International Centre for
Integrated Mountain Development

ISSN: 1027-0027

Issues in Mountain Development 98/4

Sustainable Energy Use for Mountain Areas: Community-level Energy Planning and Management

Increasing difficulties and drudgery are faced in mountain areas because of diminishing resources of rural energy caused by inefficient use of fuelwood, increasing reliance on biomass, and a consequent loss to agriculture when crop and animal wastes are used as fuel. Lack of proper mechanisms means that a significant increase in the use of renewable energy technologies has not occurred, although some governments have attempted wide-scale introduction of such. People's participation and decentralized community-level action programmes are one approach to assessing energy needs, determining appropriate technologies, and promoting their use. Integrated efforts from all stakeholders are an essential given. So far, energy programmes have had a negligible effect on unsustainable energy use patterns in the mountains.

Mountain people have always relied on biomass and animate energy in the form of draught power (mechanical energy derived from animals and human beings in the form of muscle power, hence energy from animals) to meet their basic needs – whether for cooking food, keeping the house warm, milling grain, ploughing fields, or transporting goods. However, various micro-level studies (Bajracharya 1986; Rijal 1998) have shown that present supply levels cannot be sustained; and this is due to increased demand as a result of rapid population growth and the changing needs of mountain communities. The overt impacts of this situation are increasing deforestation and the added drudgery women face in order to provide the energy needed for the household and farm. This is aggravated by inefficient use of fuelwood and significant losses in agricultural productivity because crop and animal wastes have to be used for cooking and heating. The environmental consequences are loss of forests and woodlands and ill health caused by indoor air pollution; in addition there are other adverse social and economic impacts, many of which are disproportionately suffered by women and children.

The important role energy plays in the lives and livelihoods of mountain people and the implications the prevailing trends in energy use have on the environment, have led to programmes for the development of renewable energy (including its efficient use) being undertaken in the Hindu Kush-Himalayas (HKH) over the last 15 years. Unfortunately, these have so far not resulted in any significant increase in the use of renewable energy. This is primarily because of the lack of proper mechanisms (technical and institutional) to ensure that energy resources match the needs, lack of appreciation for socioeconomic and cultural factors because women's participation has not been sought, and because the spatial characteristics of the mountains have not been understood.

The Question of Sustainable Energy Technology

There is evidence of wide-scale introduction of energy technologies, such as biogas and micro-hydro technology in China, micro-hydropower and improved cooking stoves in Nepal, and family-sized biogas plants and improved cooking stoves in India (Rijal 1998). Most of these introductions took place without an assessment of socioeconomic characteristics, analysis of the condition and position of women in the communities and their needs, and the ability of communities to pay for new energy sources. Competing to prove one technology better than the other, developers analysed the appropriateness of renewable energy technologies according to different frameworks and styles. Even external funding agencies were in a hurry to prove one technology better than the other. Some

ISSUES IN MOUNTAIN DEVELOPMENT is a series released from time to time to brief planners, development workers, researchers, and donors on recent trends, findings, and issues affecting mountain development. The papers in this series can be quoted with due acknowledgement. They can also be accessed on ICIMOD's World Wide Web pages on the Internet at:

http://www.south-asia.com/icimod.htm

Comments are Welcome

technologies were rampantly and randomly disseminated without appropriate decentralized energy planning. As a result there have been failures in distributing or in adopting technologies. The situation in mountain and hill areas is more complex. Any energy intervention in the hills and mountains needs to be assessed not only from the technical, financial, economic, and environmental sustainability aspects but also from the perspective of methods and approaches that are suitable for planning and implementing energy programmes.

Main characteristics and trends in energy use in the HKH Region

- Use of biomass predominates and fuelwood is the principal source of energy.
- The domestic sector is a major consumer of energy.
- Demand for energy is increasing as a result of growing household demands, agricultural diversification and intensification, rural industrialisation, and increasing numbers of tourists in some areas.
- The need for heat, primarily for cooking and space heating, is comparatively greater than the need for draught power as an input to production.
- The demand for fuelwood exceeds the sustainable supply and thus the process of destruction on the margins is a common phenomenon in much of the region.
- Fuelwood is becoming scarce and the time taken for its collection is increasing.
- Continuous extraction of fuelwood from the forests results in a transition within biomass resources (i,e., a shift from fuelwood to agricultural residue or animal dung thereby reducing the soil fertility), degrading the environment.
- Access to and availability of energy technologies are improving but not sufficiently to result in reduction in human drudgery.

