

NRDMS Programme aims at promoting R&D in emerging areas of Geo Information Science and Technology. The R & D studies contribute to the development of methods and techniques for operationalising the concept of local level planning. The outputs are useful in drawing up local level planning strategies in support of the 73rd and 74th Constitutional Amendment Acts relating to the Panchayati Raj Institutions (PRIs) and Urban Local Bodies (ULBs). Sharing of spatial data by data providing agencies in the framework of Spatial Data Infrastructure (SDI) is an essential prerequisite.

Several activities have been completed towards the above goal during the year 2010-11. A set of broad parameters has been approved by the Union Cabinet to help evolve a National Policy on Data Sharing and Accessibility. District geo portal prototypes have been developed and their utility demonstrated using standards-based open source software packages to provide end users with accessibility to information vital to local level planning. Sector-specific geo-information services have been validated and made accessible to the end user community in the sectors of Health and Hydrology. Studies have been completed in areas like Cartographic Generalisation, Disaster Management (floods and landslides), Biodiversity, Lake Ecosystem, and Pollution Modelling. Fresh studies have been initiated in areas like Spatio-temporal Data Analysis, Sensor Web Enablement, Marine GIS, Digital Heritage, and Hyper Spectral Remote Sensing. Technical capacity has been built through a series of training and user awareness workshops amongst the scientific and the end user communities towards operationalising National and State level SDIs.

National Policy on Data Sharing & Accessibility

Sharing of spatial data between data providers and end users has been a major bottleneck in its use in planning and decision-making. In order to improve sharing and accessibility, a set of broad parameters has been approved by the Union Cabinet for devising a National Policy. Some of the items covered in the approval include (i) the requirement for the data providing agencies or programmes/ schemes funded by Government to classify feature data sets into 'classified' and 'non-classified' categories from the angle of national security, (ii) publishing the classified features as an 'exclusion list', and (iii) provision of non-classified features in the public domain for use in developmental planning. DST is working with various Ministries/ Departments and concerned organisations towards evolving the National Policy.

Various NSDI nodal agencies have been provided with the required technical and financial support for operationalising their data/ metadata nodes using NSDI standards to facilitate spatial data sharing. A draft content standard has been drawn up and shared with the stakeholders for finalization.

District Geo Portals

In a typical district, different Line Departments and other agencies acquire and process spatial data sets on a day-to-day basis for field/ local level applications. Some of these data sets relate to watersheds, plots, weather, crime, irrigation, and facilities etc. (e.g. educational, health, public distribution system).

Inadequate access to these data sets inhibits their use and integration with other relevant layers. At times, these data sets are compiled and consolidated for use at higher area levels where a generalized representation is adequate for decision-making. In order to make the detailed data sets accessible to the end-users at lower area levels, there is a need for improving the related data access procedures. District Geo portal prototypes have thus been developed and demonstrated to user agencies for districts like Prakasam (Andhra Pradesh) (Figure 5.18), Almora (Uttarakhand) and Jammu (Jammu & Kashmir). While the Prakasam and Almora Geo portals have been developed on OGC-compliant Open Source software packages, the Jammu Geo portal has been developed on a commercial-off-the-shelf product. Various thematic layers acquired from different sources including remote sensing have been made accessible to users using OGC-compliant Web Map Service (WMS).

