APPLICATION OF SPACE TECHNOLOGY AND GIS FOR INVENTORYING, MONITORING & CONSERVATION OF MOUNTAIN BIODIVERSITY WITH SPECIAL REFERENCE TO MEDICINAL PLANTS

Chitra Sood, R.M. Bhagat and **Vaibhav Kalia**
Centre for Geo-informatics Research and Training,
CSK HPKV, Palampur 176 062, HP, India

Biodiversity implies the sum total of complexities of all life, including the great variety of organisms and their varying behaviour and interactions. It is described at three levels: Genetic diversity, Species diversity and Ecosystem diversity. Inventory of existing levels and spatial patterns of biodiversity are essential for short term as well as long term management strategies. The Indian subcontinent is one of the most distinct bio-geographic regions of the world, with a rich repository of herbal/medicinal plant species. More than 7000 species of plants are used from the earliest times by various health care systems in the country. The traditional knowledge regarding these plants and their utilization is being increasingly realized and put to use by modern medicine system. For the pharmaceutical industries, these plants form a major source of raw material requirements. Medicinal plants harvesting has been found to be a major part of livelihood options in a number of mountain communities, contributing from 3 to 44 per cent of the annual mountain household income. As a consequence of the unregulated use of these plants and fragmentation of natural habitats, their population is undergoing alarming depletion. As a first step towards conservation of biological diversity of these medicinal plants of Himalayan region, a systematic documentation/inventory of medicinal plants to assess the quality and quantity of available and commercially viable species and their useful parts followed by ex situ conservation, is pre-requisite.

Biodiversity mapping in the hostile and inaccessible mountainous terrains of the Himalayas has always posed a challenge. The use of modern Geo-IT tools like Geographic Information Systems (GIS) and remote sensing have become increasingly useful in inventorying, monitoring and conservation of biodiversity. The Indian Space Program has offered unique opportunities to work for remote and inaccessible mountain regions. The Indian Remote Sensing Satellite (IRS) imageries offer valuable sets of information on land, water and vegetation.