The socioeconomic factors that are crucial in determining the energy-use pattern in the mountains are: population dynamics and urbanisation; rise in incomes and changes in energy use; the industrialisation process; diversification and intensification of agriculture; and improvement in living standards. These factors should be clearly understood and taken into account in dealing with sustainable development of energy in the HKH context.

Centralized versus Decentralized Energy Planning

The choice between centralized and decentralized energy planning and management should be based on the quality and quantity of energy required, on the availability and suitability of resources and technological options, and on the role of indigenous knowledge systems in the management of local institutions. The type of energy needed in the mountains is usually of low quality, i.e., heat energy. This gives us an indication of the predominant role that the suitability of renewable energy resources (including biomass) will play in the context of the HKH region. In this respect, it should be noted that biomass is renewable, but only if the rate of extraction of biomass does not exceed the rate of replenishment, so that a sustainable yield of biomass fuel is consumed rather than injudiciously exploited.

Characteristics prevailing in mountain areas (i.e., inaccessibility, fragility, and marginality) become crucial in terms of the quantity of energy required. It is observed that the amount and type of energy required differ significantly between hill and mountain communities and communities in the plains because of the scattered settlement pattern and lack of infrastructural development. This, together with the fact that the hills and mountains are extremely scale-sensitive (scale-sensitive in this context means the low carrying capacity of mountain areas thus large-scale interventions such as dams and big highways are not desirable) makes decentralized energy systems more viable in the mountain context. Small-scale interventions in the hill and mountain areas are also less risky than large-scale interventions, whether these are roads or dams or a massive flow of natural resources (i.e., timber, fuelwood, medicinal herbs) into other areas to meet present/existing or future potential market demands that exist in the plain developed countries.

The fact that the hills and mountains are extremely scale-sensitive makes decentralized energy systems more viable in the mountain context.

The suitability and relevance of a particular energy form need to be examined not only from the perspective of energy demand structures and their associated environmental impacts but also from the perspective of their implications for income redistribution and income from production of energy. Box 1 summarises these concerns and examines the suitability of a particular energy resource and technology for the hill and mountain areas.

Community-level Energy Planning and Management

In addition to the factors already mentioned, the need for community-level energy planning and management in the hill and mountain areas arises because investment in these areas is given low priority by the energy sector. In addition to this, new and renewable energy technologies (RETs) are not efficiently promoted, there is lack of knowledge about biophysical aspects, lack of integration of women in the management of energy systems, inadequate energy planning database, and the urgency for removing bottlenecks in energy supply. Decentralization would make it possible to

Box 1: Suitability of Energy Resources for Mountain Areas

Energy Resources	Relevance for Mountain	Application Potential for Mountain areas		Income from Production	Income distribution Impact	Import/ Export
		Production	Consumption			
Oil	All	transport	transport	no	no	imports only
Electricity						
a) from Grid	+/- one-third of dry mountains	industry	lighting agriculture	limited	strong	imports
	+/- half of the wet mountains	industry	lighting/ agriculture	limited	strong	exports
b) Small hydro	Strong in wet mountains	cottage	lighting industry	possible	strong	import equips.
c) Diesel Gen-set (Mini Grid)	Strong in dry mountain	cottage	lighting	limited	limited	imports of oil
d) Solar unit	in dry high mountains	no	lighting	possible	if subsidised	import equips.
	high in remote mountains	no	lighting	Possible	if subsidised	import equips.
Natural Gas	may be appropriate for urban areas	no	heating/cooking	limited	limited	imports
Biomass	Major source	cottage	cooking/heating	cash&non-cash	no	exports
LPG	Minor	no	heating/cooking	no	some	imports
Wind Power	Possible	cottage	lighting	possible	possibly	import equips.
Coal	Minor	brick-kiln	heating/cooking	limited	no	imports
Micro hydel	High	cottage	lighting	possible	possible	limited import
Geothermal	Possible	Industry no	tourism/heating	possible	possible	limited import
Solar	High	cottage Industry	heating/hot water	possible	possible	limited import

Source: Rijal 1998.

operationalise planning, implementation, and management more effectively and in a manner more suited to rural, remote, and isolated areas. This concept is now gaining increasing acceptance in overall development schemes within the HKH Region. The suitability of renewable energy resources and technologies, limited accessibility, and scarcity of commercial fuels make community-level energy planning and management more appropriate for hill and mountain areas.