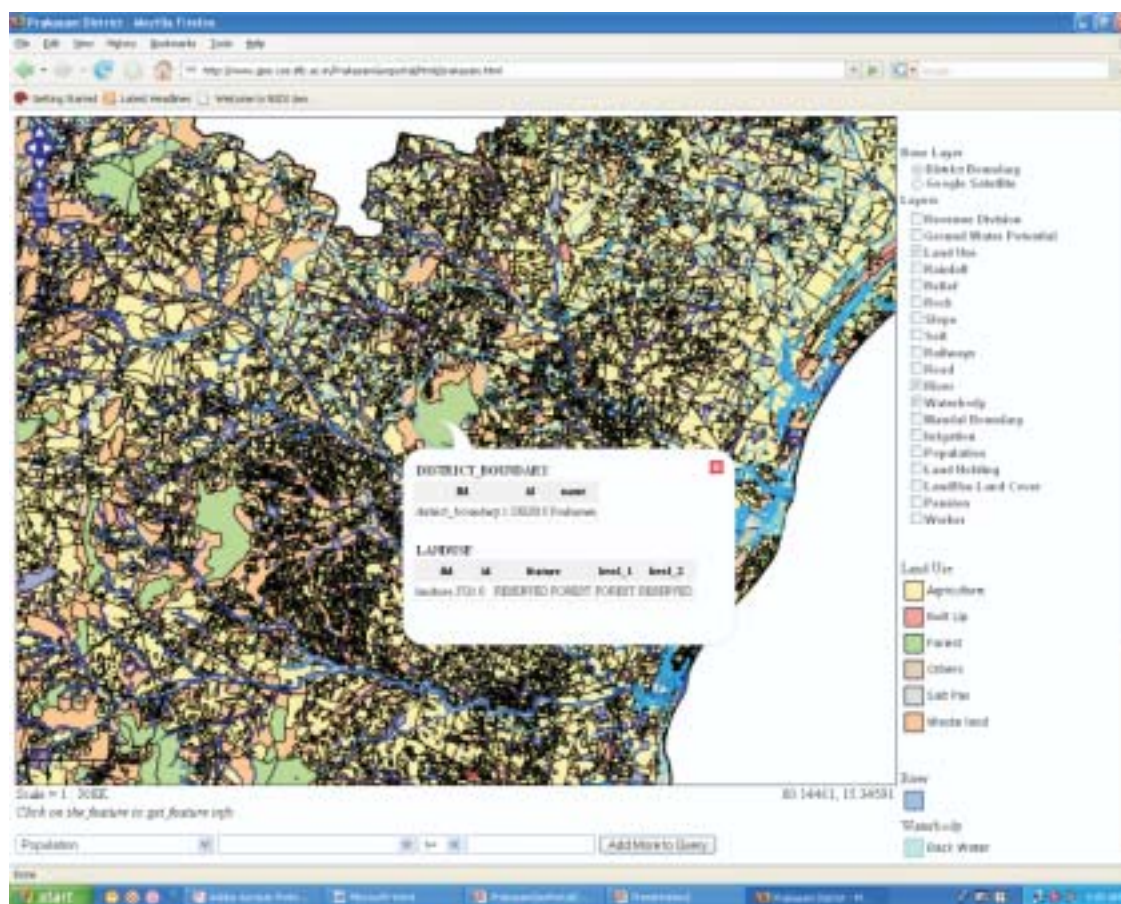


Fig. 5.18: A screenshot of Prakasam Geo Portal Web Map Service showing zoomed-in details of the land use & land cover theme along with its attribute information using the open source RDBMS and Web Service packages

State Geo Portals

Karnataka Geo-portal has been demonstrated to potential stakeholders for different applications. As an outcome, specific applications in the sectors of 'Education' (Fig. 5.19) and 'Bio-fuels' have been developed and presented to officials from Ministry of Human Resources Development (MHRD), Govt. of India and the Dept. of Rural Development & Panchayati Raj, Govt. of Karnataka respectively. The Geo Portal is being upgraded with additional metadata from the Line Departments like Women & Child Development, Transport, and Revenue etc. for provision of Catalogue Service on Web (CSW).

