

INDIA COUNTRY REPORT SUBMITTED TO
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INFORMATION MANAGEMENT



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INDIA COUNTRY REPORT FOR UNGGIM

Introduction

India, a Union of States, is a Sovereign, Secular and Democratic Republic with a Parliamentary system of Government. It is the second-most populous country (with over 1.2 billion people), the largest democracy as well as the fastest growing economy in the world. Land under active agriculture in India extends to about 1.4 million sq kms. India is one of the oldest and continuously inhabited civilizations of the world and known for its kaleidoscopic variety and rich cultural heritage blended with diversity. There are 29 States and 7 Union Territories (UTs) in the country. From the largest to the smallest, each State/UT of India has unique demography, dress, festivals, language, history and culture. The Indian landmass covers an area of 32,87,263 sq. km (1,269,346 sq mi), extending from the snow-covered Himalayan heights to the tropical rain forests of the south. As the 7th largest country in the world, India stands apart from the rest of the Asia, marked off as it is by mountains and the sea, which give the country a distinct geographical entity. Bounded by the Great Himalayas in the North, it stretches Southwards and at the Tropic of Cancer, tapers off into the Indian Ocean between the Bay of Bengal on the East and the Arabian Sea on the West. It has a land frontier of about 15,200 km. The total length of the coastline of the mainland, Lakshadweep Islands and Andaman & Nicobar Islands is 7,516.6 km. The landmass can be divided into various regions that includes Northern Mountains, Peninsular Plateau, Thar Desert, Indo-Gangetic Plain, Coastal Plains and the Islands.

Indian Geospatial Information Management Landscape

2. History. India has possibly the longest known tradition of systemically collecting Spatial Data at national level. The National Mapping Organization (NMO), Survey of India (SOI) is celebrating its 250th year of establishment this year. Other Geospatial data generating organizations are Geological Survey of India, Zoological Survey of India, Botanical Survey of India etc. During 19th century, there used to be a District Gazetteer in each district (the lowest administrative unit), which spatially used to maintain the records of the local assets and infrastructure. The national planning process of India has undergone many changes since its initiation in 1951. Decentralized local level planning is currently accepted as the national planning strategy. Towards this end, the 73rd and 74th Constitutional Amendments in 1992 & 1993 respectively have empowered the State Governments to form the Institutions of Local self-Governance (ILG). At the core of this concept lies an integrated approach to planning based on the local endowment. This led to the requirement of a large matrix of spatial data on natural resources, demography, socio-economy etc., appropriate data management and analyzing tools and techniques for information generation and integrating them to

generate appropriate information required for plan preparation. The development of database technologies, entry of computers in India in the late 70's and first Indian Remote sensing Experiment in 1977, triggered the possibility of introduction and integration of geo spatial information in the planning. Initiation of Indian Remote Sensing Satellite Programme in early 80's and other geospatial technology-based national programmes to support the National planning process has resulted into a vibrant geospatial landscape consisting of the following:-

- (a) Institutional arrangement/Policies;
- (b) Organizational Infrastructure to support data acquisition, management, information generation and accessibility;
- (c) Research and Development;
- (d) Education, Training and Capacity Building;
- (e) Usage and application in Governance and
- (f) Industry.

3. Institutional Arrangement. Various policies are in vogue which pertain to different aspects of geospatial data:

- (a) **The National Map Policy 2005 (NMP-2005)** defines the scope, distribution and liberalized access of digital Survey of India (SOI) topographic maps to user groups without jeopardizing national security.
- (b) **The Civil Aviation Requirement (CAR), 2012** detailing procedure for issuance of flight clearances for agencies undertaking aerial photography, geophysical surveys, cloud seeding etc.
- (c) **The Remote Sensing Data Policy (RSDP - 2001 and 2011)** defining the acquisition and distribution process of satellite remote sensing data, from Indian and foreign satellites for different category of civilian users in India. The Policy also covers guidelines for licensing the Indian Remote Sensing (IRS) capacities to other countries.
- (d) **The National Data Sharing and Accessibility Policy-2012 (NDSAP-2012)** providing an enabling provision and platform for proactive and open access to the data generated through public funds available with various departments / organizations of Government of India. This has led to establishment of Open Government Data (OGD) Platform, which facilitates usage and sharing of open government data for multiple commercial and non-commercial purposes.

