.40	9.11
Total	**784.11**	**100**

Source: Sharma, 2003

a figure significantly lower than that for the rest of Nepal. A study carried out in 2002 over a 784 sq km area in Surkhang VDC to obtain land-use information using image analysis of this region (see table 2) revealed a land-use pattern similar to that of the whole region found in 1978. Table 1 illustrates land-use pattern within the Upper Mustang region based on the interpretation of an aerial photograph taken in 1978 (Figure 3) (LRMP, 1986).

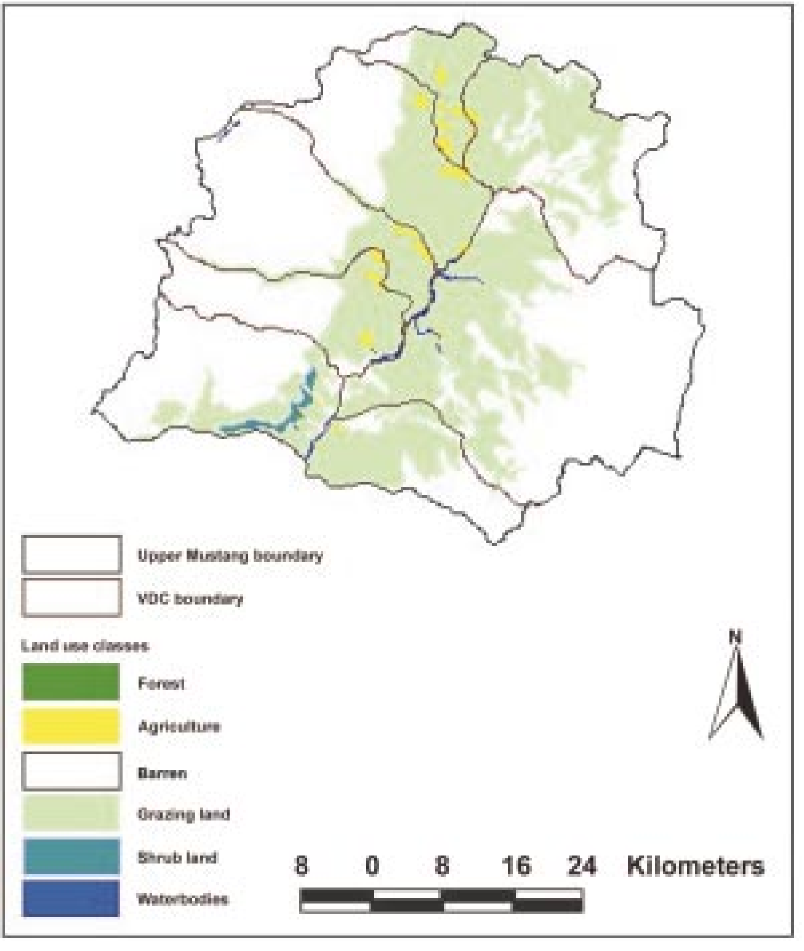
Socio-Economic Conditions

Historically, Upper Mustang was ruled by the Raja of Mustang until it was taken over towards the end of the 18th century during Nepal's expansionary phase (Rai, 1989 and Regmi, 1978). Mustang's population comprises primarily of the Bhotia or Loba, Thakali and Magar ethnic groups (Donner, 1968). The Magars live in the southern part of Mustang and the Bhotia inhabit the northern reaches. About 40 per cent of the total population of Mustang district live in the Upper Mustang region where population density stands at only 2.5 people per sq km. (Banskota and Sharma, 1998).

Upper Mustang is home to slightly over 5,000 people, with a male to female sex ratio of 1.02. According to the 2001 census, the population of Upper Mustang went down to 5,395 from 5,694 in the 1991 census, registering a negative growth rate of 0.0525. This is probably due to the high out-migration from the region. The population is so structured that the age group of 5 to 9 years numbers the highest, while the lowest age groups represents those over 75 years or more. This shows a declining number of people as the age increases. The literacy rate in this region has a high proportion of illiterate population as depicted in Table 3.

