

GEO-SPATIAL METADATA SERVICES – ISRO’S INITIATIVE

Pushpalata B Shah, Navita J Thakkar

Space Applications Centre (ISRO) Ahmedabad – 380 015 - pushpa@sac.isro.gov.in

Commission IV, Working Group IV/5

KEYWORDS: NNRMS, NRDB, NRIS, Metadata, NSF, XML

ABSTRACT:

The National Natural Resources Management System (NNRMS) supports the national requirements of natural resources management and developmental needs by generating a proper and systematic inventory of natural resources. In doing so, NNRMS adopts various advanced technologies of satellite and aerial remote sensing; Geographical Information Systems (GIS); precise Positioning Systems; database and networking infrastructure and advanced ground-based survey techniques. NNRMS standards have been adopted to enable technologies – imaging, GIS, GPS and applications – thematic mapping, services and outputs etc. to work together. Standards are important not only to facilitate data sharing and increase interoperability, as is understood from many international efforts, but also to bring a systematization and “automation” into the total NNRMS process of mapping and GIS itself. Towards this the project has defined standards for all geo-spatial data called NNRMS standards. Under the NNRMS program a large volume of spatial and non-spatial data has been generated. Most of the spatial data is in vector data format. An attempt has been made to organize the entire spatial and non-spatial data as a central repository at SAC as a Natural Resources Data Base (NRDB). The entire spatial data is organized into standard data format as per NRDB data organisation schema and managed in RDBMS environment using Oracle 10g database management system and ARCSDE. The thematic information considered is at the scale of 1:25000 and 1:50000. NRDB is a system of distributed databases where the spatial and non-spatial database resides at various locations well distributed within the country. However, the metadata is accessible and sharable from a single portal viz. the NNRMS portal. The portal provides a sharable framework with metadata as per NNRMS standards, quality evaluation procedures and their standardization. The Metadata Explorer utility is accessible only after a successful login. The login is a process of self-registration to identify one self on the portal. Details related to layer description, layer citation, layer spread, procedures adopted for achieving positional and thematic accuracy survey year, mapping year, year of digitization, collaborating agency, focal person for the data and his contact details are received from the data generating centers in XML format. A software package to simplify the task of ingesting project level information and finally generating the metadata in XML structure is developed. Tools have been developed using ArcObjects and Visual Basic to automatically generate and store in Oracle RDBMS, the thumbnails, legend and spatial information related to each layer at various administrative boundary levels such as district, state, country, map sheet covering quarter million scale as well as half million scale. A software package with a common interface is developed to routinely handle the task of generating the metadata from the contents of the project level XML files as well as the spatial layers stored in the geo-database. The metadata can be searched using the geo browser mode. An advanced search option is provided to search by category, layer, class, place name, or any combination of the same. The results are displayed as a map in jpeg format along with a legend. The metadata is displayed through hyperlinks for spatial information and description. This paper describes the technical details related to the generation of metadata and disseminating the same on Internet through the NNRMS portal.

1. BACKGROUND

Over the past twenty years the National Natural Resources Management System (NNRMS) has steered the generation of spatial information using remote sensing data from various IRS missions. Through a wide variety of user driven projects a rich base of map information for the country has been generated. Spatial information - images and maps, form the foundation and basis for most of the planning, implementation and developmental activities; including infrastructure development; disaster management support; environmental monitoring; natural resources management; business geographics and many other national activities. Even common citizens require maps and spatial information for their localized decision-making. The goal of NNRMS is to provide the most optimal and scientific decision alternatives in support of national development by generating the information on the nation’s natural resources and its infrastructure; updating and maintaining the information sets and integrating these with administrative and social datasets. An important element of the NNRMS is the task of encapsulating the entire spatial data into a Natural Resources Repository

(NRR) and making it accessible to citizens, society, private enterprise and government.

2. GIS DATA STANDARDS (NNRMS)

To bring a systematization and “automation” in the process of mapping and GIS, ISRO had spearheaded and prepared the National (Natural) Resource Information System (NRIS) standards in 1998. Accordingly, the NRIS standards have become the de facto GIS standards for database creation and organization in the country.

