

Natural resource management in mountains*

Managing our mountain systems is important for people living in these areas, because it plays an important role in determining the ecology and sustained livelihood of people of the plains and economy of the country.

Mountains have significant relief features of the second order on the earth's surface. A mountain may have several forms, viz. ridge, chain or groups. As per altitudinal variations mountains are classified as of lower altitude: 500–1000 m, middle altitude: 1000–1800 m; high altitude: 1800–2500 m. These great variations in topographical features cause immense diversity in climate and habitat conditions within the region. Its forests also display immense diversity. Present trends of environmental health suggest that existing interventions are unsustainable. Economic indicators also do not reflect the desired results as far as quality of life of hill people is concerned. Besides this, the fragile nature of the mountains and human-induced environmental impacts are proving disastrous and causing a lot of fear among people.

The people of mountains are heavily dependant for their livelihood on their immediate natural resources and production from primary sectors such as agriculture, forestry, livestock, etc. The dependency of the continually growing population on finite resources, lack of viable technologies to mitigate the mountain specificities, rainfed conditions, unsuitable land use and enhanced production to meet demands are not able to give ecological and social sustainability to the area and the inhabitants. The problems in the mountains are complex having intricate linkages between social, economic and ecological concerns on one hand and technical and legal aspects on the other hand. The solutions, therefore, cannot be addressed in isolation. The aim of sustainable development should be to maximize human well-being or quality of life without jeopardizing the life support environment.

The solutions for these problems in the mountains are to be short within the permissibility of mountain specificities and adaptability of people which is governed by socio-cultural principles. Participatory research needs to be designed based on the integration of the principles of ecological sustainability with economic efficiency and social equity for better resource management. The Integrated Management of Natural Resources (IMNRM) workshop was aimed at discussing all the issues in order to prepare a strategy for better management of natural resources in mountains.

During the inaugural function, P. L. Gautam, G. B. Pant University of Agriculture and Technology, Pantnagar, suggested that mountain regions are a source of natural resources to at least half of humankind; such as water, energy, food, food products, health and places for tourism. They are rich in biodiversity and consist of a variety of ecosystems. Mountain societies are increasingly influenced by changes in global climate due to their unique ecoclimatic variability and other factors and time. Understanding the interactions and interplay of factors that have resulted in the present mountain landscape is crucial for suggesting strategies for sustainable livelihood in this region. The need is to design a short-term and a long-term strategy for sustainable development of the mountain regions. For strong inter-linkages, the challenge is to do research in this area and arrive at meaningful conclusions relevant to sustainable mountain development. There is need for a viable alternative land use developmental pathway to the present practice for the major land use activity namely agriculture which is based on high energy-input terraced agricultural system, which is only for sustenance. The issues involved for land use management are biophysical as well as socio-economic, cultural and institutional aspects.

S. P. Singh, H. N. Bahuguna Garhwal University, Srinagar emphasized the importance of Ecosystem Services in mountains and the role of forests in climate change. The valuation of ecosystem services is particularly important for mountains, from which several services flow

and serve the people living in downstream areas. A conservation plan needs to be considered by listing ecosystem services, evaluation of their flows and identification of providers and receivers. For sustainable development, it is important to know how various activities are affecting the flow of ecosystem services.

Upeendra Dhar, G. B. Pant Institute of Himalayan Environment and Development, Almora dealt with the role of young people in better management of natural resources and called for strong institutional set-up to involve all the stakeholders.

A total of 19 lectures were delivered by invited resource persons and there were 25 contributed papers by other participants.

Many speakers stressed on a separate Himalayan Policy for water management. For water security, fragile mountain requires climax vegetation with diversity. Indicators for assessing the eutrophication are biological and chemical in order to assess the health of water resources and to plan for better integrated approach in a time bound framework. Fisheries development need to be planned in an integrated way.

