DST's Mission Mode on Program Natural Resources Data Management System (NRDMS) & its Developments at CSIR-NISTADS, New Delhi - A Few Examples

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Abstract- Natural resources are great asset for an economy. There are various resources that still are unexplored and under-utilized. Keeping this aspect in view, this paper focuses on development of an integrated approach to the exploitation, conservation and management of natural resources as well as to the protection and preservation of environment. The work is carried out by conducting project on Natural Resources Data Management System (NRDMS) which is conceived by the Department of Science and Technology (DST), Govt. of India, New Delhi.

In addition, NRDMS software package called GRIDS (Geo-Encoded Resource Integrated Data System) was developed. It generates maps with reference to geographical system. It leads to spatial database that helps in projection, prediction and planning of natural resources.

The paper also puts light on the district database centre of NRDMS that is set up at Gurgaon by National Institute of Science, Technology and Development Studies (NISTADS). The database is generated electronically by integrating the conventional land based data with data obtained from remote sensing application. The task of planning and utilization of resources is done by a team of scientists in special area called Resource Planning and Utilization for Regional Development (RPURD). After studying this paper, we are able to retrieve any information regarding any land system by using a PC based software package called NRDMS-LIS (Land Information System) that is developed at NISTADS, New Delhi.

Index Terms- ***Geo- Encoded Resource Integrated Data System (GRIDS), Natural Resources Data Management System (NRDMS), NRDMS-LIS (Land Information System) and Resource Planning and Utilization for Regional Development (RPURD)***

1.0. INTRODUCTION

Idea Generation:

In prehistoric time's limited knowledge was available on resources. It was easy to remember and was updated periodically whenever newer and better resources were found. However, with the development of settled economy and division of labor, the volume of information and data on resources increased at an volatile rate. For proper planning and management of resources, land population was divided into different administrative units, viz., villages, tehsils, districts and states. The government collected enormous volumes of data and stored them in the form of tables, ledgers and files.

It has became imperative for a government to develop a database on the resource it has, the locations where they are available, their spatial distribution, and the human requirements, so that multifaceted retrieval and analysis exercises can be carried out for optimal management. Keeping these aspects in view, the project on the Natural Resources Data Management System (NRDMS) has been conceived by the Department of Science and Technology, Government of India, New Delhi. This project is operationalization of Natural Resources Data Management System (NRDMS).

NRDMS is a multi-disciplinary and multi-agency science and technology project geared to integrate the natural resources and socio-economic databases on different spatial connotations.

2. 0. AIMS & OBJECTIVES

The main aim of NRDMS is to facilitate conductance of area specific and decentralized planning and monitoring exercises by providing data at various level - village, block and district. It specifically seeks to:

- Establish an area specific data management system for decentralized planning.
- Adapt the methodology for island system, such as natural disasters in specific areas and other ecologically sensitive areas.
- Establish linkages with the programmes of National Natural Resources Management System, National Informatics Centre Network and other sectoral information systems.
- Generate development profiles of different regions.
- Support specific studies to develop regional development perspectives using NRDMS as an aid.

3.0. FILE STRUCTURE OF NRDMS:

Following file structure is created under NRDMS district database:

- Natural Resources
- Energy
- Environment,
- Demography,
- Agro-economic,
- Socio-economic,

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- Remote sensing,
- Sectoral
- Infrastructure,
- Block information,
- Village information, and
- Household information.

4.0. GRID REFERENCE SYSTEM IN NRDMS

Problem:

The basic problem in developing an integrated multidisciplinary database is that the data collected by different methods in different forms have to be integrated, superimposed and registered properly, so that unique addressing keys can be given for proper referencing of the data. Geographical coordinates are being used normally to draw the resources maps and to identify any location or to mark an area, etc.

Solution:

Hence, the most suitable choice of a referencing system for registration, addressing and accessing land resources data would be a grid reference system based on latitudes and longitudes. The grid reference system has the following advantages:

- As the geographic units are of equal sizes, comparison among them becomes easier.
- The system remains unchanged, being not subject to changes in the boundaries of administrative divisions.
- The data required for a given area can be obtained by aggregating the concerned data of the grids contained in it.
- It becomes easy to identify locations and data relating to land configuration and distances can be easily obtained.