In addition, to support the NNRMS applications and to position a National GIS repository, a next generation NNRMS standard has been developed, which encompasses the entire process of applications. The NNRMS standard now includes standards for images, thematic and cartographic mapping, seamless GIS database organisation, outputs and quality certification. The NNRMS standards have also defined a National Spatial Framework (NSF), which provides the spatial schema for

multiple scales of data under NNRMS activities. (Refer to Figure 1)

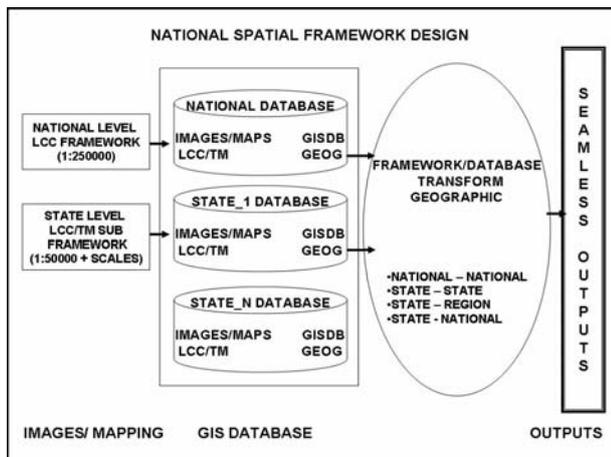


Figure 1. National Spatial Framework

Standards are a fundamental requirement for this national GIS. These standards enable technologies – imaging, GIS, GPS and applications – thematic mapping, services and outputs etc to work together. Standards are important not only to facilitate data sharing and increase interoperability, as is understood from many international efforts, but also to bring a systematization and “automation” into the total NNRMS process of mapping and GIS itself.

The NRIS standards [1] have succeeded in bringing to a common formatting and framework - different sources of data generated in a variety of formats (including spatial as well as

non-spatial form) with varying levels of details vis-à-vis the scales of mapping.

Database redundancy had to be minimized in order to increase the data integrity. The database quality parameters and the methods of data base validation had to be laid down in order to control the quality of inputs. Keeping the above in mind, the NRIS Standards define the GIS database design and attribute schema standards for NRIS project – defining content and their coding schemes for 22 layers. The standards include:

1. The database contents along with the associated coding schemes, level of details and the update cycles
2. The spatial database design standards including the spatial framework addressing the issues related to the co-ordinate system and the spatial and thematic accuracy levels to be enforced at the time of data input
3. Database structure including the naming conventions and the schema for establishing linkages amongst spatial and non-spatial data components.
4. Automated and semi-automated procedures for verification and validation of the databases against laid down design standards.

3. DATA BASE ORGANISATION

The spatial layers of the NRR are stored in a geo database. The commercial package of ArcGIS 9.2 and ARCSDE [2] with ORACLE 10g as backend RDBMS has been used for organising the database. This database is referred to as Natural Resources Database (NRDB). The NRDB contents adhere to a naming convention and category coding as specified in the NNRMS standards document [3]. Naming convention for a sub set of the layers is given in table_1.

| Sr. No. | Layer | Category Code | NNRMS Layer Name | Project |
|---------|----------------------|---------------|---------------------|---------|
| 1 | Village boundaries | 01 | Village50CENSUSYear | NRIS |
| 2 | Canal | 03 | Canal50NUISYear | |
| 3 | Drainage | 03 | Drainage50NRISYear | |
| 4 | Rail | 02 | Rail50NRISYear | |
| 5 | Roads | 02 | Road50NRISYear | |
| 6 | Settlement | 17 | Settle50CENSUSYear | |
| 7 | Watershed boundaries | 03 | Wshed50AISLUS | |
| 8 | Geomorphology | 04 | Geom50NRCYear | |
| 9 | Landuse /Landcover | 06 | Luse50NRISYear | |
| 10 | Lithology | 04 | Litho50NRISYear | |
| . | | .. | | |

Table 1. NRDB contents with category coding and naming convention

To simplify the operational activity of organising this huge volume and varied data, a software tool has been developed in Visual Basic using the object library of ArcGIS 9.2. The data received from various projects under NNRMS are in ARC Coverage format. Mandatory inputs required for the software are State name, Project name (this is a drop down menu), Scale of the data (drop down menu showing the scale as defined for the project), Year of data Creation, User Name and Password (this is the name by which Oracle will handle and protect the

data) and location (disk drive and folder) of the coverage data as shown in Figure 2.