4. Geospatial Organizational Infrastructure

4.1 Data Acquisition. India has a well-developed geospatial organizational infrastructure that covers the entire spectrum of geospatial value chain. Depending on the role, function and field of application, there are a wide number of organizations both within and outside the government which are deeply engaged in catering to the varied multi-dimensional requirements of the users. As per the Allocation of the Business Rules of the Government of India, the Department of Science and Technology (DST) is the nodal Ministry for undertaking all the geospatial and cartographic activities in the country. The organizations under DST are the Survey of India (SOI) and the National Atlas and Thematic Mapping Organization (NATMO), which have a well-established network.

4.1.1 National Mapping Organization. The **Survey of India** (SOI) is the National Survey and Mapping Organization of the country. Set up in 1767 to help consolidate the territories of the British East India Company, it is one of the oldest Engineering Departments of the Government of India completing 250 years of its existence in 2017. Headed by the Surveyor General of India (SGI), the Survey of India (SoI) acts as adviser to the Government of India on all survey matters, viz Geodesy, Photogrammetry, Mapping and Map Reproduction.

Functions of SOI. The main duties and responsibilities of the Survey of India are:

- (a) All Geodetic Control (Horizontal and Vertical) and Geodetic and Geophysical surveys.
- (b) All Topographical Control, Surveys and Mapping within India.
- (c) Mapping and Production of Geographical Maps and Aeronautical Charts.
- (d) Surveys for Developmental Projects.
- (e) Survey of Forests, Cantonments, large scale city surveys, guide maps, cadastral surveys etc.
- (d) Survey and Mapping of special maps.

- (e) Spellings of Geographical names.
- (f) Demarcation of the External Boundaries of the Republic of India, their depiction on maps published in the country and also advice on the demarcation of inter-state boundaries.
- (g) Training of officers and staff required for the Department, trainees from Central Government Departments and States and trainees from Foreign Countries as are sponsored by the Government of India.
- (h) Research and Development in Cartography, Printing, Geodesy, Photogrammetry, Topographical Surveys and Indigenization.
- (j) Prediction of tides at 44 ports including 14 foreign ports and publication of Tide Tables one year in advance to support navigational activities.
- (k) Scrutiny and Certification of external boundaries of India and Coastline on maps published by the other agencies including private publishers.

Geospatial Products and services

(a) **National Ground Control Points (GCP) Library.** Survey of India is the only government agency, which provides Geodetic Control throughout the country and also provides data to the various governments and other national organizations including defence forces, according to their requirements. A National Ground Control Points (GCP) Library has been established of 260 well spread high precision Ground Control Points (GCPs) at a spacing of 200-300 km apart and with 2260 precision Ground Control Points at a spacing of 25-30 km apart. Standard GCPs enable state cadastral department besides other agencies engaged in generating geo-spatial information to carry out their job in a national geodetic reference system.

(b) **Other products.** The SOI has been engaged in production and maintenance of various types of maps on various scales covering India, for the defence and development of the nation viz. State Maps, Guide Maps, Tourist Maps, Plastic Relief Maps, Educational Map Series, District Planning Map Series, Charts and Outline Maps, General Wall Maps, Antique Maps, Special Series Maps, Discover India Series and Route and Trekking Maps.

(c) **Services.** Being grouped under 'Scientific Surveys' of the Government of India, it has also been called upon extensively to deploy its expertise in the field of geodetic and geophysical surveys, study of seismicity and seism tectonics, environmental and disaster management, participation in Indian scientific expeditions to Antarctica, glaciology programmes and other projects related to digital cartography and digital photogrammetry etc. to provide basic data for scientific & technological requirements. Its expert advice is being utilized by various Ministries and undertakings of Government of India in many sensitive areas including settlement of International borders, State boundaries and in assisting planned development of hitherto under developed areas.

4.1.2 Indian Space Research Organization. Indian Space Research Organization (ISRO), established in 1969, provides the Nation space based services as well as undertakes development and develops the technologies to achieve the same independently. ISRO has upheld its mission of bringing space to the service of the common man, to the service of the Nation. In the process, it has become one of the six largest space agencies in the world. ISRO maintains one of the largest fleet of communication satellites (INSAT) and remote sensing (IRS) satellites, that cater to the ever growing demand for fast and reliable communication and earth observation respectively. The Indian Earth Observation (EO) System is widely acclaimed around the world for its application driven approach. The system operates under a unique national level institutional framework, National Natural Resources Management System (NNRMS) established under the aegis of the Planning Commission now renamed NITI Aayog.