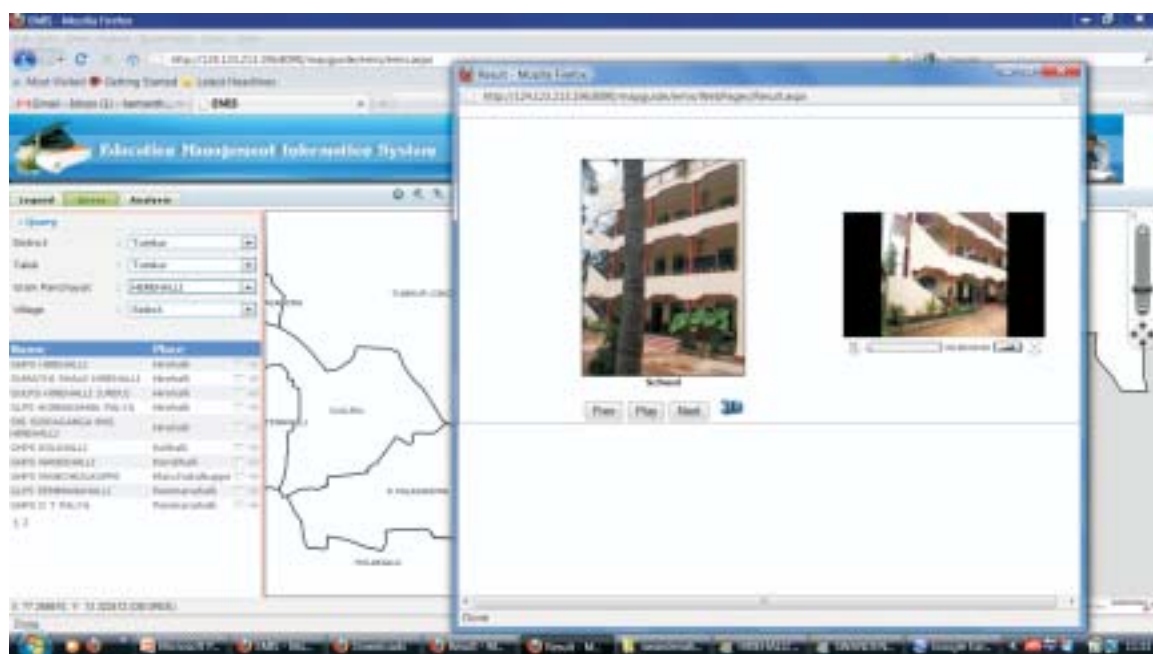


Fig. 5.19: A screenshot of a WMS on school locations and a video display of the school building accessible on the map display for a part of Tumkur Education Block, Karnataka

The State and District Geo Portals developed on open source or commercial-of-the-shelf products have been made accessible through the single window access mechanism of the India Geo Portal of the National Spatial Data Infrastructure (NSDI). Uniform set of standard specifications and compliant tools from ISO/ OGC have been used to ensure Interoperability.

Application of Web Map Service (WMS) in preparation of panchayat level plans

Strengthening Panchayati Raj Institutions (PRIs) and empowering local communities with improved access to up-to-date information is essential to their effective participation in local level planning. In a study conducted in Takula Block, Almora (Uttarakhand), year wise local development plans for a select set of villages have been prepared using up-to-date resource maps and made accessible through OGC-compliant



Fig. 5.20: Village Planning Map of Jharkote prepared with the involvement of Panchayat representatives and local villagers

WMS. The village level plans have been prepared with the involvement of local villagers and panchayats and uploaded to the district data node at Almora with a view to sharing the maps with the concerned stakeholder agencies. The present study aims at sharing the water resources information with the panchayat representatives and villagers for ensuring their participation in recharging the endangered Kosi River basin vital to meeting water requirement in the district. A cluster of 158 revenue villages covered in 8 Nyaya Panchayats, 89 Gram Panchayats, and 1 Kshettra Panchayat (Takula, Almora) and the Almora District Zilla Panchayat have been involved in the preparation of the natural resource inventory and the local level plans. Individual village level plans are proposed to be combined to prepare a block level master plan for Takula block water resources conservation planning.

Validation of the Surface Water Run-off Tool for Hydrological Information System

Access to web-enabled data processing tools for estimating surface water run-off is an essential component in a Hydrological Data Infrastructure. Relevant data needed to evaluate the cause and effect of all the proposed actions (e.g. setting up a water harvesting structure) within a drainage basin are required to be collected, maintained, processed and shared with the stakeholders on a regular basis to provide decision support. A Hydrological Information System (HIS) has been developed and demonstrated to the concerned Line Departments of Government of Himachal Pradesh like Environment, Irrigation & Public Health, Energy, Agriculture, and Horticulture. Capable of providing information on surface run-off, silt yield, biomass yield from a watershed following a rainfall event, the HIS could be accessed by stakeholders for collaborative management of the watersheds. Based on the feedback from the Line Departments and the available gauge/ discharge data, calibration and validation of the underlying Surface Water Run-off Tool for estimating surface run-off have been taken up. An initial validation exercise has been performed on Beas Sub-catchment for monthly results of the Tool with monthly observed values for the period 1995 to 1997. The simulated flows compare well with the observed flows (Fig. 5.21) and a close agreement has been observed between the mean and standard deviation values for both the results. The Nash-Sutcliffe coefficient value has been observed to be 0.7206 indicating a reasonable goodness-of-fit.