After the form is filled and submitted a list of layers available for the data along with checkboxes is provided in the adjacent text area. One can select an individual layer, or a set of layers or all the layers for organising in the geo database.

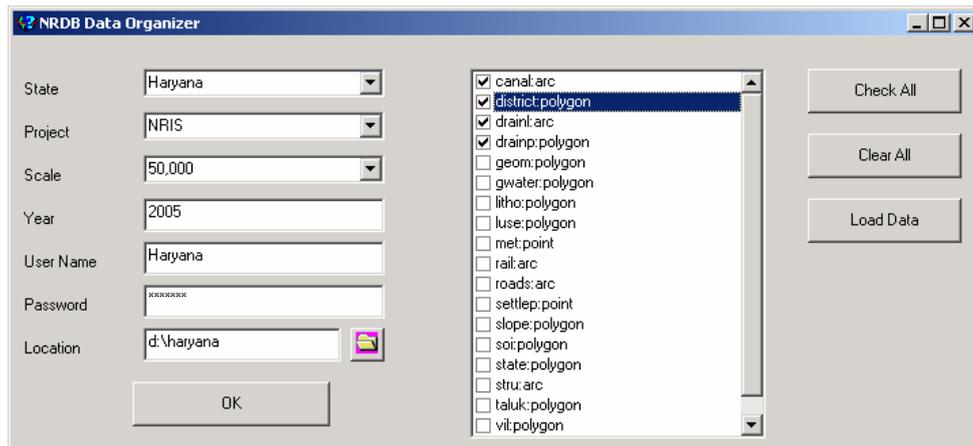


Figure 2. Data organization tool – inputs form after clicking ‘OK’

Simultaneously, a pop up window gives a complete list of the layers available and the fields missing if any are displayed. This will also indicate the layers that cannot be loaded into the geo database. A sample of this is given in Figure 3.

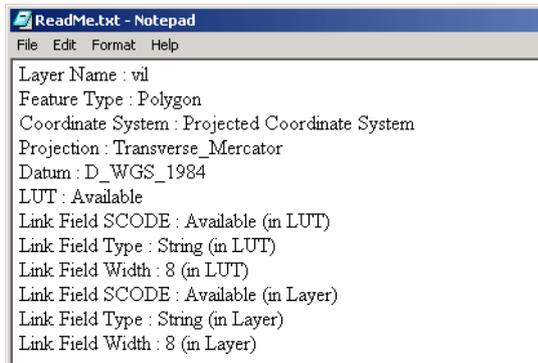


Figure 3. Data organization tool – List of layers available

Currently one thousand two hundred and five layers have been organised in NRDB.

4. METADATA STANDARDS

As a major effort towards establishment of a Spatial Data Infrastructure in India, NNRMS has developed the Metadata Standards [3] in 2002-2003. Metadata is the first element and interface of the user to a repository – which enables a user to find, on-line, spatial data that is available with NNRMS. NNRMS Metadata serves two major purposes – both for the spatial data generator and for the spatial data user.

For the generator, the NNRMS Metadata Standard provides a framework to document the spatial data and declare its content for users. For the user, the NNRMS Metadata Standard serves many important purposes, including finding the spatial data of his need; browsing spatial data; deciding on whether the spatial data will meet the application need and finding how the spatial data can be accessed.

The NNRMS Metadata Standard defines the schema and design for the NSDI Metadata. The metadata standards contain a set of relational tables that standardise the layer metadata, the geographic search metadata, the access metadata etc. The

metadata standards have been adopted by many agencies of NNRMS and have enabled for generating Metadata content in a systematic manner.

5. METADATA GENERATION

To simplify and systematize the task of metadata generation a tool has been developed in-house for handling the project level and layer level metadata. The project level information that is generated along with the project data is stored in an ‘xml’ file through software with manual entries. The entries have to be made at the project level as well as each layer level. In the second stage, the metadata (describing the spatial features as well as the bit maps) is generated through another package, which reads the data directly stored in the geo database and simultaneously stores all the metadata entries in Oracle. Ingesting the metadata from these xml files along with generation of bit maps and extraction of metadata related to the layer (e.g. feature type, number of features etc.) and storing in Oracle DBMS is done through a package named ‘metadata.exe’.