4.1.2.1 Indian Remote Sensing Programme. Starting with IRS-1A in 1988, ISRO has launched many operational remote sensing satellites. Today, India has one of the largest constellations of remote sensing satellites in operation. Currently, 13 operational satellites are in Sun-synchronous orbit viz. RESOURCESAT-1, 2, 2A; CARTOSAT-1, 2, 2A, 2B, RISAT-1 and 2, OCEANSAT-2, Megha-Tropiques, SARAL and SCATSAT-1, and 4 in Geostationary orbit viz. INSAT-3D, Kalpana and INSAT 3A, INSAT -3DR. Varieties of instruments have been flown onboard these satellites to provide necessary data in a diversified spatial, spectral and temporal resolutions to cater to different user requirements in the country and for global usage. The data from these satellites are used for several applications covering agriculture, water resources, urban planning, rural development, mineral prospecting, environment, forestry, ocean resources and disaster management.

4.1.2.2 National Remote Sensing Centre. National Remote Sensing Centre (NRSC), is a full-fledged center of ISRO. The Centre is responsible for planning,

acquisition, processing and dissemination of satellite data from various Indian & foreign satellites; extending services to set up ground stations and processing facilities; carrying out aerial surveys and large scaling mapping applications; providing geospatial solutions to users; extending a 24x7 service to support disaster monitoring and management; outreach through training, workshops, student projects & promotional activities related to remote sensing applications at regional and national level. The mandates of National Remote Sensing Centre (NRSC) are:-

- (a) Providing Earth observation (EO) Data from space and aerial platforms.
- (b) Develop technologies & applications for Natural Resources Management.
- (c) To provide support for monitoring and Management of Disaster.
- (d) Capacity building for utilization of EO data.

Data Products and Services. The NRSC offers a wide suite of data products from the IRS Satellites viz.

- **High Resolution (5.8m and better)**-Cartosat-2 (1m) System Corrected Geo-referenced/ Orthokit; Cartosat-1 (2.5m) Geo/ Orthokit, Stereo Orthokit, DEM; RISAT (1-8m) Standard Full Scene; and Resourcesat-1&2 LISS-IV FMX, SMX (5.8m) Geo/ Orthokit, Orth corrected.
- **Medium Resolution (5.8 m to 56 m)** - Resourcesat-1&2 LISS-III (23.5m) Geo/ Ortho; and Resourcesat-1&2 AWiFS (56m) Quadrant Geo/ Ortho.
- **Low Resolution (360 m and coarser)** - Oceansat 1&2 OCM (360m) Full Scene, Geophysical.

4.1.2.3 Indian Regional Navigation Satellite System (IRNSS)

IRNSS is an independent regional navigation satellite system being developed by India. It is designed to provide accurate position information service to users in India as well as the region extending up to 1500 km from its boundary, which is its primary service area. An Extended Service Area lies between primary service area and area enclosed by the rectangle from Latitude 30 deg South to 50 deg North, Longitude 30 deg East to 130 deg East.

IRNSS will provide two types of services, namely, Standard Positioning Service (SPS) which is provided to all the users and Restricted Service (RS), which is an encrypted service provided only to the authorized users. The IRNSS System is expected to provide a position accuracy of better than 20 m in the primary service area.

4.1.3 National Urban Information System (NUIS). NUIS is a project of the Ministry of Urban Development in collaboration with Survey of India and National Remote Sensing Centre (NRSC). Under the NUIS, geospatial thematic database (comprising of 12 layers) for 152 towns on 1: 10,000 scale and Aerial survey of 132 towns at 1: 2,000 scale have been developed for enabling formulation of Master Plans by state town planning departments.

4.1.4 Forest Survey of India (FSI). Forest Survey of India (FSI) is under the Ministry of Environment and Forests and nationally mandated for mapping entire forest cover of the country at 1: 50,000 scale every two years. The main objective of this organization is to present information on state of forests at state and district levels.

4.1.5 Geological Survey of India (GSI). Geological Survey of India (GSI) is under the Ministry of Mines and nationally mandated for mapping the geological and geomorphological features of the country at 1: 50,000 scale. The other map products from GSI are Coal Maps, Marine Maps for Exclusive Economic Zones, National Geothermal Mapping.

