

MahaBHUMI: GIS Based Digital Basemap on 1:4k for Integrated Planning - Maharashtra State

Industry

Government

Organization Profile

Maharashtra Remote Sensing Application Centre (MRSAC) was established in January 1988, as an autonomous body under the Department of Planning, Govt. of Maharashtra. It is a premier institution, dedicatedly involved in serving the state of Maharashtra through use of geospatial technology like remote sensing, geographic information system (GIS), global positioning system (GPS), mobile technology, photogrammetry, drone (UAV) and LiDAR for 3-D mapping.

Solution

MahaBHUMI Geo-Portal.

Highlights

The aim of designing an integrated information system - MahaBHUMI Geo-Portal is multi-fold:

- To develop a system that shall depict the basemaps prepared from very high resolution satellite data on 1:4k with details of transport system, water resources, irrigation, urban areas and landuse. The Contours generated under the MahaBHUMI project are at 2m interval and are also shown in the topomaps collated at 1:10K scale.
- To integrate data generated in MRSAC from high resolution satellite images & geotagged information on water supply schemes, forest boundaries (upto beat level), orchards, mining lease boundaries, historical monuments, etc. with topomaps.
- To create a central repository of departmental data & assets in GIS.
- To create Web services of various databases so that these could be consumed by various departments in their own applications.

Website

<https://mrsac.gov.in/MRSAC/>

Project Summary

In order to make effective use of the very high-resolution satellite database and to achieve the e-governance objective of Maharashtra State, MRSAC has designed an integrated information system/unified geo-portal called MahaBHUMI. The aim of designing MahaBHUMI Geo-Portal is to acquire high-resolution satellite data and provide as services, the value-added processed satellite image data, under a common base of coordinate and projection system. The value-added base maps are generated by the process of abstraction of the visible features distributed into various base themes. The integration of the base themes generates the base map with various assets and topographic information. This can aid in creating a central repository of base information in a GIS environment. The project employs database standards with a standard schema for the generation of base geodatabase using very high-resolution ortho-corrected satellite data.

Challenges

For any kind of planning, a strong and robust database forms the backbone. This is the first of its kind in the country and therefore involved setting new benchmark in satellite data ortho-rectification to designing Geodatabase standards to meet the large scale mapping needs of different departments involved. The present initiative of standardization and feature extraction from very high-resolution satellite imagery, for planning, implementing, monitoring, and management of various government schemes is therefore taken up. The aim of such standardization is to enable individual state level partner institutions (Line Departments) to create, update, and carry out capacity building and disseminate the information up to grassroot (Gram Panchayat) level. In other words, the whole effort is for designing, creating, updating and disseminating the resource information under the ownership of individual stakeholder departments. The outcome of creating and organizing information is to establish and enable the information system comprising spatial natural resources and non-spatial data (MIS) towards supporting the decentralized planning at various levels in the Govt. The GIS database is customized to meet the requirements of the Government departments based on their problems/priority/developmental programs at the Cadastral/ Village/Block/Taluka/District level.

Solution

The base maps and the geo-portal that are generated under the MahaBHUMI project would lay the foundation for efficient infrastructure planning, monitoring

and management. Monitoring is a continuous process that involves data collection and analysis. The findings from monitoring and evaluation form the basis for establishing key goals and targets, adjusting strategies and making them effective and efficient. The information generated under MahaBHUMI will help in the integration and coordination of various databases in all state and local agencies involved in ensuring the success of the implementation of the various state development programs. MRSAC's systematic approach for base map preparation ensures accuracy and precision which can be effectively utilized for any/all planning purposes of various line departments of Maharashtra.

Objectives

1. Feature extraction and interpretation on 1:4K scale using high-resolution ortho-rectified and geocoded stereo satellite data of 50 cm resolution. The activity is carried out for the following base layer themes based on the standard document and schema provided:

URBAN Bag containing settlement, buildings, habitation, industries, mining areas, historical monuments, etc.

TRANSPORT Bag containing all transportation layers including roads, railways, airports, helipads, waterways, metros, mono rails, road land use, etc.

WATER Bag Water Resources layers and irrigation layers with canals, hydro structures, etc.