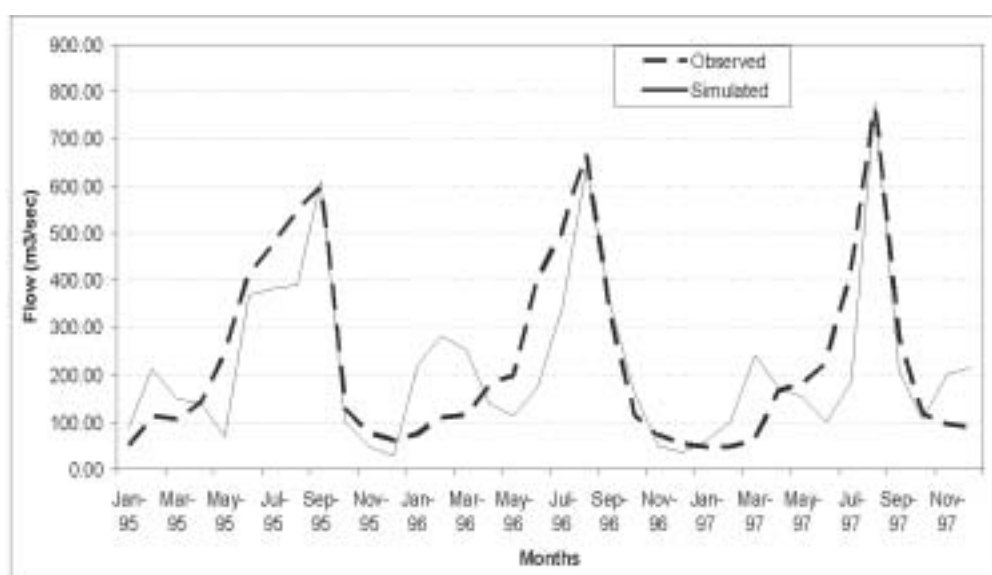


Fig. 5.21: Comparison of SWAT model simulated and observed monthly flow for the duration 1995 to 1997 for the Beas Sub-catchment

A comprehensive validation of the tool is proposed to be taken up with the availability of long-duration flow data sets in the next phase of the work.

Cartographic generalisation

A city map primarily consists of features like buildings and roads. While viewing such a map at a reduced scale, as on a mobile device, the features not only become smaller but tend to overlap as the small area available for visualisation gets smaller. Cartographic generalization plays an important role in overcoming these effects and preserves the required legibility considering the need for communicating (maps) geographical data to mobile device endusers. Various computing operations are performed during generalization of these features.