4.2 Data and Information Management

4.2.1 Bharat Maps. India's National Mission on Digital India aims to establish end to end geo-spatial electronics delivery systems as part of Mission Mode Projects in e-Governance domain and envisages "National GIS Mission" as core foundation of location based Electronic Delivery of Services for Planning & Governance. National Informatics Center (NIC) under Ministry of Electronics and Information Technology (MeitY) has created Multi-Layer GIS Platform named "Bharat Maps" which depicts core foundation data as "NICMAPS", an integrated base map service using 1: 50,000 scale reference data from Survey of India, ISRO, FSI, Registrar General of India (RGI) and so on. This encompass 23 layers containing administrative boundaries, transport layers such as roads and railways, forest layer, settlement locations etc., including terrain map services.

4.2.2 National Atlas and Thematic Mapping Organization (NATMO). The broad objective of NATMO is to prepare atlases and thematic maps of the country to cater the various needs of administrators, planners, politicians, researchers, students and the people at large. Various themes include physiography, hydrology, climate, administrative, political, social, agricultural,

industrial, cultural & economic scenario of the nation and the spatio-temporal changes happening in the country. Major products and services of the organisation are:

- (a) Atlases and thematic maps for the benefit of various users.
- (b) Collaborating with other central and state government organisations to meet their map requirements.
- (c) Providing training in Remote sensing, Geographical Information System, Global Positioning System and Digital Cartography.

4.2.3 GPS Aided Geo Augmented Navigation (GAGAN)

The ISRO and Airports Authority of India (AAI) have implemented the GPS Aided Geo Augmented Navigation-GAGAN project as a Satellite Based Augmentation System (SBAS) for the Indian Airspace. The objective of GAGAN to establish, deploy and certify satellite based augmentation system for safety-of-life civil aviation applications in India has been successfully completed. The system is inter-operable with other international SBAS systems like US-WAAS (Wide Area Augmentation System), European EGNOS (European Geostationary Navigation Overlay Service), and Japanese MSAS (Multi-functional Satellite Augmentation System) etc. GAGAN GEO footprint extends from Africa to Australia and has expansion capability for seamless navigation services across the region. GAGAN provides the additional accuracy, availability, and integrity necessary for all phases of flight, from en route through approach for all qualified airports within the GAGAN service volume. GAGAN Payload is already operational through GSAT-8, GSAT-10 and GSAT-15 satellites.

4.2.4 Regional Remote Sensing Centers (RRSCs). Established by ISRO, RRSCs support various remote sensing related tasks specific to their regions as well as at the national level. They support fields in natural resources like agriculture and soils, water resources, forestry, oceanography, geology, environment and urban planning. RRSCs also undertake software development, customization and packaging specific to user requirements and conducting regular training programs for the users of Remote Sensing application, digital techniques, GIS and theme based applications. There are five RRSCs in India. They are located at Bangalore, Jodhpur, Kolkata, Dehradun and Nagpur. All of these are integrated with National Remote Sensing Centre (NRSC) located in Hyderabad.

4.2.5. Indian National Centre for Ocean Information Services (INCOIS)

INCOIS was established as an autonomous body in 1999 under the Ministry of Earth Sciences (MoES) and is a unit of the Earth System Science Organization (ESSO). INCOIS provides round-the-clock monitoring and warning services for the coastal population on tsunamis, storm surges, high waves, etc. through the

in-house Indian Tsunami Early Warning Centre (ITWEC). For this purpose, it uses 34 Tidal Observatories of SOI. The Intergovernmental Oceanographic Commission (IOC) of UNESCO has designated ITWEC as a Regional Tsunami Service Provider (RTSP) to provide tsunami warnings to countries on the Indian Ocean Rim. INCOIS has also been designated as the National Oceanographic Data Centre by International Ocean Commission (IOC) of UNESCO and is also identified as the Regional Argo Data Centre for the Indian Ocean.

INCOIS deploys and maintains a suite of Ocean Observing Systems in the Indian Ocean to collect data on various oceanic parameters to understand the processes in the ocean and to predict their changes. A national network (Indian Seismic and GNSS Network (ISGN)) has been established to integrate Seismic and GNSS stations and provide high quality data for research and operational use. Some of the important services by the INCOIS are daily advisories to fisher folk to help them easily locate areas of abundant fish in the ocean while saving on both fuel and time used to search for the same, short term (3-7 days) Ocean State forecasts (waves, currents, sea surface temperature, etc.) to different users.