LUSE MASK Bag: Creation of land use/land cover integrated mask using the features extracted from the above-defined three themes along with FOREST, WASTELAND, and AGRICULTURE base themes. Reserved/Protected Forest boundaries for the state are used as a reference for Reserved Forest interpretation.

2. The activity is processed on 10K sheet based on the NSF OSM grid.
3. The database is generated as per the ArcGIS geodatabase scheme.
4. Integration is performed to generate a seamless mosaic of all theme data with respect to the adjacent grid data.

Methodology

Spatial distribution of Earth's surface features, both natural and man-made, represented in the form of a map is the best tool available to catalogue and view the arrangement and distribution. For the preparation of thematic maps, the base map becomes a pre-requisite, and many times this base map itself serves as an excellent tool for various application purposes- both for planning and implementation. With the very high

spatial resolution satellite images available these days, it is possible to prepare a very accurate base map on a larger than 1:2000 scale. The base layers generated should be so accurate to lay the foundation for efficient infrastructure planning, monitoring, and management of natural and man-made resources of Maharashtra. MRSAC employed a very systematic approach for base map preparation under the MahaBHUMI project. The stereo and tri stereo data of World view-2 and Pleiades data on 50 and 30 cm was used to generate orthomosaic using dedicated DGPS points classified as Iconic, Primary and Secondary. The data so prepared is used for the generation of DEM and 2 m contour. A comprehensive schema and data standard is prepared for the project with proper nomenclature, domains and data types.

The following base layers are generated under MahaBHUMI with full theme details along with their attribute information. A complete metadata standard is generated along with the data using the metadata software generated by MRSAC. The base layers are contained in the following Data "BAGs":

Directory Nomenclature
MBIMAGEBAG (MahaBHUMI Satellite Images Bag)
MBGRIDBAG (MahaBHUMI OSM GRID Layers Bag)
MBTOPOBAG (MahaBHUMI topographic Layers Bag)
MBURBANBAG (MahaBHUMI Settlement/Urban Layers Bag)
MBTRANSBAG (MahaBHUMI Transport Layers Bag)
MBWATERBAG (MahaBHUMI Water Resource Layers Bag)
MBMASKBAG (MahaBHUMI Land Use/Land Cover Bag)

Thematic interpretation is done using very high-resolution ortho-rectified and geocoded satellite data of 50 cm resolution. The data is generated on 10K sheet wise with scale of interpretation of 1:2000. The various theme features, which need to be abstracted/interpreted, are based on Geodatabase Standard which facilitates generating the databases, organizing them, and integrating them in a better way to achieve various goals of the MahaBHUMI project. The features that need to be abstracted/interpreted in each bag are described separately in separate sections of the Standard document. The description is comprehensive information about the minimum content of the base data, and in the future other information can be generated and augmented to these data through attribute object tables.