Preparation of Action Programmes

Inter-relationships between small-scale development activities, decentralized energy technologies, and energy requirements for subsistence and production should be assessed and evaluated. The idea behind such an approach is to prepare and implement a community-level energy action programme to meet energy needs for both consumption and production at least cost to the economy and the environment; associated with this is linking community-level energy programmes with economic planning and development programmes at district and national levels - including those for the energy, forestry, agriculture, cottage industry, and rural development sectors.

Appropriate Unit for Community-level Energy Planning

The unit chosen for planning should be justifiable from the point of view of building a database for energy planning and implementation (FAO & ESCAP 1990). In this context, a cluster of villages or a community sharing and using physical resources (such as forest and water) from the same locality should be considered for the purposes of decentralized energy planning and management. A cluster of communities, which also coincides with a local administrative unit or micro-

Key Factors for Community-based Energy Planning

Given the objectives and characteristics of the energy system in the hill and mountain areas, as well as the various issues and factors involved, the following need to be taken into consideration while carrying out community-level energy planning and management (Bajracharya 1986; Ramani et.al 1995; Rijal 1997) in the HKH Region.

- Community-level energy planning has to be consistent with mountain development objectives as well as the national energy planning approach.
- Intersectoral relationships in the resource base, in general, and the biomass base, in particular, have to be recognised. This requires a holistic approach and multisectoral integration in designing and implementing energy action programmes.
- Desired economic transformation for poverty reduction should be accompanied by an energy mix that will lead towards efficient use of resources, or vice versa.
- Considering the agro-ecological variations, sociocultural heterogeneity, and economic diversity, there is less possibility of bringing about uniformity in programme design. Instead, the approach should be to maintain a great deal of flexibility within a framework of appropriate principles and guidelines.
- The urgency of problems within the region suggests that interventions cannot wait for a good database. Action programmes have to start as soon as possible and a systematic database can be developed as part of the process.

watershed, such as a Village Development Committee in Nepal or a number of *gram panchayat(s)* within a micro-watershed in India, may be suitable.

Multi-level Spatial Planning

Harmonious working relationships at different levels of the planning mechanism, from the community to the central planning body, are a prerequisite for achieving broader development goals. A multi-level spatial planning approach makes it possible for this process to take place. Various innovations in decentralized energy systems are envisaged within a community through participation of the villagers for their own benefit. Efforts in the community are directed towards bringing about changes in the internal resource flows through the application of new and renewable energy resources and technologies. Such a change is necessary for better access to basic needs, more employment opportunities, and equitable income distribution. Positive change in the existing social order is also anticipated during this process.

Various innovations in decentralized energy systems are envisaged..

Integration with Development Activities

Energy planning is not an independent exercise; it has to be linked with overall, continuing and planned development activities (Shrestha & Bajracharya 1991). It needs to be oriented towards removing energy constraints by providing more efficient ways of using energy or, when necessary, by providing alternative sources of energy (Sinha et al. 1997). For example, use of electricity from a hydropower plant can be integrated with replacement of diesel in milling and of kerosene in domestic lighting (Rijal 1995). It can also be used to promote additional activities such as power looms, poultry raising, and other small-scale activities. When integrated in this way, electricity generation becomes economically viable. However, the use of electricity for multiple activities will not materialise unless necessary commitments and material support from all related sectors are forthcoming.