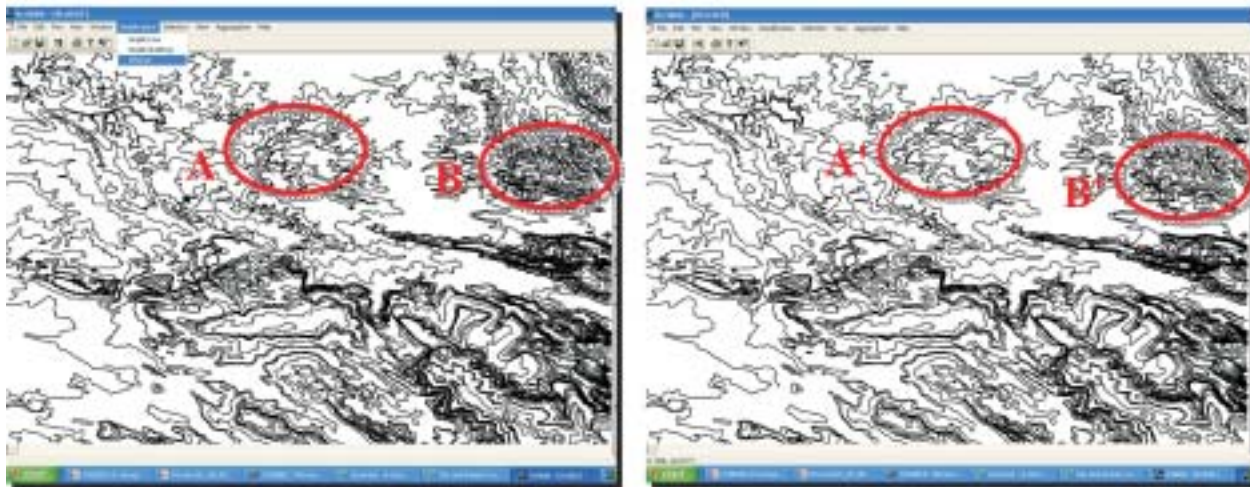


Fig. 5.22: Contours in the screenshot on the left shown after cartographic generalisation on the right (process of simplification) . For easy visualisation, please compare density of features at A and B on the left with those at A' and B' on the right

One of the important processes - simplification of the features like buildings, roads, contours etc. - involves automatic smoothing and elimination of small but unimportant features (Fig. 5.22).

Advanced Research Laboratory on Geo-information Science & Engineering (GISE)

In order to promote R&D in different emerging facets of Geo-information Science and Engineering, an Advanced Laboratory on Geo-information Science & Engineering (www.gise.cse.iitb.ac.in) has been set up at the Department of Computer Science & Engineering, Indian Institute of Technology Bombay. Some of the priorities identified for investigation at the Laboratory include Spatio-temporal Data Analysis, Geo-spatial Statistics, District Geo portal prototypes, General Purpose Wireless Sensor Node Development etc. The Laboratory is expected to facilitate closer interaction between different research groups in the area of Spatial Data Technologies for the achievement of long term goals in the field of Geo-information Science by leveraging the expertise and experiences available at various IITB Centres/Departments, and other similar research organizations in the country or outside. Some of the activities pursued during the year include Smart Campus Grid, Wireless Sensor Node, and Spatio-temporal Data Analysis etc.

Smart Campus Grid

The Smart Campus Grid Project (referred simply as IITBGrid) proposes to develop and deploy innovative applications to support managing, planning and optimizing campus resources by making use of

GIS and related technologies. It plans to use IIT Bombay campus as a model to demonstrate the utility of such a concept. The platform is proposed to be made available for supporting R&D in various IIT Bombay Departments/ Schools as it provides detailed spatial context for development and validation of research models (such as studies in energy management, water management, disaster management), including research in mainstream computer science areas such as database techniques, sensor networks, data visualization etc. A set of spatial data layers of IIT Bombay has initially been made accessible to the stakeholders like researchers and other end-users over web using OGC-compliant WMS Services (Fig. 5.23).



Fig. 5.23: A screenshot of the WMS from the IITBGrid Project showing different data layers relating to the IIT Bombay campus

The Grid is expected to offer a platform to build state-of-the-art geo-spatial technology based applications for managing, planning and monitoring the resources and the environment for better serving the campus community. In addition, the IITBGrid will help support collaborative research activities, technology development, innovation, infrastructure building, modernization, and education within the unit. The Grid is expected to be used as a model for similar applications for larger communities like villages and cities for GIS-based operation management and planning.

General purpose wireless sensor node

The general purpose wireless sensor node has been fabricated with a view to equipping the IITB smart campus grid with sensor nodes for capturing information to support campus resource management. Designed to be a low cost and easily deployable device, the node consists of a Zigbee Module (ZM), GSM/GPRS Module, and a GPS Module.