6. METADATA SERVICES

The metadata services are hosted through the NNRMS portal. NRDB maintains a standardised GIS database of all the NNRMS and NRR spatial information and positions spatial data services from the database to serve the needs of Department of Space (DOS) and NON-DOS users, business and citizens at large. To access the metadata services a user has to make a self-registration on the portal.

The open GIS consortium has specified standards for web map services and web feature services. The metadata service provided through the NNRMS portal is comparable with the web map service specification of OGC. An end user is provided with the following details when he/she is searching for the metadata

- i. Service level metadata
- ii. Map with well defined geographic and dimensional parameters
- iii. Information about features shown in the map

Two modes for searching the metadata are available. The default mode is the geo-browser mode for fetching metadata. This mode is designed for users who wish to look for specific

layer information. User specifies his area of interest by navigating through a dynamic map of the administrative boundaries of India (country – state – district – taluka – village). The second mode is an advanced search mechanism by category, layer name, class, place name or any combination of these parameters. In either case the metadata is presented as a 'jpg' image with appropriate legend along with hyperlinks for project level information and spatial information. In fact the jpg image is a raster form of the corresponding map display along with its legend. A typical metadata service is elicited as a sequence of snapshots in Figure 4 to Figure 9.

In case metadata is not available, appropriate message is flashed. Metadata of all data stored in NRDB is published. This is followed by a display of the requested metadata as a thumbnail (map in the form of a 'jpg' image) along with a legend as depicted in the figure below. The highest level of detail is considered in cases where data is available at multiple classes (e.g. land use level3, geomorphology level3 etc.).

This display is associated with three hyperlinks viz. 'SPATIAL INFORMATION', 'DESCRIPTION' & 'MAP DISPLAY'. The hyperlink 'SPATIAL INFORMATION' gives the metadata as shown in Figure 6.