Partnerships among Stakeholders

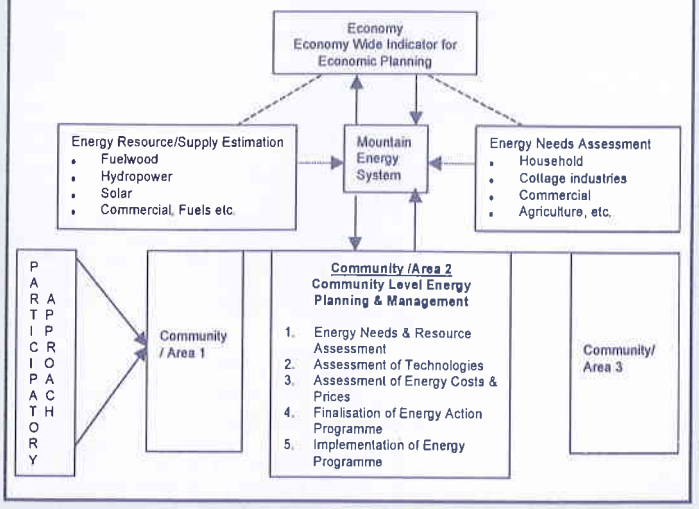
Energy planning and development at the local level are dependent on external inputs for mobilising internal resources and capabilities. It is important that all stakeholders interact with one another to make each feel like a winner in a positive-sum process (Bajracharya 1986). The main stakeholders are: a) extension officers, agents, and others representing government and donor agencies; b) technologists, researchers, and research and development communities; c) private voluntary organizations and manufacturing and consulting firms; and d) villagers (primarily women) who are the main beneficiaries. At present, these groups operate from crisis to crisis or operate in a limited rather than an optimal environment and their interactions are minimal.

Guidelines for Community-level Extension Workers

The conceptual linkages between community-level energy planning and management and macro-level planning for energy and for the total economy, as part of the framework, are shown in Chart 1. The information and data required for community-level decision-making would be as follow.

- Estimating end-use energy needs and identifying appropriate technologies that could meet these needs
- Identifying income-generating opportunities that could be linked to village energy projects
- Assessing locally available resources for decentralized energy generation
- Assessing the absorption capabilities of local technologies
- Establishing the techno-economic feasibility of selected decentralized energy systems identified for promotion in the area concerned
- Investigating the technology diffusion and adoption process from social and economic perspectives and identifying strategies to maximise local community involvement and financial commitment
- Estimating financial capabilities and financing requirements of end users and devising mechanisms for co-operative enterprises to obtain credit and to operate and manage decentralized energy installations

Chart 1: Macro- and Community Level Energy Planning Linkages



Source: Modified and adapted from FAO & ESCAP (1990)

Community Mobilisation

In order to carry out community-level energy planning and management, the community needs to be mobilised through a participatory approach. This approach requires a facilitator/extension worker who enters into dialogue with village residents and motivates them to organize themselves and use internal as well as external resources to plan and implement decentralized energy systems to suit local conditions.

Energy Needs and Resource Assessment

The present and future energy needs of the communities for consumption (i.e., cooking, heating and lighting) and production (agricultural and economic activities), as well as use of energy resources (traditional and commercial), need to be assessed through the active participation of the community (Rijal et al. 1987; Rijal et al. 1991). For example, the energy flow in mountain areas is shown in Chart 2. Care should be taken to ensure that energy needs are sufficiently linked to the felt-needs of the community.

The present and future energy needs of the communities ...need to be assessed through the active participation of the community.

Assessment and Suitability of Energy Technologies

It is necessary to assess the availability/access to various types of energy technology along with the technological options adopted by the community. The option for and suitability of a particular energy technology to fulfill the energy requirements should be examined on the basis of economic, financial, sociocultural, and environmental sustainability (FAO & ESCAP 1990). There are technological options available for intervention that can take place on the supply and demand side of a mountain energy system. The suitability of energy technologies to match demand side end uses with appropriate supply sources requires thorough understanding of the need for energy services.

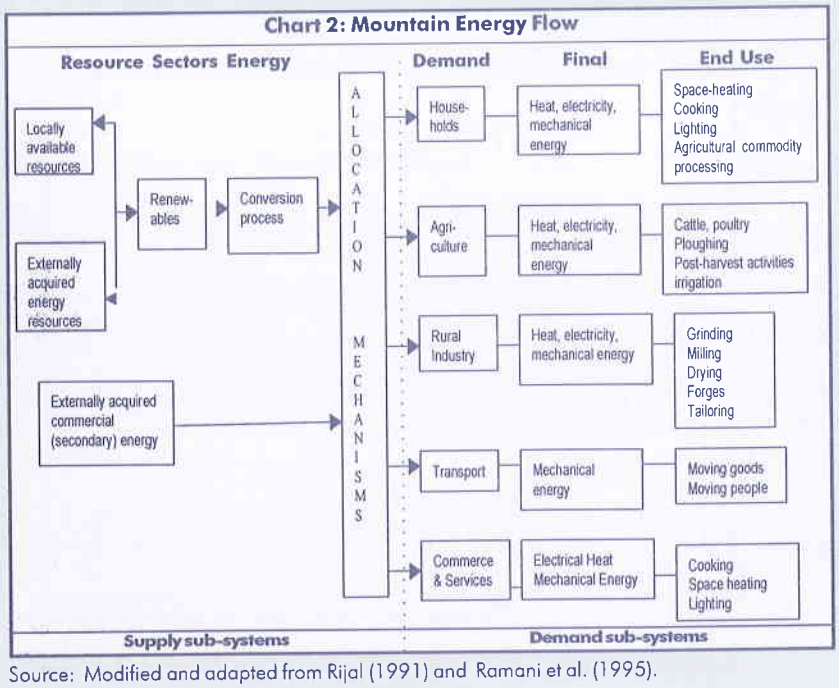
Energy Costs and Prices Including Environmental Impact

