

Frequent damage to agricultural crops by Nilgai is reported from Delhi, Gujarat, Uttarakhand, Uttar Pradesh and many other places. Although there are provisions to kill this animal at agricultural fields after duly notifying each case by state authorities; unavailability of trained shooters and the associated religious beliefs hamper such operations. Wild boar has emerged as a major threat to agricultural crops in many states in view of tremendous increase in its population. In Jammu and Kashmir, farmers have been replacing their agriculture crops with horticulture crops to compensate the loss due to damage by wild boar. In Uttarakhand as well the problem of wild boar is severe. One of the reasons for increase in the number of wild boar in recent years has been linked with low populations of jackal and fox which used to prey on piglets. Since the populations of jackal and fox registered a decline in recent years, pig population and its impact on crop depredation have increased considerably. Similarly, an increase in monkey population in North India and their migration to cities and nearby habitation areas has become a serious problem. The state governments run different schemes for controlling monkey population. In Delhi, for example, under a project more than 14,000 monkeys were trapped and relocated into the nearby Bhati Asola sanctuary; however, the feeding cost under

such schemes is high. Sterilization practised as most reliable means to control their population was not cost-effective (Rs 2000 per case of sterilization).

The workshop resulted in many important recommendations to overcome human-wildlife conflicts. It strongly advocated for the need to develop standard operating principles for each wild animal at national level. Considering that most human-wildlife conflicts occur due to loss of natural habitats, encroachment to forest areas, and developmental activities, it was strongly emphasized to improve quality of forests with a view to maintain a healthy food chain balance by optimizing herbivore and carnivore population/ratio, and by augmenting the herbivore stock through plantation of native species, suitable fodder, wild edibles, fruits, and broadleaved species, control of forest fire, and captive breeding. Fencing of agricultural land by different means to control the destruction of crop fields by elephant and Nilgai in plain areas, and by monkey and wild boar at mid-hills was highlighted as an important issue that needs appropriate policy backing. Furthermore, development of simple mechanisms for speedy disbursement of compensation against wild animal-led damages to human lives, domestic animals, crop fields and property was suggested. Besides, need for a change in crop combinations and crop-

ping pattern by substituting crop species that are not so vulnerable to animal damage, such as ginger, cardamom, etc. in the hills, up-scaling of agriculture by creating incentives to stop out migration of workforce, simplification of permission procedure for killing wild boar in agricultural fields, development of sheds to capture monkeys in villages so as to hand them over to the Forest Department, prevent/guard against animal attacks, reinstating the old system of village patrolling, and formulation of appropriate pro-people policies were the other recommendations that emerged from the discussions. It was strongly emphasized that there is need for unique and innovative site and species-specific proactive measures to deal with human-wildlife conflicts. Therefore, a need for better cross-sectoral and interdepartmental coordination amongst forest-agriculture-horticulture-animal husbandry departments, frequent exchange of ideas on human-wildlife conflicts between Central and State governments, and dissemination of effective and efficient best practices were also underlined.

R. C. Sundriyal and P. P. Dhyani, G.B. Pant Institute of Himalayan Environment & Development, Kosi-Katarmal, Almora 263 643, India
e-mail: sundriyalrc@yahoo.com

MEETING REPORT

Application of Remote Sensing and GIS in Water Resource Management*

Use of Remote Sensing (RS) and GIS in natural resource and environmental monitoring has been advocated strongly in recent years. Considering this, a two-day workshop was organized. The major discussions in the workshop comprised (i) application of remote sensing and GIS

management such as water resource, retreat of glaciers, status of groundwater reservoirs and polluting water resources, if any, (ii) development of GIS, DEM and other hydrological models for water resource conservation and management, and (iii) use of such information system for enhancing recharge, improving governance and economy in water resource use.