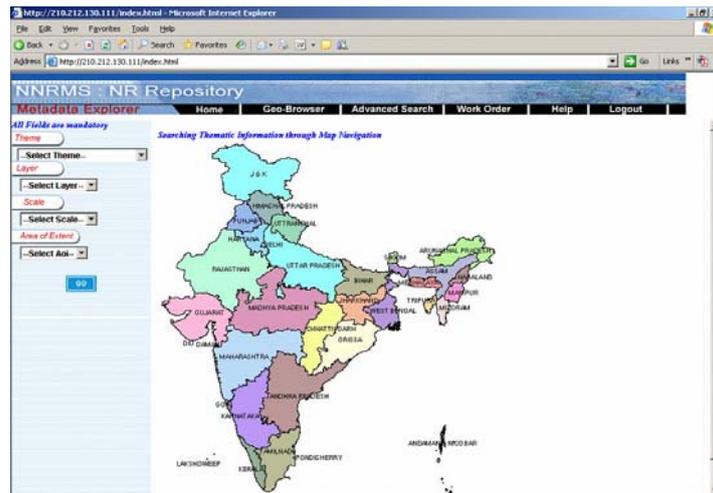


Figure 4. GUI for exploring metadata

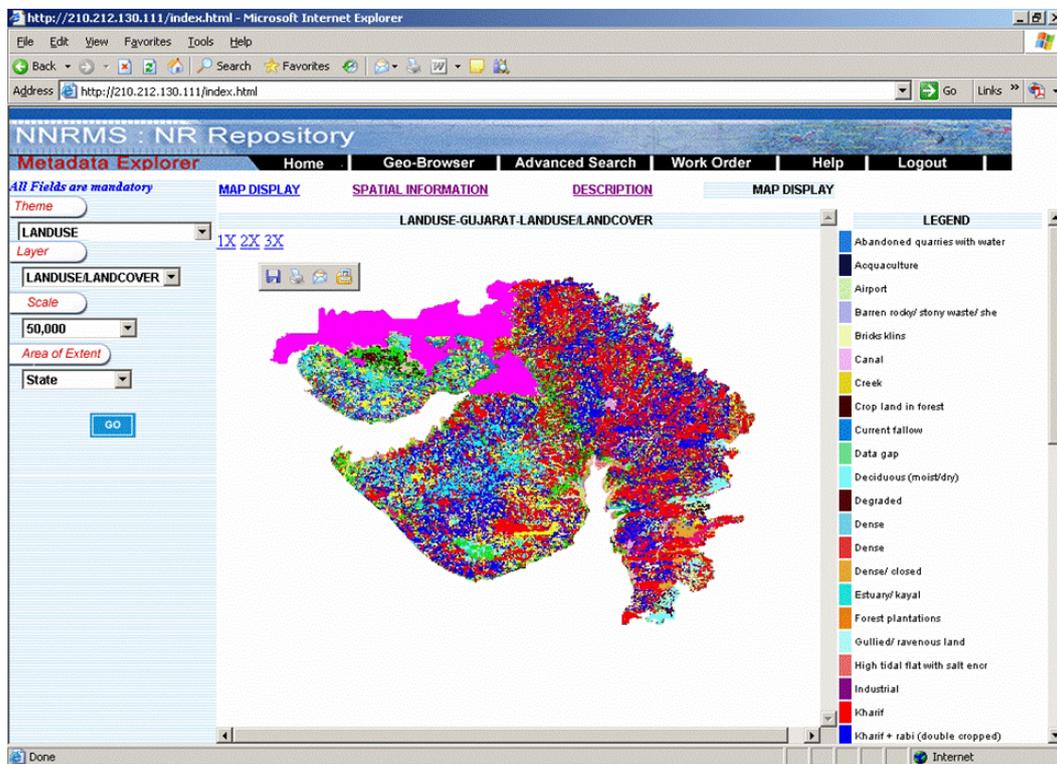


Figure 5. Thumbnail display of Metadata

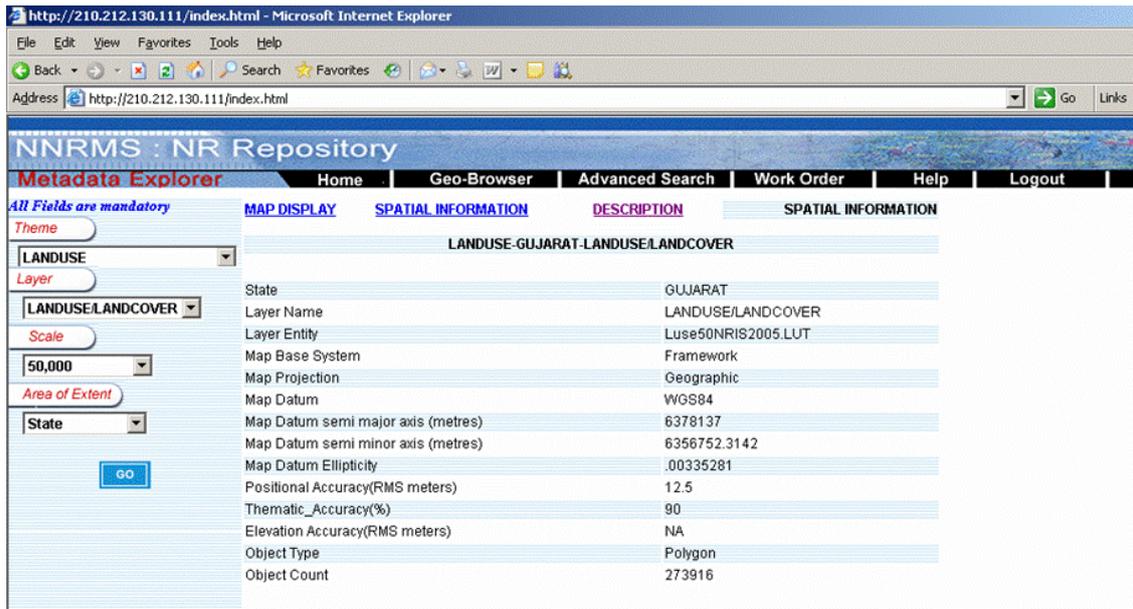


Figure 6. Display of metadata - Spatial Information

The hyperlink 'DESCRIPTION' gives the metadata as shown in Figure 7.