4.3 Research & Development. Considering the emphasis on technological self-reliance and development and adaptation of suitable technologies for local needs to make an impact on the lives of ordinary citizens (Technology Policy statement, 1983), the Government of India initiated a number of geospatial technology-based national programmes to support the Research and Development in Geospatial Information technology. The Geospatial R&D in India has mainly focused on application of the Geospatial technology.

4.3.1 Natural Resources Data Management System (NRDMS). Natural Resources Data Management System (NRDMS) programme was initiated in 1982 by the Department of Science and Technology, Government of India as a multi-disciplinary and multi-institutional R&D programme. Vision of the NRDMS programme is enabling people, communities and institutions of local-self Governance with requisite databases and S&T tools for informed participation in local self-governance. At the core of the NRDMS methodology is the application of geo-spatial technologies for generating information needed by different users for planning and development at local level. Under the programme, other than establishment of NRDMS Geospatial data centers in 30 Districts of Karnataka, 17 Districts of West Bengal, and 13 Districts of Uttarakhand, around 800 extramural research and development projects have been supported in different aspects of Geo-Information management.

4.3.2 Sponsored Research (RESPOND) Programme. RESPOND is a programme developed by the Indian Space Research Organization (ISRO) to support research and development activities related to Space Science, Space Technology and Space Application to academia in India. The aim of RESPOND

is to encourage quality research in areas of relevance to the Indian space programme. The main objectives of the RESPOND Programme is to establish strong links with academic institutions in the country to carry out research and developmental projects which are of relevance to space and derive useful outputs of such R&D to support ISRO programmes. RESPOND programme aims to enhance academic base, generate human resources and infrastructure at the academic institutes to support the space programme.

4.3.3 Space Applications Centre (SAC). Built in 1966, Space Applications Centre (SAC), is a major research and development center of the Indian Space Research Organization (ISRO). The core competence of the centre lies in development of space borne and air borne instruments/payloads and their applications for national development and societal benefits. These applications are in diverse areas and primarily meet the communication, navigation and remote sensing needs of the country. Besides these, the centre also contributes significantly in scientific and planetary missions of ISRO like Chandrayan-1, Mars Orbiter Mission etc. SAC designs and develops the optical and microwave sensors for the satellites, signal and image processing software, GIS software and many applications for Earth Observation (EO) programme of ISRO. These applications are in diverse areas of Geosciences, Agriculture, Environment and Climate Change, Physical Oceanography, Biological Oceanography, Atmosphere, Cryosphere, Hydrosphere etc. The facilities at SAC includes highly sophisticated payload integration laboratories, electronic and mechanical fabrication facilities, environmental test facilities, systems reliability/assurance group, image processing and analysis facilities, project management support group and a well-stocked library. SAC has active collaborations with industry, academia, national and international institutes for research and development.

4.3.4 Centre of Studies in Resources Engineering (CSRE). Established in IIT Bombay in 1976, Centre of Studies in Resources Engineering (CSRE) has grown into one of the premier centers in the country working in the frontier area of Geo-informatics and Natural Resources Engineering. Modern technologies like Geographic Information System (GIS), Global Positioning System (GPS), Satellite image processing and Remote Sensing are extensively used in the Centre's teaching, research, consultancy and continuing education programmes. CSRE has been active in contributing significantly towards the needs of developing and demonstrating the technology of satellite data utilization and development of Geographic Information Systems. The Centre has successfully demonstrated the application potential of remote sensing technology in the programmes of disaster mitigation like drought and flood along with national agencies.

4.3.5 Some prominent R&D centers. Specific geospatial R&D activities are also being undertaken by many centers in Universities, National Institutes and

other government departments viz. Anna University, Bharatidasan University, Jawaharlal Nehru Technological University, Department of Computer Science and Engineering of IIT Kharagpur ,IIT Bombay, Indian Institute of Information Technology, Hyderabad, Geospatial Lab-Indian Institute for Human Settlements, National Bureau of Soil Survey and Land Use planning, Indian Agricultural Research Institute.