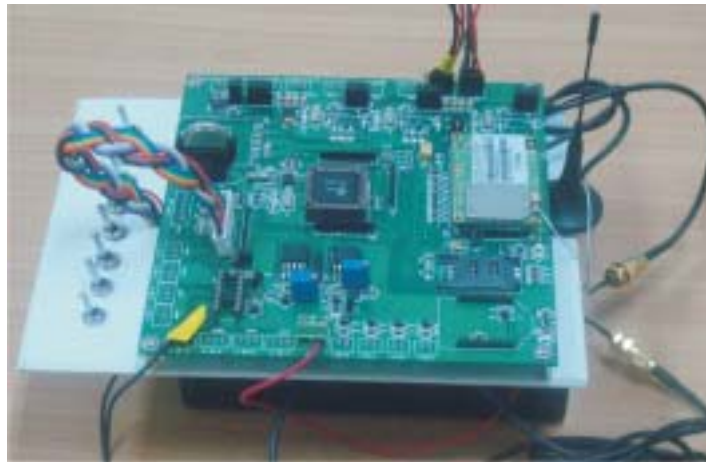


Fig. 5.24: Low cost general purpose wireless sensor node for deployment in the IITB Smart Campus Grid Project for the management of campus resources

Multiple sensors can be connected to this node via 6 serial ports, 8 ADC channels, one SPI port, and 8 General Purpose I/O lines. The GSM/GPRS module can send data to a Server via SMS or the internet via GPRS for automatic sharing with the end user community (Fig. 5.24).

Spatio-temporal analysis of cyclone data from Bay of Bengal region

Study of movement (trajectory) of cyclones is a pre-requisite to improve early warning and devise better strategies for preparedness. Behavior of tropical cyclone trajectories needs to be better understood in order to isolate potentially predictable aspects of landfall. Cyclone trajectories in a given ocean or sea can be better analyzed using cluster analysis by grouping them into small subgroups with homogeneous spatio-temporal characteristics. A set of 139 tropical cyclone tracks over the Bay of Bengal has been studied and classified into different subcategories using spatio-temporal data sets for the period 1990-2009 and applying K-means clustering algorithm based on the concepts of vector geometry and higher order statistical moments. Using the first two moments of a cyclone track, it has been possible to estimate a measure of its central location, length, orientation, and to an extent, its curvature.



Fig. 5.25: Maps showing mean centroid location and variance ellipse for a cyclone track and similar ellipses (red line) with mean variance ellipse (black bold line) for all the cluster 1 cyclone tracks in Bay of Bengal

A vector of five attributes (two centroids and three variances) per track has been considered for clustering. Fig. 5.25 shows the cluster 1 individual ellipses (red ellipses) and the mean ellipse (represented by the bold boundary in black) for the set of cyclones studied in the work. Cluster 1 is centered close to Tamil Nadu coastline and the mean variance ellipse of this cluster is more elongated in the longitudinal

direction with a negative tilt indicating that the cyclone tracks of this cluster are generally moving in the north easterly direction. Characteristics like landfall location, genesis location, life span, intensity, and seasonality of cyclones for all the clusters are proposed to be analyzed in the near future.

Urban Flood Risk Mapping of Chennai City

About 400 Sq. Km. area of Chennai City has been taken up for flood risk mapping using ALTM technique. The study focusses on (i) selection of flood mitigation techniques to manage flood risk in the study area using Orthomaps, DEM and thematic layers in GIS (ii) site specific mitigation strategies for the 36 flood prone hotspots in Chennai corporation limits and Ambattur Industrial Estate (iii) implementing intensive artificial recharge and rain water harvesting in Chennai (iv) post project activities and follow up projects for Chennai corporation using ALTM data and automatic weather stations (development of DSS and EWS for a pilot area) to make the best use of the high resolution data base (Fig. 5.26).