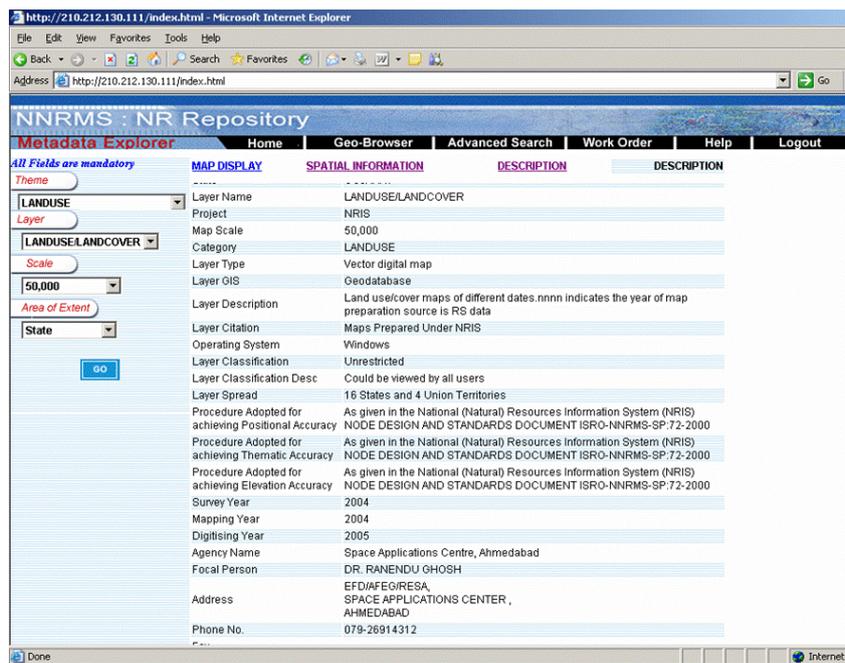


Figure 7: Display of metadata – Description

The hyperlink 'MAP DISPLAY' displays the bitmap, which is the default when searching for metadata. The metadata can be fetched map sheet wise (scale 250000) also. The selection of map sheet is provided as a labeled map sheet grid over the selected state. When the area of extent is 'District', user has to

first select a state. This will lead to a hyperlinked map with district boundaries, for specifying the district. When the area of extent is 'India', the selected theme bit map is displayed directly.