From the point of view of role of livestock in sustaining natural resources in mountains, afforestation with mixed species and promotion of horticulture with small scale industries are important. Job opportunities to local people and maintenance of grazing lands are important from an horticultural point of view. Integrated approach with focus on diversification to horticulture would enhance farm income besides effective use of resources. Therefore, depending upon agro-climatic situation, horticulture has to be promoted to get maximum output with available natural resource. Cost effective precision irrigation system such as gravity fed micro irrigation most suitable for hill horticulture is capable of supplying water, but improvement in the quality and quantity of produce of horticulture in mountains is required. To harness the potential, holistic management system has to be adopted addressing all the issue of production and consumption chain through policy support, which should provide ample oppor-

*Based on the Workshop on Integrated Management of Natural Resources in Mountains, sponsored by DST, from 28 November to 2 December 2005, at the G.B. Pant University of Agriculture and Technology, Pantnagar.

tunities. In agriculture, although there was no direct government intervention in production and investment decisions of farmers, Government did, and still influences the legal and economic environment in which farmers and other economic agents operate agricultural productivity in the mountains. Areas should be identified/earmarked for cultivation/production of specific horticultural crops as per their niche potential. Areas with assured input supply should be utilized for high value crops. Cultivation of horticultural crops, viz. fruits and vegetables should be encouraged. Farmers should be compensated for conserving agro biodiversity. Hill farmers should also be compensated for maintaining clean ecology through clean agricultural practices. Organic farming and its certification should be encouraged in the rain fed areas where agriculture is organic by default. The potential of agriculture has remained largely unrealized in the hills and mountains of Northern India.

For the sustainable development of alpine grasslands, there is an urgent need to set up a long term plan to monitor vegetation changes along with soil characteristics in order to see the annual variation in structure, growth, biomass production and species diversity of the region. Moreover, in order to exploit the natural resources for grazing other studies on estimation of carrying capacity of these ecosystems at micro level studies are required which will enable the rationale exploitation of resource on sustainable basis.

Proper management of forest resources is required for environmental conservation including soil and water conservation. GIS technology is useful in planning and management of natural resources and

there is need to remove technical, financial, administrative constraints in facilitating wider application of the technology by the target users. These could be removed by interlinking school and college education with requirements of the development planning of the country and evolving low cost and more user friendly GIS technology.

In mountainous areas judicious planning is necessary for sustainable utilization of natural resources. There is need to prepare an integrated management plan at micro level as per ecoclimatic conditions acceptable at local and national level. Diversification is required promoting organic agriculture with agrobiodiversity, agroforestry, dairy farming, fisheries, small hydel energy, ecotourism, etc. The valuation of the ecosystem services/functions and appropriate methodology is very much required to be incorporated in these plans. Biodiversity needs to be conserved and sustainable harvest limits for resource utilization need to be quantified. Other alternatives for diversifying natural resource utilization, conservation and improved economy such as fibre utilization from fibre-yielding animals at high altitudes, broom grass cultivation, etc. may be promoted. It is urgent to take care of protective and regenerative potential of these fragile and biodiversity-rich natural resources. This calls for environmental impact studies and studies on global warming effect on various ecosystems, biodiversity, recession of glaciers and water management at research and policy level. Water and soil go together in the hills and it is necessary that soil and water regimes are carefully nurtured to maximize sustainability of other resources namely agriculture, horticulture and forestry. Several biotechnological

techniques for training and demonstration have been identified using biotechnological solution in mountains. Use of eco-friendly and sustainable technologies such as bioengineering becomes important for the conservation of this fragile environment through making best use of locally available resources for slope stabilization and slope protection.

Several recommendations were aimed at based on various presentations during the workshop and they have shown an intricate relationship among various natural resources in the mountain areas.

R. B. S. Rawat, Watershed Management Directorate, Uttaranchal in his valedictory address, highlighted the importance of watershed management project in Uttaranchal stating that watershed development aims at sustainable utilization and management of natural resources like water, land and vegetation through sustainable farming systems and rural livelihood opportunities with the participation of local communities for ensuring long-term ecological and economic security. The basic approach for watershed development is to accelerate the pace of rural development by involving the communities in planning, implementation and monitoring. He elaborated the district-wise position of micro watershed in Uttaranchal through various schemes and called for integration of every developmental need with full participation of stakeholders.

Uma Melkania*, **H. J. S. Prasad** and **Jyothi Prasad**, G.B. Pant University of Agriculture and Technology, Pantnagar 263 145, India

*e-mail: umamelkania@yahoo.co.in