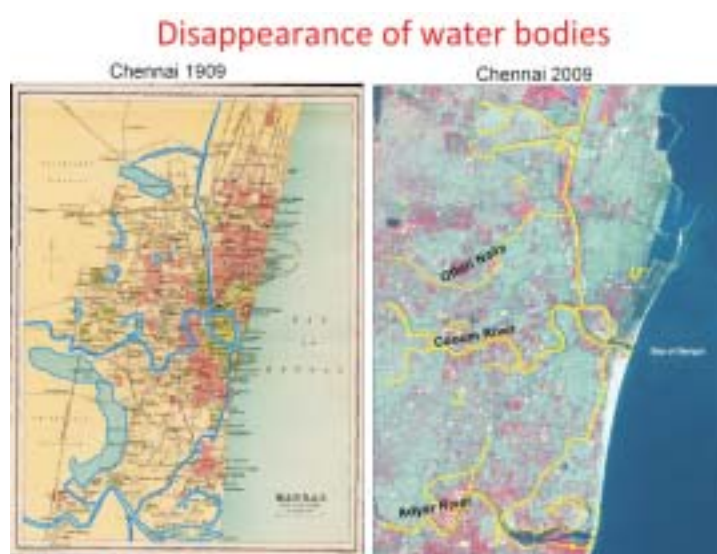


Fig. 5.26: Disappearance of water bodies in Chennai

Landslide Hazard Mitigation

The Kaliyaur landslide on NH-58 between Srinagar to Badrinath has been mapped on 1:500 scale with detailed geological, structural and geo-morphological features. Based on this, a DTM has been prepared to demarcate slope distribution and slip surfaces. Rock mass characterization has been carried out to carry out slope stability analysis and propose suitable remedial measures.

Surbee Landslide near Mussoorie has been investigated in detail with the geological and geotechnical properties. Slope stability analysis for debris material and rock mass have been carried out. Numerical modeling of the slope has been attempted using FLAC2D package. Based on the analysis, causative factors have been identified and accordingly protective measures have been designed.

A regional study in Garhwal Himalaya covering parts of Chamoli and Rudraprayag districts has been carried out for landslide hazard and risk zonation using Advance Pattern Recognition Technique. Remote Sensing and GIS have been used in the Study. The results have been validated and it has been observed that such an approach for studies in a hilly region is more accurate than conventional techniques.

Mapping in 1:10,000 Scale

A Task Force under the Chairmanship of the Secretary, Ministry of Earth Sciences has been constituted for preparation of a detailed methodology to carry out benchmark studies for preparation of topographic maps in 1:10,000 scale using different technologies and resolutions for various land forms. The Task Force Report has been released by the Hon'ble Minister for Science & Technology and Earth Sciences during the inaugural function of NSDI-10. An implementation strategy is being worked out with the concerned partner agencies.

Bio-Geo Data Base and Ecological modeling for Himalayas

The coordinated programme on 'Bio-Geo Database and Ecological Modelling for Himalayas' is being implemented for the identified study transects in the North-western (NW) & North-eastern (NE) Himalayan ranges. Under the programme, specific R&D studies at the micro-watershed level have been taken up primarily to enhance scientific knowledge on the mountain environment to support local level decision-making.

(A) Uttarakhand Study Transects in the NW Himalaya

(i) Development of Socio-Economic Profile of Selected Micro Watersheds in Uttarakhand

A database has been developed for two micro watersheds - Dabka and Khulgad - located in the Kumaon region. The study identifies important locally relevant developmental indicators and indices to prioritize villages for developmental intervention. Both primary, through questionnaire survey, and secondary data have been used. A framework has been developed to collate household information at village level that in turn could be used for developing a socio-economic database. The demographic, social, economic and infrastructural indices have been developed along with a composite index to understand the disparities in development among the villages in the watersheds. Under the study, a geospatial information system at village level consisting of demographic, social, economic and infrastructural variables has been developed.

(ii) Database on forest and agricultural ecosystem dynamics along an altitudinal transect in Garhwal Himalaya

Agro biodiversity comprises the whole plant resource diversity that human societies use and manage for agriculture, food, healthcare, and livelihood. It includes the enormous diversity of crops and crop varieties that small-scale farmers conserve and cultivate, representing both the basis for their subsistence and a source of income. Agricultural diversification and low-input agriculture with indigenous agro-ecological knowledge and practices have been the major focus for development of societies. A watershed based development approach leading to a concrete set of suggestions for enhancing productivity and sustainable development of the study area has been evolved under the study. Monitoring at the level of watersheds or sub-watersheds in the basin helps in analyzing impacts of current and future activities and accordingly plan area specific management alternatives based on the local priorities. A five second grid of the land use map was taken and the agricultural area was covered for field sampling where the agro diversity was computed and analysed to help preserve the local ecology. Techniques for agro biodiversity and sustainable livelihood assessment at the local level based on an extensive set of data like land use/ land cover, drainage, settlements etc. using a GIS could be upscaled to cover a region or a state for framing suitable policies.