The people of Mustang depend on agriculture, livestock-rearing and trade. For generations, salt from Tibet was traded with the Tarai regions of Nepal, with the Kali Gandaki Valley

Figure 3: **Landuse Map of Upper Mustang in 1978**



In fact, the mountain areas of Nepal are now some of the most impoverished regions, with a HDI rating of 0.378, which is significantly lower than in other regions of Nepal (see Table 4).

The development of the tourism industry in the last three decades has brought back revenue to southern half of Mustang (Lower Mustang), diversifying and boosting the economy (Khatri-Chhetri *et al*, 1992). In contrast, Upper Mustang remains in isolation. The government's restricted tourism policy for Upper Mustang only allows self-sufficient group tourism (only 1,000 tourists are allowed annually), which severely limits the trickle-down effects of tourism.

To supplement their income, people from Upper Mustang have resorted to seasonal migration during the food-deficit winter months to Pokhara, the Tarai and India. Seasonal migration provides up to 42

providing the easiest link between north and south. Given the volume of trade, the Raja of Lo-Manthang was able to build tremendous power and influence. But, since the introduction of Indian salt in the latter half of the 20th century, this trade has virtually ceased and the people of this region now migrate as seasonal labourers during the food-deficit winter months. What was once a relatively prosperous region has now reverted to subsistence economy, and poverty is severe as well as widespread here.

Table 3: Literacy status in percentage of 6 years and above (of total 4733) population

Category	Total	Male	Female
Cannot read or write	56.9	23.09	33.78
Can read only	33.78	9.8	5.66
Can read and write	32.88	21.38	11.51
Not stated	0.42	0.17	0.25

Source: CBS, 2001

Table 4: Human Development index rating of Nepal, scoring is out of a potential 1

Region	Human Development Index rating (HDI)
Mountains	0.378
Mid-Hills	0.510
Terai	0.474

Source: UNDP, 2002

per cent of a household's annual income in this region (ACAP / WRUP, 2002), followed by agriculture and livestock as depicted in table 5. In many cases, migration is forced by lack of food. Of the Upper Mustang population, 45 per cent grow food that is sufficient for less than six months (ACAP / WRUP, 2002). Mustang district as a whole is also categorised as one of the worst districts in terms of percentage of landless and marginal farm households, with 48.13 per cent households living off farms that are smaller than 0.5 ha (ICIMOD, 1997).

Agriculture and Livestock Rearing

All cultivated land in Upper Mustang lies adjacent to settlements, which have perennial water sources. Agriculture is practised up to 3,900 m.a.s.l; above 3,300 m, only one crop is harvested annually. The major crops cultivated are buckwheat, naked barley (*uwa*), potato and radish (Donner, 1968). Intermittently, mustard is also grown in the region (Banskota and Sharma, 1998). The crop residue provides an important source of fodder for livestock, especially during the lean winter months.

Since farming alone cannot sustain livelihoods, livestock plays an integral part in the lifestyle of communities living in the trans-Himalayan region (Raut and Richard 2000, Banskota and Sharma 1998, Miller 1998). The people of Upper Mustang follow a lifestyle similar to the nomadic and semi-nomadic pastoralists of the Tibetan frontier and the Central Asian plains—a combination of agriculture, animal husbandry and trade (Craig, 1997). Livestock consists of cattle, yaks, dzos, sheep, goats, horses, mules and donkeys, which are reared mainly on the free-range grazing system (Karky, 2002).

Table 5: Sources of income generation amongst the Upper Mustang population

Income sources	% of population engaged
Seasonal Migration	42
Agriculture and Livestock	39
Micro Enterprises	11
Salaried Work	5
Tourism	3

Source: ACAP/WRUP, 2002

Biological diversity

The Himalayan elevation gradient is the longest bioclimatic gradient in the world, and vascular plants are found from 60 to 6400 m.a.s.l. in Nepal. Within an area of only 150 km, one moves from the tropical zone to the nival zone covered in permanent frost and snow. The southern part of Nepal, the Tarai, has a tropical climate up to around 1,000 m. Between 1,000 and 2,000 m lies the sub-tropical or warm temperate zone. Above this and up to approximately 3,000 m, the cold temperate zone dominates. The highest limit of the overlying sub-alpine zone, between 4,000 and 4,500 m, defines the tree limit in Nepal. Some shrubs can be found in the alpine zone, but grassland is predominant here. In the high alpine zone, the vegetation is sporadic (Dobremez, 1976).