4.4 Education, Training and Capacity Building. At present, geospatial education and knowledge dissemination in India takes place through specialized organizations and the university and education systems that provide the capacity-building and human resources development activities. Some Nationally important organizations, which offer specialized training on geospatial Science and Technology are:

4.4.1 Indian Institute of Remote Sensing. Indian Institute of Remote Sensing (IIRS) under Indian Space Research Organization India is a premier Training and Educational Institute set up for developing trained professionals in the field of Remote Sensing, Geo-informatics and GPS Technology for Natural Resources, Environmental and Disaster Management. The Institute is the first of its kind in entire South-East Asia. While nurturing its primary endeavor to build capacity among the user community by training mid-career professionals, the Institute has enhanced its capability and evolved many training & education programmes that are tuned to meet the requirements of various target groups, ranging from fresh graduates to policy makers including academia. It awards M.Sc, M.Tech and Ph.D degrees. The Institute also houses the headquarters of the Centre for Space Science and Technology Education in Asia and The Pacific (CSSTEAP), affiliated to the United Nations and first of its kind established in the region in 1995. IIRS provides support to conduct all its remote sensing and GIS training & education programmes at postgraduate level.

4.4.2 Indian Institute of Surveying and Mapping. In Post-independence India, the developmental activities and need for mapping brought urgent need to impart training to officers and staff in various aspects of surveying and mapping with state-of-the art technologies. With this objective, the Centre for Survey Training and Map Production was established at Hyderabad in 1967 with a Human Resource Development Institute within Survey of India under technical assistance from the United Nations Development Programme (UNDP). The Indian Institute of Surveying & Mapping (IIS&M) was established on 6th May, 1967 and is now recognized as the prestigious training institute in the field of Surveying and Cartography to impart training to the Officers and the Staff of Survey of India and other Government Organizations, Private Individuals, and Scholars from other Afro-Asian countries. The Institute also conducts M.Tech (Geomatics) and M.Sc. (Geospatial Science), two year Post

Graduate programmes in collaboration with Jawaharlal Nehru Technical University, Hyderabad.

4.4.3 Indian Institute of Space Science and Technology. Indian Institute of Space Science and Technology (IIST), situated at Thiruvananthapuram is a deemed to be university under Section 3 of the University Grants Commission (UGC) act, 1956. IIST functions as an autonomous body under the Department of Space, Government of India. It offers undergraduate (B.Tech), masters (M.Tech) and PhD programs in space science and technology, and also serves as a research center. Doctoral programmes in basic sciences and post-doctoral programs are also offered.

4.4.4 National Geospatial Chair Professor Scheme. In order to strengthen the capacity building and human resource development in different areas of Geospatial Science & Technology, the Department of Science & Technology, Government of India has launched a National Geospatial Chair Professor Scheme to establish 15 National Geospatial Professor Positions over the next 5 years across the country.

4.4.5 Geospatial Education in Universities. Geospatial science and technology is taught mostly at Post graduate level except in engineering courses, where it is being taught at undergraduate level as Bachelor of Engineering (BE)/ B.Tech in Geomatics/ Geoinformatics. It is also taught as one of the elective subject in BE Civil Engineering, B Planning courses at undergraduate level. PhD in Geoinformatics is also taught in some selected Institutions that Includes Andhra University, Pune University, IITs, Bharati Vidyapeeth, Pune and Symbiosis Institute of Geoinformatics, Pune. The Postgraduate courses vary from M.Sc. in Geoinformatics, M.Sc. Applied Geography and Geoinformatics, M.Tech. in Geoinformatics and M.Tech. in Remote sensing for two years, Post Graduate Diploma for one year. There are B.Sc. Applied Remote sensing course for one year and certificate courses varying from six months to two months also taught at University level. These institutions bring out about 200-300 professionals in geospatial technology every year.

4.5 Data accessibility. Despite mechanism for acquisition, processing and compilation of spatial and statistical data sets in place, there are inherent problems inhibiting data sharing, integration and effective utilization by the end users. Inaccessibility to up-to-date and GIS processable data, inefficient data discovery mechanism, lack of standardization, absence of seamlessness in data layers, non-availability of decision support tools, inadequate integration of Geoinformation with the end user workflows, insufficient capacity amongst end users have been some of the major bottlenecks. Recognizing the same, the Department of Science & Technology and Department of Space have taken

various initiatives towards Spatial Data Infrastructure development in the Nation.