The disadvantages of a grid reference system are:

- As original data are not usually collected on grid basis, compilation of data on grid basis requires readjustment of the data collected for irregularly shaped real units of unequal sizes; this may involve high labor input and may introduce certain errors.
- The use of grid system as a surveying unit may be difficult.
- The grid size has to be chosen in such a way that it should be a good approximation for storing the relevant data,

5.0. REMOTE SENSING APPLICATION IN NRDMS

Proper management and utilization of known resources and identification, delineation and quantification of new natural resources in a short time span has become the need of the day. As the conventional field survey methods are costly and time-consuming, they are not suited for precise monitoring of new natural resources. Space technology in general and remote sensing supplemented with limited field surveys in particular appears to be the ideal technology for identifying new locations and estimating potentials in a short period. The advantages of utilizing satellite digital data and imagery include their repetitive coverage, broad synoptic view, negligible distortion, suitability for computer processing, cost effectiveness and time efficiency. At present, in India, the following remote sensing data products are available for studying natural resources:

(A) Aerial data - (1) Panchromatic photographs, (2) Color photographs, (3) Color infrared photographs.(4) Thermal photographs, (5) MSS photographs, and (6) SAR photographs

(B) Satellite data (imagery as well as digital data in the form of CCTS) - (i) Multispectral sensor data, (ii) Thematic Mapper, (iii) SPOT, (iv) IRS, (v) SAR, (vi) Sea Sat, and (vii) Mat Sat.

In addition, the following ground data products are available: (a) survey toposheets, (b) survey maps, (c) manually collected data (like meteorological data).

The accuracy of this data as of today for Land sat products in terms of mapping accuracy is about 250 m for MSS and about 100 m for TM data. With the improvement of technology, mapping accuracy (i.e. resolution) is improving (spot data).

6.0. GENERATION OF VILLAGE CODE IN NRDMS

To establish the computer-aided database covering various sectors of each village, a numeric code has been designed to uniquely cover each village using the database software package. For example, at Gurgaon district database a five-digit numeric code has been generated as identification code for villages. In the first step, the names of the blocks have been sorted alphabetically and a one-digit numeric code has been allotted to each block. In the second step, the names of the villages belonging to each block have been sorted and a three-digit code has been allotted to each village. All the NRDMS files have block code and village code as their common references, so that they can be joined for any interdisciplinary query and for studying the facilities of a particular village in detail.

7.0. NRDMS SOFTWARE

NRDMS computer software is available to generate thematic maps compatible with the geographic referencing system. Maps of different scales ranging from 1:1,000,000 to 1:250,000 or 1:50,000 may be generated. The primary source of data collection decides the analytical level of the thematic maps which have interpolated components. An attempt has also been made to develop and adopt a spatial data management system, in which polygonal and point referencing have been used. The thematic map so generated in the system would present a single variable within a sub-aerial zonation and would be similar to the maps generally prepared by economists and planners.

The integrated composite software package called "GRIDS stands for "Geo-Encoded Resource Integrated Data System". This is a special software package which is operational on a cost effective microprocessor based system. GRIDS takes into its fold the conventional databases which are available at various state and central levels coupled with data generated from canvassing of structured questionnaires at various levels for specific studies. An innovation in the system is the integration of high technology like remote sensing, computer-aided data processing, computer graphics and instrumentation surveys with the classical data sources. The package consists of

a number of programmes which may be classified into four categories:

- Thematic map generation for different sets of data like natural resources, demography, agro-economy, socio-economy, infrastructure, remote sensing, etc. and selection of areas suitable for specific applications or developmental programmes.
- Determination of development indices and potential indices for blocks or districts.
- Remote sensing application programmes.
- Analysis programmes for geophysical parameters for such essential purposes as ground water evaluation.

8.0. USE OF NRDMS IN PROJECTIONS

The database can help in specific projections, predictions, zoning and planning. Population projection and flood zoning and planning are two examples cited below.