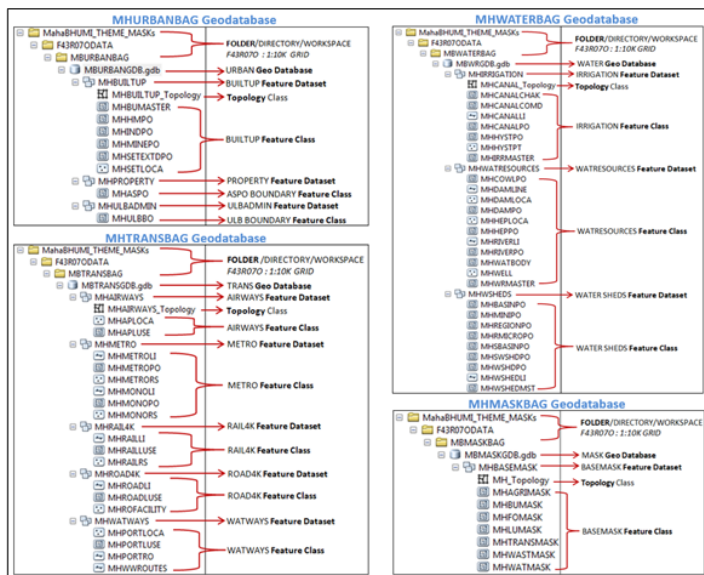


Figure 1: MahaBHUMI Database Schema

Output

Interpretation under various themes is being done for 11,109 grids of 10K of SOI for Maharashtra State. Feature extraction for the 10K SHEET is done using high-resolution ortho-rectified and geocoded satellite data of 50 cm resolution stored in the IMAGEBAG for URBAN (Settlement, Habitation & other urban layers), TRANSPORT (Transportation layers), WATER (Water Resources & Irrigation layers) and MASK themes as per the Geo-Database Standards. In the MBMASKGDB, the MASK feature class is initially interpreted for three classes only viz. FOREST, WASTELAND, and AGRICULTURE level-1 base themes. For interpreting the Forest theme, under MASKBAG, Reserved/Protected Forest boundaries generated using HR satellite data are used as reference. Data interpretation is carried out for all the Point, Line and Polygon features designed for the specified themes under the GDBs in their respective feature datasets (FD) and feature classes (FC). Topology is created in the individual FDs for each theme. The interpreted/abstracted polygon master database of URBAN, TRANSPORT, and WATER is integrated with the MASK using union command for final integrated LUMASK.

The project is intended to enable user departments with necessary applications using the data created under MahaBHUMI to be served on internet. Sample applications are configured for one district for the feasibility of applications and workflows for the project implementation. The details can be seen in Figure 2 covering the area of Gondia Municipal Council. An example of one 10K grid interpreted using the STANDARDS is presented in Figure 3.

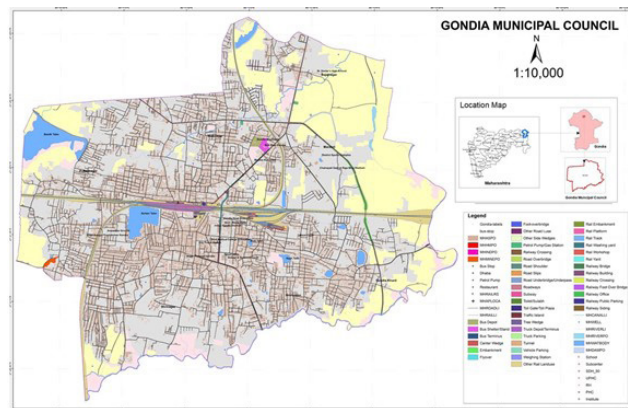


Figure 2: Gondia Municipal Council Map as per MahaBHUMI Standards



Figure 3: MahaBHUMI 1:10K TOPOMAP

The Sample applications can be seen in Figure 4 to 8 for Gondia district covering dashboards and geoportals.