The Upper Mustang region is important for its endemism in rich flora and fauna, especially that of steppe habitats. Besides, the area also serves as a corridor for many passage and Trans-Himalayan migratory birds. Though Upper Mustang covers only 1.74 per cent of the country's total area, it contains a high percentage of the threatened mammal species of the country since this region is relatively undisturbed and serves as an excellent refuge for the Tibetan Plateau wildlife species (Yonzon, 2001 and Shah et al 2002). The area's high-altitude rangelands are home to the endangered snow leopard, the Tibetan wolf, the Tibetan argali, the lynx and the brown bear as well as endangered plant species (UNDP, 2000).

Floral Diversity

Upper Mustang comprises of six major habitat types to support faunal diversity. These habitat types are classified on the basis of the availability of different plant species. They are *Betula utilis* forest habitat, *Populus ciliata* strands habitat, dry alpine habitat, alpine meadows, croplands and home yards.

Table 1: Summary of Major Floral and Faunal diversity in Upper Mustang

Description	No. of species In the World	In Nepal	In ACA	In Upper Mustang
Butterflies	112,000	640	not available	8
Fish	18,150	185	not available	not available
Reptiles	6,300	141	39	2
Amphibians	4,184	43	22	2
Mammals	4,000	181	101	28
Plants	248,428	7183	1226	530
Birds	9,040	862	474	211

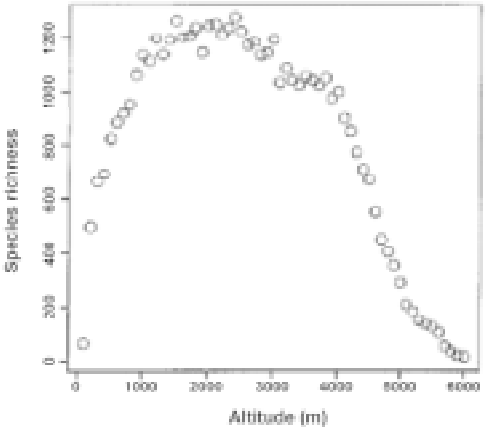
Source: MFSC (2000), Suwal (2003) and Shah (2002)

Altogether, a total of 530 plant species are found here, including all forms of trees, graminoids, forbs and shrubs. Among these plant species, more than 200 bear medicinal value.

Table 6 indicates a declining trend in species richness in Upper Mustang compared to the rest of the world. This can be explained by the known pattern of latitudinal decrease in species richness. The latitudinal pattern is commonly explained by a monotonic relationship with climatic factors, such as primary productivity or other energy-related factors; and altitudinal trends in species richness are generally thought to mimic latitudinal trends in species richness, and the same factors are often used to explain this altitudinal pattern (Rhode, 1992). Several studies have found a decreasing trend in species richness with altitude (Grytnes and Vetaas, 2002). Rahbek (1995) presented a critical literature review on the species richness pattern in relation to altitude and showed that approximately half of the studies detected a mid-altitude peak in species richness.

The above figure shows a unimodal response to altitude with maximum richness found between 1,500 and 2,500 m.a.s.l. with a pronounced decrease towards 6,000 m.a.s.l. These arguments are also supported by the status of biodiversity of Upper Mustang since there is a hard elevation boundary that might have caused some degree of resistance to dispersal.