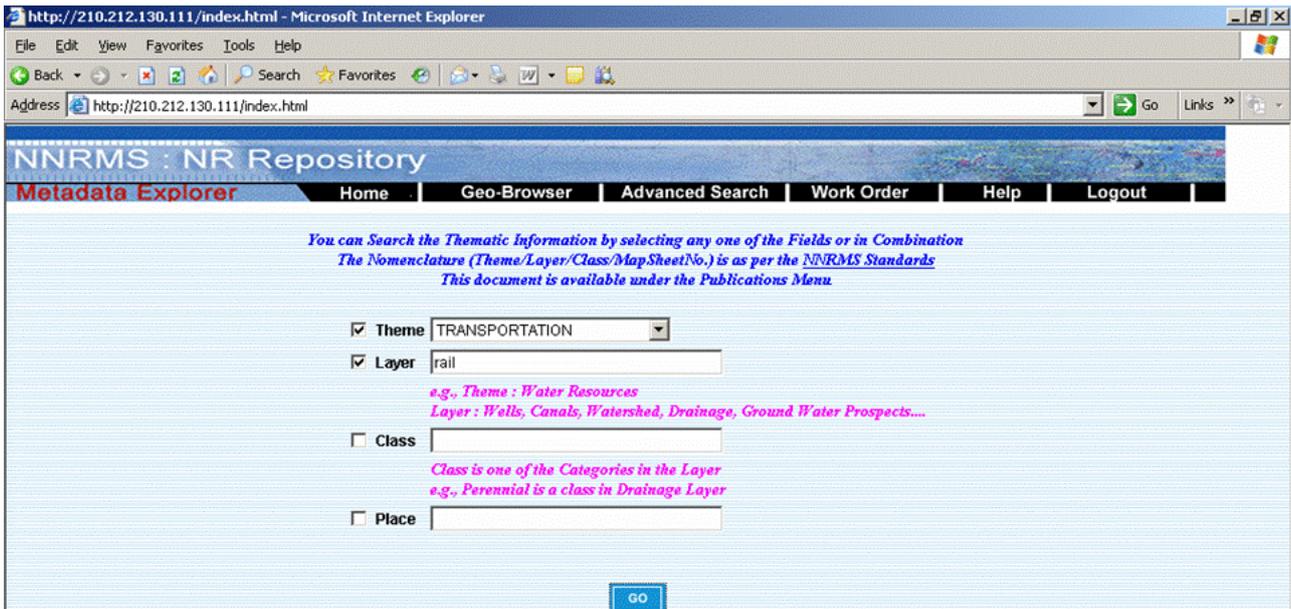


Figure 8: Advanced Search – specifying search options

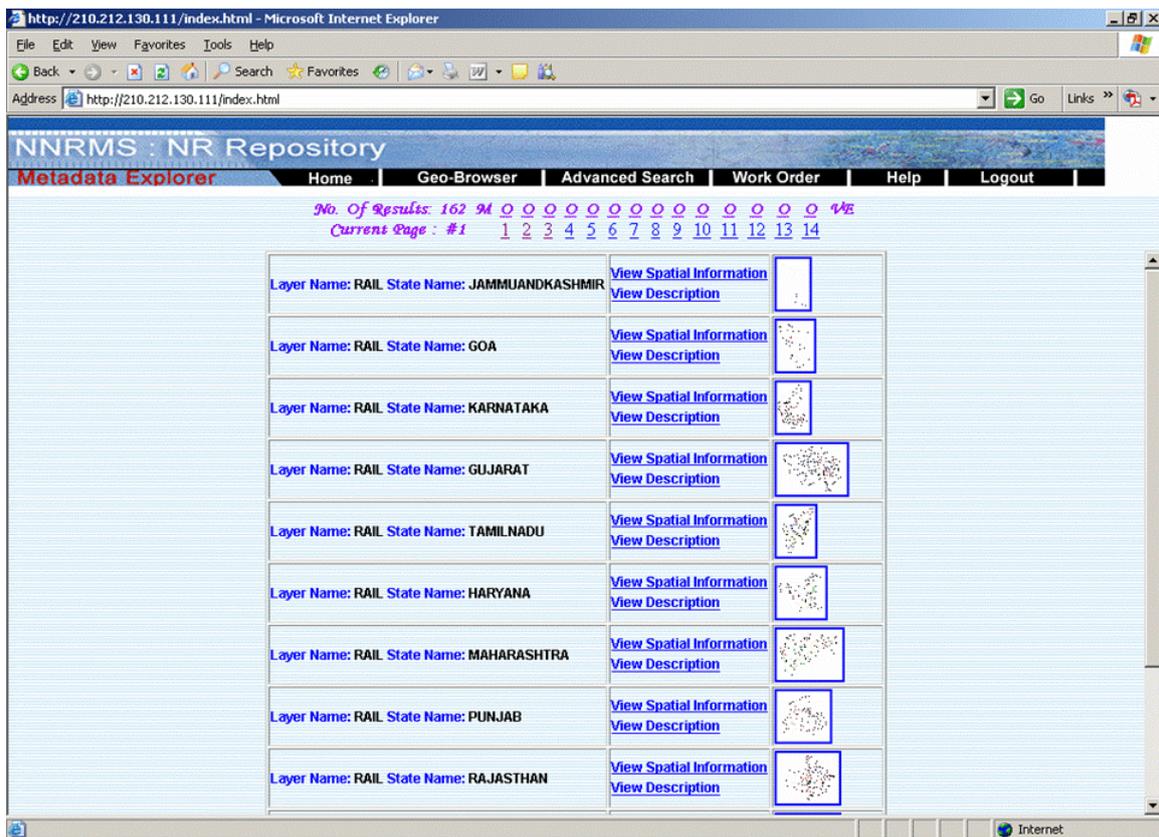


Figure 9: Advanced Search – search results

The results are presented in a tabular format in multiple pages. Each page holds ten results. The total number of results is specified. Each page number, thumbnail, 'View Spatial Information' and 'View Description' in each row is

hyperlinked. Clicking on the bit map will display the map as a jpeg image as shown in Figure 10. The other hyperlinks are self-explanatory.