8.1 Case I

Population projections comprise one of the basic pre-requisites for predicting and planning for future needs in such areas as food, energy, employment, community facilities and social services. It would be ideal to have a single forecast of population on which there is general agreement. However, since the factors influencing population trends—fertility, mortality and migration—are not perfectly predictable, projections usually represent individual or collective judgments that differ greatly, even among experts. There is often disagreement about the data as the base for projections.

In view of these inherent difficulties, it is better to present the population estimates in terms of an illustrative base, i.e. representing the highest and the lowest population counts that may have a reasonable chance to occur. The important question with the projections is not how accurate they are but how the users can cope with the inevitable uncertainty. The main projection methods are:

- Mathematics
- Component,
- Economic, and
- Analytical

8.2 Case II

Flood plain zoning and planning includes in its purview disaster evaluation and mitigation, and, therefore, requires varied inputs and information. Technological inputs like remote sensing and automated natural resources data acquisition models would provide a large database, which would otherwise not be possible from conventional sources and surveys. Such technological inputs would be of consider-able importance for flood plain studies. For instance: (a) the advance/recession of floods can be effectively monitored by satellite and other remote sensing techniques; (b) large scale computer maps generated from air borne MSS (1:25,000) and Land Sat data (1:50:000) demarcate, quite accurately, features like water bodies (deep and shallow), road, railway lines, canals, settlements, agricultural lands, forest areas, etc. Information on parameters like permeability, soaking potential of surface deposits, geomorphic details, micro-relief and man-made features like embankment, earthen builds, rails, roads which cause formation of local pools of water is important in the execution of disaster mitigation plans. There is a requirement to have information and topographic maps having elevation contours of 0.25-0.50 m interval in specific areas. It is possible to divide the flood plain areas of the country into different segments with varying requirements of resolution on topographic levels.

The strength of the district database depends on its building up and use through the active participation of all data generators and users at state and national levels in general and district, block and village levels in particular. In fact, it is a joint venture of experts, academicians and government officials. Active participation of district administrators and field functionaries is a prerequisite for successful operationalization of the computerized database. The district administrators may require social and cultural profiles of the district, blocks, tehsils and villages to identify the problems, set priorities and take remedial measures. Computerized database can go a long way in helping the district planner in almost all these specific situations.

9.0. NRDMS DISTRICT DATABASE

For decentralized planning, a program on the setting up of district databases in different agro-climatic regions has been launched under its project; "Natural Resources Data Management System (NRDMS)". The main function of a district database is to manage various items of information (both natural resources and socio-economic data) for each grid for the entire district. The demarcation of the grid is based on the Survey of India (SOI) toposheets. In these toposheets, the grid interval is 5 minutes. Thus, each SOI grid is sub-divided into four equal grids for the purpose of the NRDMS project.

The Principal application areas of a district database pertain to:

- Land use for agricultural development;
- Area affected by soil erosion and type of treatment needed;
- Soil and water analysis;
- Estimation of forest covers to plan for forestry, including social forestry;
- Location of water resources for agriculture, drinking and other uses;
- Identification of water bodies for irrigation and fisheries,
- Demarcation of flood plain zones;
- Carving of catchment areas for watershed planning in drought prone areas;
- Location and estimation of biomass;
- Thematic mapping;
- socio-economic status of the people;
- intra-district migration;

10.0. STATUS OF NRDMS- District Database, Gurgaon (Haryana)

The database centre at Gurgaon is set up by the National Institute of Science, Technology and Development Studies (NISTADS), a constituent establishment of Council of Scientific and Industrial Research (CSIR), New Delhi at district Headquarters of Gurgaon (Haryana), under the Department of Science and Technology, Govt. of India's national mission mode project titled, "Natural Resource Data Management System (NRDMS)".