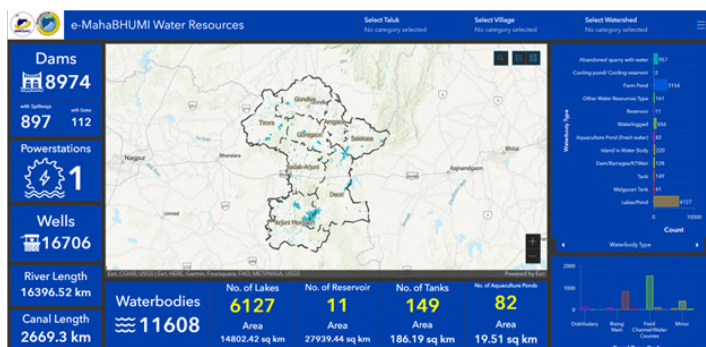


Figure 4: MahaBHUMI Water Resources Sample Dashboard – for Gondia District

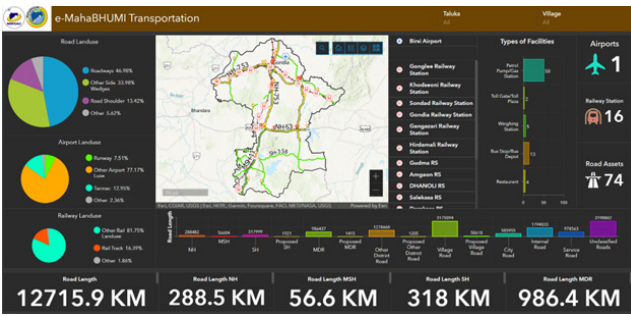


Figure 5: MahaBHUMI Transportation Theme Sample Dashboard – for Gondia District

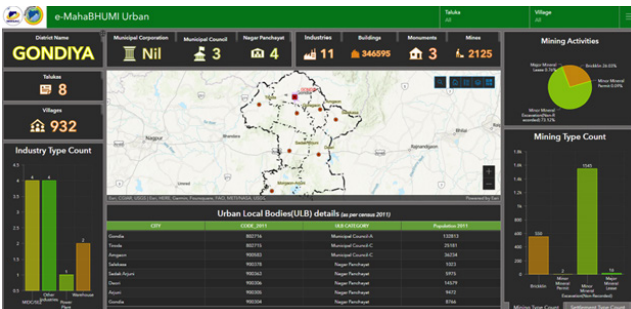


Figure 6: MahaBHUMI Urban Theme Sample Dashboard – for Gondia District

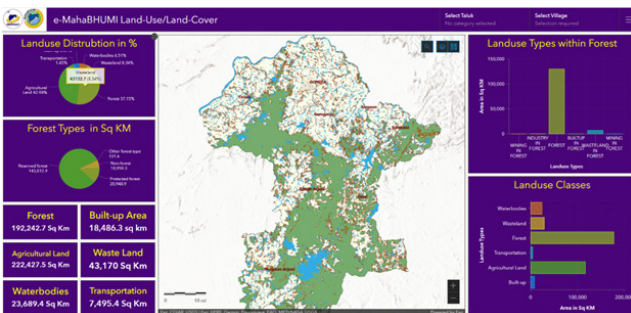


Figure 7: MahaBHUMI Land use/Landcover Theme Sample Dashboard – for Gondia District

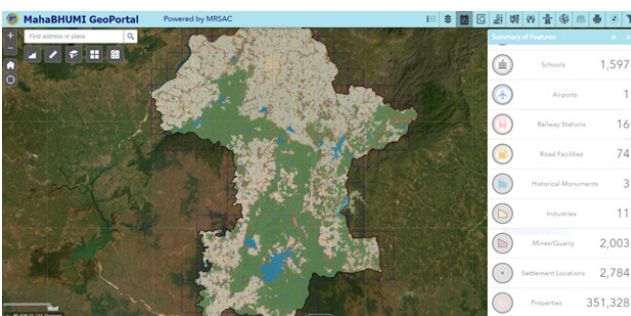


Figure 8: MahaBHUMI Sample Geoportal – for Gondia District

About MRSAC

MRSAC has carved a niche in the e-governance program of the Government with its small but highly dedicated team of Domain Expert Scientists called as ‘Guardian Scientists’ who help and guide the various line departments in understanding how their data or MIS can be integrated with the geospatial technologies for transparent, reliable, timely decision support along with ‘ease of doing their regular activities’. MRSAC has an indigenous geospatially trained team who generate the standardised data and a software team responsible for

customised mobile applications and geoportals for the display, query, report generation of the geospatial data so created. The branch offices of MRSAC at Mumbai and Pune cater to the needs of Mantralaya and the various department headquarters for liaisoning between the various departments for the use of geospatial technology. MRSAC is governed by a governing body consisting of Secretaries of various departments headed by Chief Secretary to Govt. of Maharashtra as Chairman and Director, MRSAC as Member Secretary.

“ Base maps generated under MAHABHUMI Project on 1:4K scale and its integration with Cadastral maps, MIS data of various Govt Depts and also the data from location based services shall change the way planning, implementation and monitoring are carried out for citizen centric services in the state. Geospatial services of this data through decision support system for each department will be a game changer in the state, setting a new benchmark in the e-Governance. ”

- Dr Ashok Kumar Joshi, Director, MRSAC

Dr. Ashok Kumar Joshi (Director, MRSAC, Nagpur) - Technical and Administrative Support, Overall Guidance, Management and Monitoring of the Project.

Shri. D. M. Kolte, (Former Director, MRSAC) and Senior Resources Scientist for Overall Monitoring and Management of the project.

PROJECT TEAM

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B) HARDWARE/ SOFTWARE MEMBERS

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Dr. G.S. Rao, Scientific Associate (Coordinator- Database & Archival)

FORMER PROJECT MEMBERS

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Dr. Arvind Hadap, Documentation Officer (Retd.) and Coordinator- Database & Archival

Project team extends gratitude to Dr. S. N. Das (Former Director, MRSAC, Nagpur) for conceptualization and formulation along with Senior Scientists of MRSAC, Nagpur