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Remote sensing for natural resource assessment and management

P.S. ROY, Guest Editor

Indian Institute of Remote Sensing (NRSA), P.O. Box 135, Dehradun 248001, UA, India

Most of the world's ecosystems are in a state of constant change at various spatial and temporal scales by a variety of socio-economic and environmental factors. The changes today, particularly, in Tropical Ecosystems are more extensive and occur at faster rate than ever before. The ramifications of these changes have become very significant. They have altered ecosystem functioning, and have resulted in land cover changes. We have seen sign of changes which threaten biodiversity, water and energy resources, and contribute to the trace gas emissions. The increasing human interventions in tropics and other natural ecosystems have established the link of climate changes with such alterations. The maps produced by using aerial photographs and satellite images are excellent tools for spatial and temporal characterization. The sequential maps of the habitats can bring out dynamic processes. The recent developments in the field of remote sensing with its wide spectrum of sensor systems provide opportunity to gather information on ecosystems in space and time domain for vast range of scientific discipline. Major technological developments have taken place in improving spatial resolution, quantisation level and spectral resolution. The advancement also encompasses various application areas, information extraction techniques, multi-thematic information analysis and geospatial modeling.

This issue of *Tropical Ecology* aims to bring out an interdisciplinary approach on remote sensing of natural resources. The papers included in the volume are review of the work carried out in tropics for assessment and monitoring of forests, biodiversity, agriculture system, coastal resources and geomorphology. It will have cascade effect on scientific communities for research on earth observation and monitoring system at various scales. Mapping forest vegetation from aerial photograph was first attempted in 1850s. It was first utilized by the geologists for mapping, landform and terrain analysis. Research with colour photography permitted vegetation scientists to look at terrain in infrared spectral region for better separation of vegetation types and associated landuse. The development of optical mechanical scanning devices revolutionsed the process of data acquisition. These sensors were invented on satellite remote sensing in early 1970s. Since, then researchers have been using satellite remote sensing technology as a tool for mapping natural resources. India has made most significant contribution by developing state of art sensor systems, building launch capabilities of remote sensing series satellites and developing applications needed for national development.

With judicious combination of satellite data sets with ground-based studies, it is possible to carry out detailed mapping and monitoring of ecosystems. Most extensive application of satellite remote sensing technique has been reported using coarse and medium resolution datasets from sensors like, NOAA-AVHRR, SPOT-VEGETATIO, ERS and IRS-WiFS. These satellites not only provide multispectral data but also have very high temporal resolution, allowing reconstruction of phonological trend and use it for discriminating major communities of the forest. These applications are most suitable for global, continental and regional estimations. They have been used for large scale deforestation in Amazonia, Thailand, Indonesia and North-east India. The national forest cover assessment, however, requires medium resolution sensors (in order of ~50m), depending on the areas of investigation. Such a study was carried out in India by National Remote Sensing Agency (1983), the first of its kind at national level to assess forest cover during the periods of 1972-75 and 1980-82. The multispectral digital data from satellite viz., IRS LISS or SPOT or Landsat MSS/TM have also been used comprehensively to stratify forest types on the basis of community formations. Advanced digital image processing

techniques like, artificial intelligence and neural network further improve the accuracy of the derived thematic layers from satellite image. In such an approach, it is also possible to include altitude, climate and contextural details for accurate classification. Digital change detection has also been used to study the human dimensions (encroachment, deforestation, and shifting cultivation) in the forest landscape. This has provided new dimensions to the understanding of ecosystem dynamics and bio-physical parameters in the forested landscape. Finally, these satellite derived forest/vegetation cover maps provide authentic basis for designing sampling and sampled distribution for detailed ground inventories.

Understanding and proper interpretation of remotely sensed data require *a priori* knowledge of the underlying physical, biological, and chemical processes that contribute to a particular spectral reflectance spectra. This knowledge can be obtained only through cooperation and research among scientists from pertinent disciplines. Therefore, it is imperative to encourage and establish open communication and future cooperation among scientific community using remote sensing as a tool to study land surface processes. In this special issue, we intend to cover the applications of remote sensing in a wide range of tropical ecosystems that are concerned with land surface conditions and processes.

The papers included in this issue encompass wide range of themes viz., geomorphology, forest, soil resources, crop inventory, hydrology, wetland, soil degradation and wildlife habitat evaluation. The geomorphology is important discipline for managing natural resources. The basic information on landform is essential for planning landuse. D.P. Rao reviews the application of remote sensing for characterizing landform, their relationship with natural vegetation and landuse. The tropical forest cover assessment has always been an important issue as they form important component of bioproductive system. F. Achard *et al.* and R. Tateishi present techniques to monitor global/regional forest cover in Asia and humid tropics using narrow/wide swath satellite data. These efforts are noteworthy in the context of preparing global landcover maps. P.S. Roy *et al.* review the work on the tropical forest cover assessment and developments using remote sensing technologies. The satellite data are now being used operationally to prepare forest cover type and density maps. They are also being used as precursor for quantitative estimation of volume or biomass. A. Rikimaru *et al.* present an approach for forest density mapping using biospectral response modeling. The optical satellite remote sensing based technique has been validated in south east Asian region.

The estimation of biomass and productivity and their spatial representation have always been a major concern for the ecologists. Sarnam Singh *et al.* review the techniques and present an approach for regional estimation. Biodiversity characterization at landscape level is an important requirement for conservation planning. P.S. Roy and Mukunda Behera review the various techniques of rapid biodiversity assessment and present an approach by incorporating habitat, field knowledge, environment and human impacts (disturbance) for biodiversity mapping at landscape level. S.P.S. Kushwaha *et al.* review the work carried out the area of wildlife habitat mapping and its use for conservation planning. In relation to agroecosystems some papers review aspects of soil mapping (M.L. Manchanda *et al.*), soil degradation (R.S. Dwivedi) and Crop Inventory (V.K. Dadhwal *et al.*). These results highlight the capability of satellite remote sensing data for crop yield forecasting, soil resource mapping for sustainable agriculture and its expansion.

The satellite remote sensing applications for water resources and hydrology have been reviewed by A.M.J. Meijerink. Major application highlighted are irrigation planning, ground water prospecting, snowmelt monitoring and surface water delineation. The wide swath satellite with high temporal resolution are used for modeling evapotranspiration. Information on wetlands has been reviewed by S.N. Prasad *et al.,* and the paper also highlights the unique Indian efforts of Space Applications Centre, Ahmedabad and Salim Ali Centre of Ornithology, Coimbatore in building database of wetlands. Such databases are of immense value for planning network of wetlands for conservation. A review on marine resources has been provided by S.B. Choudhury *et al.* The techniques on assessment of coastal water productivity, sea surface temperature, its use for identifying potential fishing zone have been reported.

I am sure researchers will find the issue informative for identifying areas for further research. The adoption of the space technology to the maximum extent, in almost all branches including research and developmental activities, yet remain to be seen !