(B) Arunachal Pradesh Study Transect in the NE Himalaya

The coordinated programme on 'Bio Geo database and Ecological modeling' for the North East is being implemented for the state of Arunachal Pradesh occupying a major part of the north-eastern Himalayan region. The West Kameng and East Siang Districts of Arunachal Pradesh have been identified for a detailed study of the biodiversity. Inventorization and mapping of natural resources including exploration of floral and faunal diversity, monitoring of water quality, socio-ecological assessment of existing land use systems in Jhum areas of North-Eastern Himalayas, namely (1) Remi (East Siang), (2) Kalaktang (West Kameng) and (3) Tenga of West Kameng District in Eastern Himalayas of Arunachal Pradesh are proposed to be undertaken. Agencies located in the North East are involved in the Programme's activity.

Modelling Tool for Assessment of Non Point Source Pollution in a Watershed

A GIS- Based Modelling Tool for Assessment of Non Point Source Pollution in a Watershed - NutriL - GIS has been developed. Comprising of three modules - RunEstim, ADAM and NutriLEM to evaluate the effects of management decisions in a watershed in terms of run-off augmentation, fertilizer application and nutrient pollution control, NutriL-GIS is a user-friendly, stand-alone package tool for assessment of nutrient pollution load e.g. nitrogen (N) and phosphorus (P) generated from an agricultural watershed (Fig. 5.27). The software integrates Application Programming Interfaces (APIs) in a GIS environment. Data sets like land use, soil cover, topography in a watershed in addition to secondary data on rainfall and agriculture are used in the analysis. NutriL-GIS incorporates GIS features and functionalities for database management and data processing.



Fig. 5.27: A screenshot of the home page of the NutriL-GIS package

End user/ stakeholder sensitisation and training workshops

Advanced Lab on Geo-Information Science & Engineering organised a two day workshop on “Standards and Technologies for Spatial Data Infrastructures” at IIT Bombay on 24-25 January 2011 for the nodal officers of NSDI and the scientists / officials from the agencies implementing the State SDIs. Experts in the field from Canada, United States, and Germany delivered lectures on the next generation SDIs, and related standards & technologies.

In order to assess the geo-spatial data sets available for setting up the North Eastern Geo Portal and sensitize the participating State Governments on spatial data sharing, a workshop on ‘North Eastern Spatial Data Infrastructure (NESDI)’ was held at Shillong and Guwahati on 19 – 20 August 2010.

Brainstorming sessions on ‘National Geo-technical Facility (NGF)’ and ‘Application of Geo-Statistics & Soft-computing Techniques in Geo-spatial Data Analysis’ were held at Dehradun on 17 September 2010 and at Tirupati on 22-24 November 2010 to prepare a road map for operationalising the NGF and work out areas of research in Geo-statistics & Soft-computing respectively.

User sensitization workshops on ‘Urban flood management’ and ‘Landslides’ were held at Chennai on 21 November 2010 and at Ooty on 17-19 September 2010 respectively. A workshop on ‘Capacity building’ was organised at Hyderabad on 27-28 October 2010 to draw up a strategy for building the required human resource base in Geo-spatial Technologies.

A special session on “Hyper spectral remote sensing” was organised with the Indian Society for Remote Sensing (ISRS) Conference held at Lonavala, Bombay on 29 November 2010 to present the research outputs from various projects in this emerging field.

Centre for Geo-information Science & Technology, Kerala University, Thiruvananthapuram organised day-long user awareness workshops on ‘Application of Spatial Data Modelling in Urban Health’ and ‘Human-Wild life conflict: application of Spatial Technologies in Database Development and Management’ on 27 May 2010 and 20 December 2010 respectively for the end users. The former was organised to discuss and improve the health data model through the feed back and requirement analysis of the end user like Councilors of the local City Corporation, health officials, representatives from the State Health Department, National Rural Health Mission (NRHM), the local Medical College, and NGOs. The latter was attended by officials from the State Forest Department as well as scientists and researchers from the Kerala Forest Research Institute (KFRI), World Wildlife Fund, University Zoology Department and a select group of NGO’s for finalizing the forest data model towards improving management of forest data in the State.