In the district computerized database is created by the integration of conventional land based data with data secured from remote sensing sensors. The secondary conventional data were collated from district and state agencies, census reports, topographic, hydrological and geological maps, aerial and satellite products while the primary data were generated for specific studies and to fill up data gaps through undertaking limited primary surveys. Natural resources data are collected and stored on a grid basis to provide spatial connotation to thematic information. Maps were generated on 2.5 x 2.5' (21 sq. km) and 30" x 30" (0.9 sq. km) in consonance with universal latitude and longitude system. Various indicators of development and potentiality are calculated. Outputs are taken in various forms including thematic maps, tables, projections, graphics, reports, etc. The thematic maps facilitated overlaying of parameters and permitted the study of interrelations and correlations. With the close interaction with administration information requirements of various users are identified.

The existing information flow structure and information gaps are studied. Data collection formats are developed, tested and standardized for this purpose. About 300 attributes are stored on various aspects such as forests, land use, cropping pattern, water resources, mineral resources, meteorology, environment, agriculture, industry, demography, and infrastructure. Required software packages are developed for storage, analysis and retrieval of data. Specific test application exercises to demonstrate utility of database for developmental planning are undertaken. Some of these exercises are: preparation of model district and block plans, computerization of land records and electoral rolls, setting up of databases on wastelands and water resources and bringing out planning atlases. Specific files are created which contain data on drinking water mission, national literacy mission, poverty alleviation programmes and industries, etc. Data are organized into a specified file structure - agro-economic data file, infrastructural data file (educational, medical amenities, drinking water facilities, communication, transportation and electricity), household data file, remote sensing data file and sectoral data file (agricultural implements, land revenue, wasteland, industrial resources).

A study was conducted at NRDMS Database, Gurgaon, on "Drought Condition Assessment" with a view to facilitating the district authorities by providing required data through NRDMS district database at micro level and in a manner it is easily and timely accessible to take appropriate action for alleviating the drought suffering. The information was collected on daily basis and reports were generated weekly to access the impact of drought in terms of rainfall, starvation deaths both in human beings and animals, current prices of wheat and fodder, drinking water supply during morning and evening, power supply for domestic and agricultural purposes and water availability for animals.

Since the study had two fold aims, viz providing data of value and required analysis to Deputy Commissioner, Gurgaon, to effectively tackle the severe drought conditions in the district and to develop and test the methodology of NRDMS Database in such a situation.

At the instance of Planning Commission, Govt. of India, the exercise of preparation of model district plan - Gurgaon (1988-2000 A.D.) was undertaken in collaboration with NRDMS district database, Gurgaon within a short period of 3 weeks. The document thus produced contains the perspective, objectives, resource inventory, allocation priorities, sectoral programmes and strategies. The plan states that in future computerized micro level database for the district developed under the Project NRDMS will be put to full use for undertaking decisions, at household, village, block, tehsils, sub-divisional and district levels.

10.1 Problems during NRDMS Database Center

The major problems envisaged during the operationalization of NRDMS Database, Gurgaon, are:

- Channels of inflow and outflow of the data to be on sustainable basis are yet to be identified.
- District Planners are yet to find out what are their data requirements particularly for district planning. Mechanism for updating of database is not devised.
- Questions relating to the legal validity of data kept in storage system form rather than as records of papers as currently understood by the administrative and local system may arise.
- Aspects relating to data security will have to go into.

11. RESOURCE PLANNING AND UTILIZATION FOR REGIONAL DEVELOPMENT (RPURD)

In NISTADS, CSIR a full fledge research theme/area was developed by the research workers and scientists with the theme known as, in short, RPURD. A brief content of the same includes the following contents:

11.1 Overview

Sustainable Development requires Planning for the Utilization of Regional Resources in a Decentralized Mode. In this context, the Resource Planning and Utilization for Regional Development (RPURD) team is actively pursue research at the National Institute of Science, Technology and Development Studies (NISTADS), with focus on the use of spatial technology for ensuring the rational utilization of resources.

11.2 Management of Natural Resources Using Spatial Technology

Resources fall within four broad categories:

- Biological - human, animal, plant and microorganism

- Physical - water, minerals, land and forest
- Infrastructural
- Financial.