Figure 4: Species richness pattern along altitude in the Nepal Himalaya (Grytnes and Vetaas, 2002)



Faunal Diversity

Butterflies

A study by Smith (1994) revealed that of the 18 endemic butterflies in the country, eight are found in Mustang. But a detailed study of butterflies within Upper Mustang has not been conducted yet. The species found in Mustang are *Parnassius cephalus horri, Polyommatus nepalensis, Albulina orbitulus lobbichleri, Coenonympha amaryllis forsteri, Parnassius epaphus capdevillei, Parnassius acdestis laurentii, Synchloe sherpae* and *Crebeta lehmani* (Smith, 1994).

Fishes

Shrestha (1995) reported that fish fauna of this region has never been studied and Shah (2001) confirms the rarity of fish in the region. Shah (2001) reports spotting *Scizothorax* *richardsoni* in Mustang khola at Dhi village (3,320 m.a.s.l.) in Upper Mustang. Shrestha (1995) and the National Red Data Book (NRDB, 1995) have declared this species of fish to be vulnerable.

Reptiles and Amphibians

Since the area is in the rain shadow of the Annapurna Range and consequently receives very low precipitation, the area has a high-altitude steppe vegetation exactly like that of the Tibetan Plateau. The area is found to be free of snakes (Shah 2001, Shah 2002), while in terms of other herpetofauna, two species of lizards and two species of amphibians have been recorded so far in this region.

Avifauna

Studies by Suwal (2003), Shah (2001), Shah (2002) and Inskipp (1989) show that the Upper Mustang region houses a total of 211 species of birds, including the Tibetan sandgrouse (*Syrhaptes tibetanus)*, which was recorded for the first time in Nepal in 2002 (Shah et al 2002*)*. Of these, three are in HMG's list of protected species, 8 are in the NRDB list and 13 are in the CITES list (4 in Appendix I, 5 in appendix II and 4 in appendix III of CITES). Classifying them according to foraging-habitat group, the majority are arboreal—69.8 per cent, birds of prey—11.5 per cent, aerial birds—9.4 per cent, waders—6.2 per cent, and finally terrestrial or game birds—3.1 per cent (Suwal, 2003).

Mammals

Twenty-eight different species of mammals have been recorded in Upper Mustang, including the kiang (Tibetan wild ass, *Equus kiang)* and the Tibetan Gazelle, which was recorded for the first time in Nepal in 2001. Of these 28 species, 13 are listed in different categories to be of global importance (Shah, 2001 and Shah, 2002). Besides these 28 species, the study of topography and the reviewed literature indicate the likelihood of Tibetan antelope (*Pantholops hodgsoni*) and the Wild Yak (*Bos grunnies*) being found here (Shah 2001). But this can be confirmed only by local sightings of these animals.

Conclusion

Water is the limiting factor for all ecological activities in Upper Mustang. In turn the semi-arid temperate desert-like conditions limits land use, resulting in much of the land being either barren, grassland or shrubland. The communities living in the region have limited economic options; they are inherently poor, leading a below national average living standard. Government tourism policy imposes a controlled tourism in Upper Mustang and has limited opportunity from the tourism sector as well. The agriculture sector barely produces enough, as arable land is extremely scarce due to the aridity, poor soil structure and extreme climatic conditions. Livestock rearing, thus forms an integral part of the lifestyle in the region.

In terms of floral and faunal diversity, the region lying in the rain shadow area has less biodiversity than at comparable latitudes in lower elevations. The semi-arid landscape forms a significant corridor habitat between the mountains and the plateau, providing refuge to Tibetan wildlife. This area is also an important migratory path for birds; of the 211 species found, 24 species are of significant importance. Of the 28 species of mammals sighted in the region, 13 are listed in different categories of global importance; and of the 530 floral species, 200 have medicinal value and many of which are rare. Low rainfall and high elevation have limited the biodiversity in the region, but much of what exists also bears global significance.

The semi-arid conditions in the water deficit trans-Himalayan region of Upper Mustang landscape have nurtured a ecologically and biologically unique habitat sustaining high-value species. The same arid conditions have aggravated the vulnerability of the communities living in the remote and high altitude dry desert steppe. These conditions are a boon for in situ conservation, while simultaneously proving a bane for improving the livelihood conditions of marginalised communities. This paradox is what poses the greatest challenge for practitioners of nature conservation.

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