The delivered cost has to be estimated for each energy option, including the capital cost of resources and technology, based on assumptions about the life cycle for the option, the interest rate, the annual operating and maintenance costs, and the cost of transportation and distribution. The administrative prices, as well as financial (including subsidies and incentives, if any) and social costs for each option for (i) the user, (ii) the community or area, and (iii) the country have also to be worked out for the planning horizon chosen (FAO & ESCAP 1990; Rijal 1991). Environmental impact costs, if these can be quantified, should be incorporated in the costs. When such quantification is not possible, classification of the different options may be made in regard to their environmental implications; and these should include the trade-offs between the impact of the option on the local and regional environments.

Energy Action Programme

A comprehensive energy action programme should be prepared based on analysis of the data and information collected for a cluster of villages or an area - defined as a community. The final operational plan may differ from this programme, because it has to incorporate non-quantifiable variables to capture various socioeconomic, cultural, and ecological considerations. The final energy action programme should thus provide feasible options for meeting the energy needs of the community, given the constraints of physical and financial resources, technology systems, and non-quantifiable socioeconomic, cultural, and environmental parameters. Continuous dialogue with the communities, community leaders, informed and knowledgeable individuals, NGOs, extension workers, and line departments implementing development programmes will help in designing an 'Energy Action Programme' suitable for the community. The Energy Action Programme should also include a programme implementation strategy.

Chart 2: Mountain Energy Flow



Source: Modified and adapted from Rijal (1991) and Ramani et al. (1995).

Current Issues

Planning and implementation of energy action programmes and projects will have to be undertaken as part of a national effort in which the institutional and administrative infrastructures at community level are actively involved in the effective preparation and implementation of these programmes. For this purpose, institutional mechanisms and coordination arrangements need to be developed or organized at community level. The implementation of energy programmes and projects will require inputs from ongoing development programmes such as agriculture, cottage industries, micro-enterprise, kitchen improvement, health and sanitation, drinking water supply, etc, in addition to energy supply programmes

such as those for fuelwood, rural electrification, renewable energy resources and technologies, etc. Credit schemes run by development banks and subsidies available for various types of renewable energy technology from government and donor agencies will be instrumental in providing energy to mountain communities. What is lacking most of all is the process of facilitation through awareness, participation, and human resource development specifically geared to the energy sector.

The key question is to what extent should decentralized renewable energy systems be planned by the government..

A wide range of decentralized renewable energy systems based on indigenous renewable resources has been installed in the HKH Region over the past decade and a half. However, planning for such systems varies in terms of emphasis on technology, the scale of the effort, and area covered. At the same time, planning efforts continue to be project–based with no long-term funding and institutional support. The key question is to what extent should decentralized renewable energy systems be planned by the government and to what extent should their dissemination be left to market mechanisms? Past experiences suggest that government planning alone is not sufficient. Planning and management of decentralized energy systems should be carried out by the communities themselves together with extension workers. The government's role should be limited to removing market barriers, focussing on market creation to promote private sector initiatives, on promotion of local R&D and manufacturing capabilities, and on linkages between R&D institutions and the manufacturing sector in order to accelerate the commercialisation of decentralized, renewable energy systems.

The responsibility for planning and managing decentralized renewable energy resources and technologies does not fall into the jurisdiction of a particular institution or sector. Seen from the conventional sense, parts of it fall into such sectors as agriculture, irrigation, forestry, power, and cottage industries. Proper linkages between various institutions operational at local level not only need to be established, they also need to have a functional relationship with district and national level institutions involved in research, development, and promotion of decentralized, renewable energy systems.