In the welcome address Manju Sundriyal (Uttarakhand Science Education and Research Centre (USERC)) highlighted the importance of natural resources in general and water resource in particular and emphasized the challenges in con-

servation and management of glaciers, aquifers, catchment area and pollution of water reservoirs. She dwelt upon application of remote sensing and GIS in management of such resources.

Y. V. N. Krishnamurthy (Indian Institute of Remote Sensing (IIRS)) in his keynote talk pointed out that RS and GIS application is one of the best approaches to enable proper monitoring and managing of natural resources and for predicting their future trend. It helps in modelling and decision-making process. He mentioned that lack of awareness and casual approach of people is the prominent hurdle in water resource management. He

*A report on the two-day workshop on Application of Remote Sensing and GIS in Water Resource Management organized by Uttarakhand Science Education and Research Centre in collaboration with Uttarakhand Space Application Centre and Uttarakhand State Council of Science and Technology during 4 and 5 May 2014 at Doon University, Dehradun.

also highlighted many examples of successful use of RS and GIS-based decision system and said that it has helped to understand demand-based irrigation system, control of disease in crops, predicting temporal variation in water erosion, cloud cover, land use and land cover, glaciological information, soil moisture and salinity. He suggested the participants to use 'BHUVAN', an official geoportal of ISRO to observe village, drainage pattern and numerous other geographical features, that will enable them to understand the significance of RS and GIS applications.

Vijay Kumar Dhaundiyal (USERC, Dehradun) drew attention to two major requirements which are of societal concern, i.e. water governance and water economy. He highlighted with different examples the management of natural resources, including water resources adopting a decentralized approach involving local communities. In this connection traditional management of water resources and providing incentive to local governance can lead to developing an appropriate pathway for sustainable management of water.

Sanjay Jain (National Institute of Hydrology, Roorkee) demonstrated application of RS and GIS for predicting rainfall, surface water flow, groundwa-

ter, status of aquifer, elevation and slope, land surface, surface temperature and evapo-transpiration rate, etc. Using various case studies, he explained use of databases such as NOAA-AVHRR, MODIS and TRMM along with various digital elevation models (DEMs) for topography studies, SRTM and ASTER Global DEM.

Sushma Gairola (USAC) spelt out the application of RS and GIS for management of wetlands by explaining georeferencing of satellite data, creation of digital database, thematic map preparation from satellite data using digital analysis and generation of spatial framework in GIS environment on the basis of Survey of India grids.

S. P. S. Kushwaha (NRSA, Dehradun) highlighted the development of 3D images and explained the Biodiversity Information System. He also suggested introduction of RS and GIS courses in the undergraduate curriculum, so as to cater to the need of trained human resource in the field. Illustrating water scarcity in hilly terrain of Uttarakhand and Himachal Pradesh, Pankaj Kumar (Himalayan Environmental Studies and Conservation Organization, Dehradun) highlighted their efforts in collaboration with BARC, Mumbai to locate the recharge sites of seasonal hilly water

stream by applying Isotope Technique and recharging through treatment of identified watershed/catchment area. He showed that seasonal streams were recharged perennially after treatment, due to which farmers could be able to increase wheat production from 70 to 150 kg/ha.

Hands-on training was provided to the participants in the area of GIS/RS application for management and maintenance of the quality of water resources. Over 100 participants from different universities, and institutions were trained in methods of chemical analysis of ground and surface water quality using HPTLC, ion analyser and atomic absorption, spectrophotometer by Bhavtosh Sharma. They were also trained in microbial identification in water.

Manju Sundriyal*, Uttarakhand Science Education and Research Centre (USERC), 33, Vasant Vihar, Phase II, Dehradun 248 006, India; **Kailash N. Bhardwaj**, Uttarakhand State Council for Science and Technology (UCOST), Vigyan Dham & Regional Science Centre, PO-Jhahjra, Dehradun 248 007, India; **Prashant Singh** and **Vijay K. Dhaundiyal**, USERC/UCOST, Dehradun 248 001, India.

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