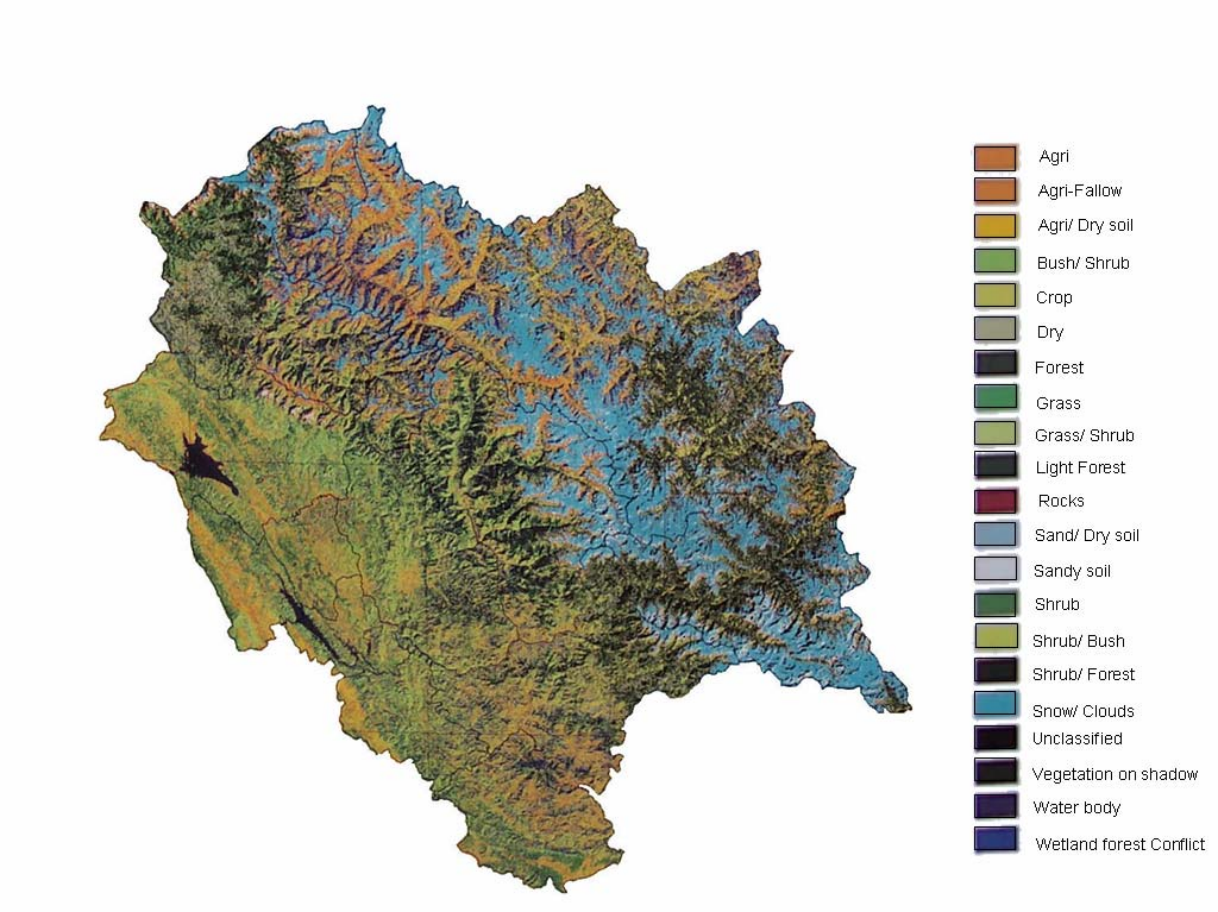

Fig. 1 ISODATA Clustering of Geo Cover Landsat TM (Bands 7, 4, 2) Himachal Pradesh, India

Remote sensing is defined as the science of acquiring, processing and interpreting images, & related data, obtained from aircrafts and satellites that record the interaction between matter and electromagnetic radiation. For mapping biodiversity, remote sensing can provide information on habitat type, vegetation structure of an area, landscape geometry and habitat fragmentation (Fig. 1). It also provides data to produce digital elevation models (DEM), net primary production rates, amount of biomass and leaf area indices. Percentage of vegetation cover can also be estimated using Normalized Difference vegetation Index (NDVI). These provide useful tools also for monitoring livestock production, agriculture and desertification. Remote sensing provides information at regional and landscape level. With the help of high resolution satellite imageries vegetation of different biodiversity rich regions can be studied in both time and space. Different representative vegetation patches can be sampled using ecological surveys and results can be extrapolated on a regional scale. Species, Populations, habitats, communities, ecosystems and processes are geo-referenced and documented in the form of databases and biodiversity maps can be prepared. Vegetation derived from Geo Coded IRS 1D LISS III Image of Himachal Pradesh is shown in Fig. 2.

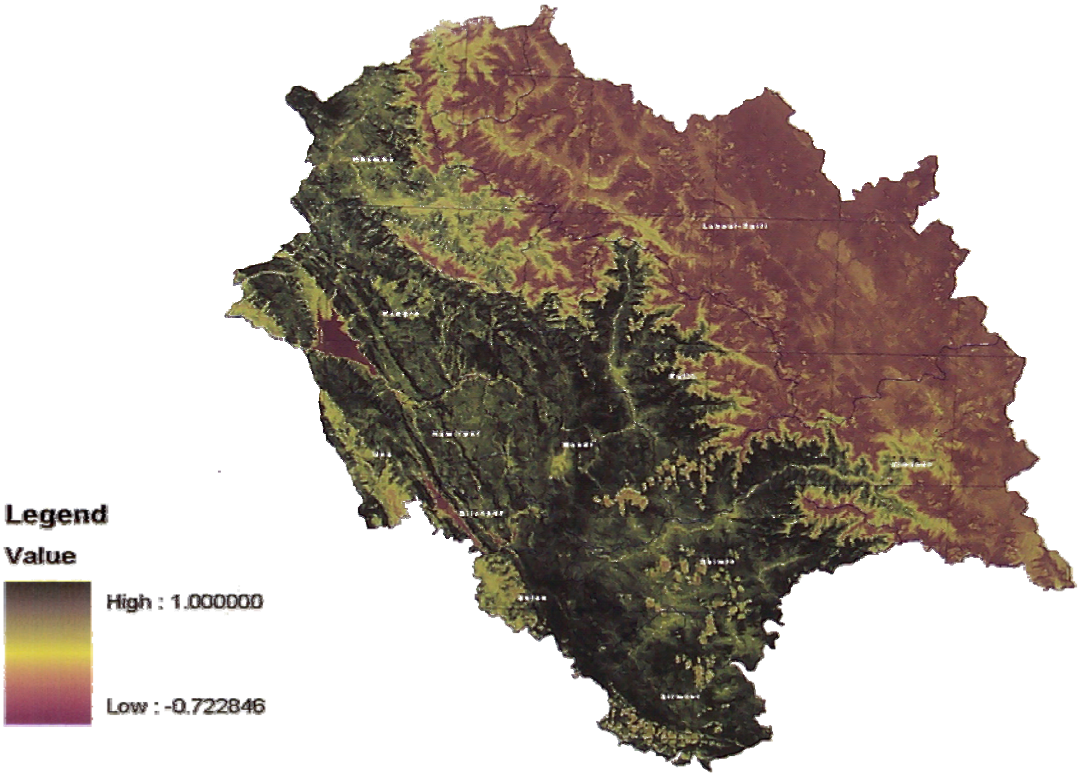

Fig. 2. Vegetation derived from Geo Coded IRS 1D LISS III Image of Himachal Pradesh

GIS is capable of assembling, storing, manipulating and displaying geographically referenced information i.e. data identified according to their location on the earth. Geographical information systems (GIS) can provide information on the relative richness, dominance, fragmentation, patchiness, patch density at the landscape level. Moreover the spatial analysis and modeling capabilities of GIS render them useful in mapping and modeling habitats, assessing degrees of biodiversity, conservation planning and mapping of different eco-regions.