Financing decentralized energy development in the mountains is constrained by the inability of borrowers to offer collateral and by their limited ability to repay. Furthermore, financing institutions are not inclined to process small-scale loans as the servicing cost is high in comparison to the institutional overhead required. Changes in lending policies, loan appraisal, and lending modalities are necessary.

Kamal Rijal
Energy Specialist
Mountain Enterprises and Infrastructure, ICIMOD
e-mail: rijal@icimod.org.np

Mountain areas are characterised by isolation from the mainstream market, inadequate infrastructural support systems, socioeconomic diversity, cultural heterogeneity, and agro-ecological variation (Jodha & Shrestha 1994) associated with ecological fragility and multiple end uses for resources and technologies. These characteristics have not received adequate attention in national plans or in the bottom-up planning approach. As a result, ... most energy programmes have had a marginal impact in terms of changing the prevailing unsustainable patterns of energy use in the mountains.

Finally, the inadequate attention given to the potentials of renewable energy technologies to reduce the work burdens and ill health associated with household use of traditional fuels and to the possibility of their increasing the productivity of the poor, has led to the failure of energy plans and programmes in the mountains.

Selected References

Bajracharya, D., 1986. *Decentralised Energy Planning and Management for the Hindu Kush-Himalaya*. ICIMOD Occasional Paper No. 4. Kathmandu: ICIMOD.

FAO & ESCAP, 1990. *A New Approach to Energy Planning for Sustainable Rural Development*. Rome: FAO.

Jodha, N. S.;Shrestha, S., 1994. 'Sustainable and More Productive Mountain Agriculture: Problems and Prospects'. International Symposium on Mountain Environment and Development. Kathmandu: ICIMOD.

Ramani, K. V.; Reedy, A. K. N.; and Islam, M. N., (eds), 1995. *Rural Energy Planning: A Government-Enabled Market-Based Approach*. Kuala Lumpur: APDC and GTZ, SP-Muda Printing Sdn. Bdh.

Rijal, K., Manandhar, A., Kharel, T., & Bajracharya, D., 1987. 'Participatory Action Research for Rural Energy Planning in Nepal: Experiences in Hill and Terai Panchayats.' In *Village Voices in Rural Development and Energy Planning*, Bajracharya, D. et al.(eds), East West Centre and Chulalongkorn University, Thailand, pp. 40-148.

Rijal, K., 1991. 'Technology Assessment, Planning and Modelling of Decentralised Rural Energy Systems' Ph. D. Dissertation, New Delhi: Centre for Energy Studies, Indian Institute of Technology.

Rijal, K., 1996. *Developing Energy Options for the Hindu Kush-Himalayas: Rethinking the Mountain Energy Development Paradigm*. Discussion Paper Series No. MEI 96/1. Kathmandu: ICIMOD.

Rijal, K. (ed), 1997. *Energy Use in Mountain Areas: Emerging Issues and Future Priorities, Report of a Regional Meeting*. Kathmandu: ICIMOD.

Rijal, K. (ed), 1998. *Renewable Energy Technologies: A Brighter Future*. Kathmandu: ICIMOD.

Sinha, C. S.; Ramana, P. V.; Joshi, V., 1997. 'Rural Energy Planning in India: Designing Effective Intervention Strategies'. In Venkata Ramana P. (ed), *Rural and Renewable Energy: Perspective from Developing Countries*. New Delhi: Tata Energy Research Institute.

Shrestha, G. R.; Bajracharya, D., 1991. *Implementation Aspects of Rural Energy Planning with Specific Reference to Nepal*. MIT Series No. 8. Kathmandu: ICIMOD.

Established in 1983, ICIMOD is dedicated to the cause of poverty alleviation and environmental conservation in the Hindu Kush-Himalayan range of Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan. ICIMOD is a focal point for documentation and information exchange, training, applied research, and demonstration on a wide range of issues affecting mountain people.

Editors: Shahid Akhtar/Archana S. Karki
ICIMOD, P. O. Box: 3226, Kathmandu, Nepal
Tel. (977 1) 525313 or Fax (977 1) 524509, e-mail: dits@icimod.org.np

September 1998