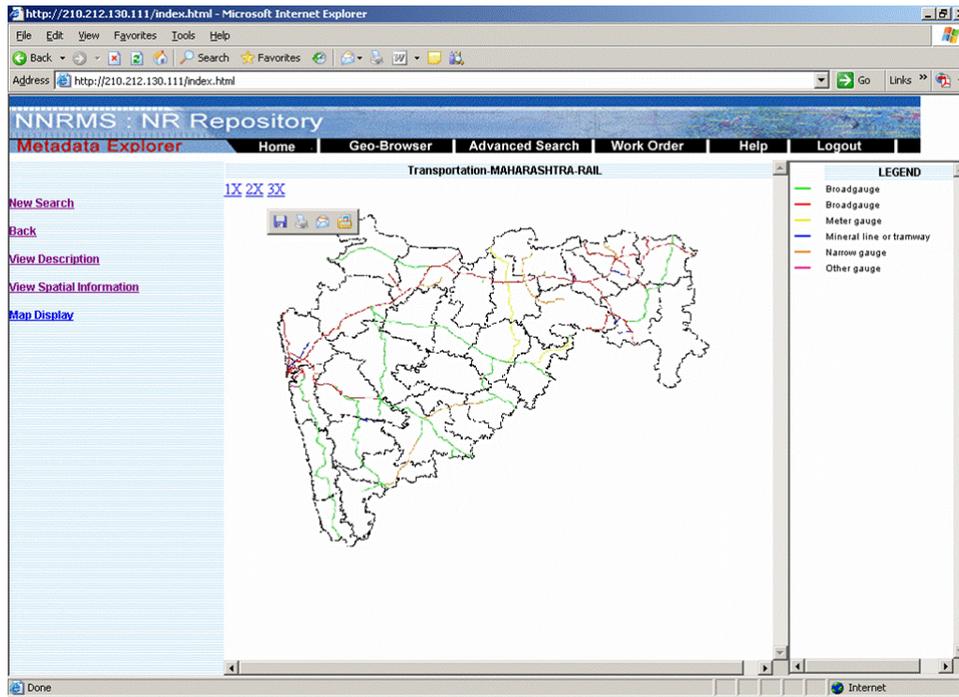


Figure 10: Advanced Search – search results

7. CONCLUSION/ANALYSIS

The NNRMS portal designed in the study provides a sharable framework with metadata as per NNRMS standards, quality evaluation procedures and their standardization. The tools developed are useful to search various thematic maps with respect to administrative units as well as natural boundaries such as watershed etc. It also provides an advance search tool to search thematic information either by category, layer, class, place name, or any combination of the same. The search results are displayed in the form of bit maps with standard legends. The paper provides all technical details related from the generation of metadata to disseminating the same with different kinds of options meeting the requirements of users.

REFERENCES

- [1] NRIS Standards, 1999 - NRIS Node Design & Standards. A NNRMS publication - ISRO-NNRMS-SP-72-99
- [2] <http://www.esri.com/library/brochures/pdfs/arcsde-server.pdf>

[3] NNRMS STANDARDS (A National Standard for EO Images, thematic and cartographic maps, GIS databases and spatial outputs) – ISRO:NNRMS: TR: 112: 2005 Committee report

[4] NRDB Project Execution Document, September 2005.

ACKNOWLEDGEMENTS

The authors wish to express their indebtedness to all the functionaries of the NRDB Project, in particular Dr. Ajai, Project Director, Mr. I C Matieda, Deputy Project Director, Systems, Networking and Tools Development, Dr. S K Pathan, Chairman Test & Evaluation Committee for NRDB Tools development and Mrs. A S Padmavathy, Project manager NNRMS Portal. Our special thanks to Dr. V Jeyraman, Secretary NNRMS Program and Dr. J Krishnamurthy, Program Office, NRDB for their valuable suggestions and critical views during the development of the portal. He authors thank Dr. R R Navlagund, Director Space Applications Centre for giving us an opportunity to work on this prestigious project of National importance.