Conservation:

The conservation efforts are best aided by vegetation and land use maps. Hence there is always a need for mapping the distribution pattern of the species crops up. Systematic mapping of the occurrence of the species in an area provides distribution patterns related to the ecological parameters. It gives an insight into the region where the conservation has to be initiated. This also provides information on the extent of protection required. Biodiversity can also be estimated using species richness. But this involves extensive field surveys however, remote sensing can be a better option to estimate biodiversity using higher taxa and environmental surrogates minimizing extensive field surveys. This is particularly important in mountain perspective, where inaccessibility due to slope, altitude, overall terrain conditions and seasonal hazards, fragility and diversity or heterogeneity (immense variations among and within ecozones) is the major constraint.

Use of spatial technologies (RS and GIS)

There are three functions of GIS that are important for biodiversity modelling. These are terrain analysis, data integration and data visualisation. Terrain analysis can be used to identify micro, meso and macro terrain indices. Data integration can be used to determine the environmental characteristics of known habitats of species. Data visualisation uses maps, graphs and statistics to make the enormous amount of data that can be derived on a species' habitat easy for understanding. Biotic and abiotic data are also important for biodiversity inventory and assessment. They are used by integrating Remote sensing, GIS and ecological methods. The existing vegetation, land-use, land cover, forest type are also essential for biodiversity inventory and assessment.

It is also possible to use GIS to graphically represent the data as it is difficult to interpret information from a table containing a large number of records. By applying the functionality of GIS, information on the location of species can be ascertained using a variety of visualisation tools. These tools can be used to make information on the relationships between the location of the species and the environmental characteristics more apparent. The use of GIS to map data is well known, as a map is a basic spatial analysis tool. The graphical display of environmental characteristics of the habitat of a species helps to understand the complex nature of species distribution patterns. Thus, the potential habitats of species could be predicted and mapped.

These spatial technologies integrated with comprehensive information related to agro-ecological zones, climatic pattern, topography, soil and terrain, landuse/landcover can accord a spatial position to different species on the basis of their growing conditions, occurrence, climate and soil types, height etc. A geo-spatial database developed in GIS environment that includes assembling and storing available information in the form of an inventory based on scaled and geo-referenced data can be easily prepared. These data can be stored as different themes (data layers) which can be combined or superimposed into one image showing their relationship to one another. Based on these data/information management practices for the sustainable use and conservation can be developed.

Scope of an Inventory

Since the GIS based inventory is digital and user-friendly which is easy to update using simple GIS software interfaces. These spatial inventories can store huge amount of complex data sets that can be combined and integrated according to the desired use. For example, it can help the users in different ways i.e using this system one can easily locate any species for its study/ identification. Major advantage of this system is its immense use for field managers in planning plantation since it can provide information about the mortality, number of big trees, small trees, herbs, shrubs, climbers etc in each grid. It becomes easy to plan which species has to be planted in which grid and at which location depending upon the habitat and association of the species in its surrounding area. One can locate a species by its botanical name. It can also be made capable of locating a species by its vernacular name since all the users are not aware of botanical name of the species. This can provide users the grid wise details on species availability and its status. It gives detailed information of each species with respect to flowering, fruiting, identification characters, medicinal uses, and herbarium number. This system can also help in filtering out species as per its

habit wise, threat, endemic and monotypic status. Besides, based on spatial analysis and predictive models, new potential suitable areas for growing a particular plant species can also be delineated.

Suggested Readings and links:

- Heywood, I., Cornelius, S., and Carver, S. 2002. An Introduction to Geographical Information Systems. Andison Wesley Longman. 2nd edition.
- Campbell, J.B. 2002. Introduction to remote sensing. 3rd ed. The Guilford Press.
- Jensen, J.R. 2000. Remote sensing of the environment: an earth resource perspective. Prentice Hall.
- Lillesand, T.M., R.W. Kiefer, and J.W. Chipman. 2003. Remote sensing and image interpretation. 5th ed. Wiley.
- Biodiversity of India, http://www.teriin.org/biodiv/biodiv.htm
- Mountain forum online library: www.mtnforum.org
- http://www.frlht-india.org
- www.GISdevelopment.net