Knowledge on resource base and the capabilities to utilize and conserve the resources in a region are indicators of the socio-economic and political strengths of a region. Regions that lack the capability to develop the capacity to exploit their resources rationally, as also those whose resources are over - exploited by others, are backward, the socio-economic institutions developed in the framework of inadequate utilization of resources, in turn, become obstacles to development. Better resource management is, therefore, a matter of prime importance.

Studies on natural resources management have brought out the basic concept that the methods of recovery and use of natural resources are closely interrelated with many human dimensions. Planning and management are facilitated by the application of spatial technology based primarily on Geographic Information System (GIS) and Remote Sensing (RS) techniques, Spatial technology is a powerful too/ for conducting spatial analysis and presenting the dynamics of various spatial features.

11.3 Objectives

The main objectives of RPURD are:

- Elucidation of Theoretical concepts and the analytical framework required for planning and management of utilization of regional resources;
- Undertaking studies on application of development planning in areas like land use, agriculture and allied activities, forestry water management, wasteland development, environmental pollution and urbanization;
- Providing technical services to government agencies/Institutions and NGO's on preparation of Thematic maps for various uses in policy formulation and management in respect of regional development;
- Organizing training facilities relating to data management, software packages and concepts and skills of spatial management, and
- Demonstrating / evolving technology delivery systems for rural areas.

11.4 Main Facilities

- Advanced computer systems
- Scanning, digitization and reproduction facilities
- Reading and interpretation of remote sensing data products visually as well as digitally
- GPS use, map-making and advanced computerized cartography
- Testing and application of GIS and RS software packages like ARC/INFO and ERDAS
- Development of software's like LIS, MIS and DSS
- Creation of natural and socio-economic resource databases
- Audio-visual and multimedia facilities
- Library of specialized publications and documents
- Spatial technology application training kits.

12.0. USEFULNESS OF NRDMS

NRDMS would be handy in:

- Providing a sound information base for a district at one point for decision-making;
- Facilitating assessment of resource potential and extent of development of different sectors in different regions;
- Making available the resource and opportunity profiles in different sectors for entrepreneurial initiatives;
- Assisting in identification of target groups, specific location and situations;
- Supplying information for taking suitable measures for managing natural disasters like droughts, floods., earthquakes, cyclones, landslides and avalanches;
- Assisting in agro-economic services by providing ready information on commodity prices and their trend, crop yields, cropping pattern, soil characteristics, moisture content, etc.

13.0. NRDMS LIS – SOFTWARE

NRDMS LIS: NRDMS - Land Information System is a PC-based Software Package for land records computerization, developed at NISTADS, New Delhi under NRDMS Project of DST, Govt. of India.

- It allows input, storage, integrations, analysis, retrieval and printing of different data given in a typical land record viz**.** ***Jamabandi*** (record of rights) ; ***Khasra Girdawari*** (record of land use & crops); ***Intkal*** (mutation); ***Lal Kitab***(village statistics) registers and ***Sizra*** (cadastral map) etc.
- It handles and facilitates integration of geo-graphical (spatial), statistical (non- spatial), and textual data.
- It allows single, multiple and conditional queries, display of information and query in map, graphics, tabular and textual modes.
- This facilitates thematic map preparation, super imposition and zooming.
- It works in user-friendly, interactive, menu driven, easy-to-read and simple-to-operate environment.
- This provides on-line help to the user regarding revenue terminology and other trouble-shooting aspects.
- Effective implementation of land reforms. Bringing uniformity of procedure and standardization of formats of land data maintenance
- Increasing reliability of land information
- Distinguishing Features

14.0. CONCLUSION AND FUTURE SCOPE

The developed LIS software allows storing, editing, retrieval, formatting and integration of spatial, non spatial and textual data in an easier manner. It is used to scale and zoom map

Cartesian points and making it available in different sectors for entrepreneurial initiatives.

15.0. FUTURE SCOPE

In addition to remote sensing and GIS, the spatial data can be integrated by using semantic web technologies to provide diversity of information and enhance process of knowledge management in domains like industrial applications, identification of household databases and many more.

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