4.5.1 National Spatial Data Infrastructure (NSDI). The National Spatial Data Infrastructure (NSDI) has been set up through the joint initiative of the Department of Science & Technology and Department of Space. The Initiative aims at developing and maintaining standard digital collection of spatial data, common solutions for discovery, access and use of spatial data in response to needs of diverse user groups, and to increase awareness and understanding of the vision, concept and benefits of NSDI. Since December 2009, the India Geo Portal (Fig.1) has been increasingly making accessible the data holdings of various agencies through interoperable geographic information services like Catalogue Service on Web (CSW), Web Map Service (WMS), Web Feature Service (WFS), and Web Processing Service (WPS).

Current status of NSDI:

- (a) Provision of Standards-compliant Web Map Services from SOI, NRSC, GSI, FSI, Central Water Commission (CWC), Central Ground Water Board (CGWB); and those from National Bureau of Soil Survey and Land Use Planning (NBSSLUP), Central Pollution Control Board (CPCB), and Ministry of Statistics & Programme Implementation (MoSPI) are in pipeline.
- (b) Development/ publication of National Standards for Metadata, Data Content, Data Exchange, Web Map Service, Web Feature Service, and Conceptual Schema Language etc.
- (c) Demonstrated utility of National Data Registry (NDR) for NSDI (catalogue/ Registry Service) to support GIS application development.
- (d) Geospatial service applications demonstrated through assigning unique ids to parcels with Department of Land Resources (DoLR), Geo-enablement of Railways.

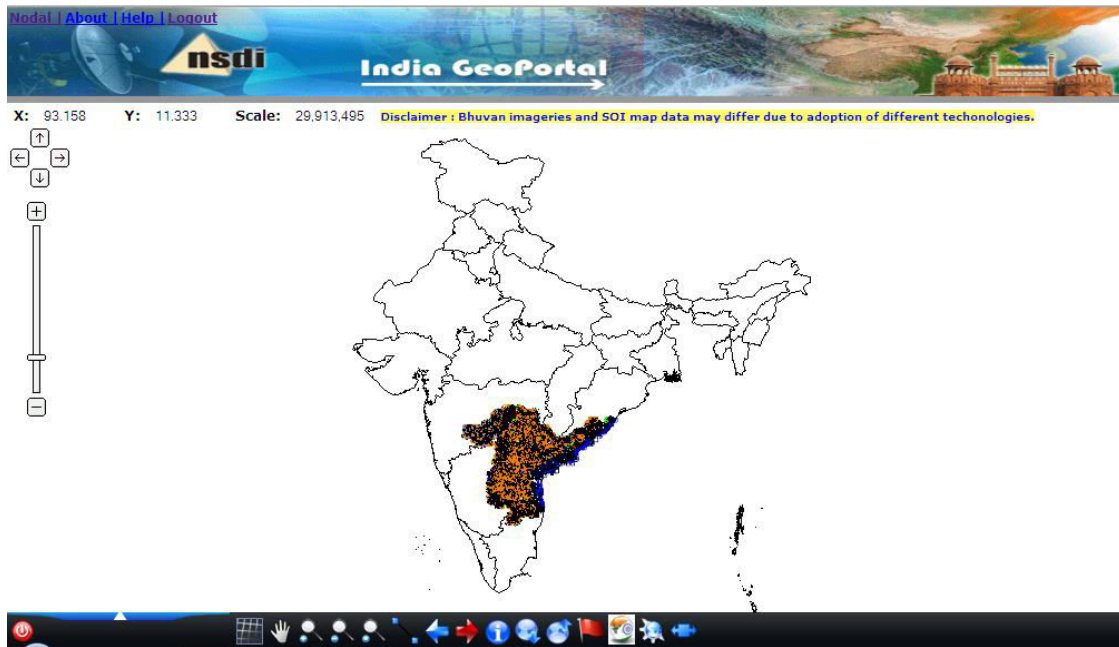


Fig.1. India Geo Portal of NSDI.

4.5.2 State Spatial Data Infrastructure (SSDI). In order to make the higher resolution data sets available with the State level Government Departments/ Agencies accessible to the end users, the State level Spatial Data Infrastructures are being set up during the XII Plan period. State Geo Portal prototypes are being developed in States like Karnataka, Kerala, West Bengal, the North East, Haryana, Uttarakhand, and Jammu & Kashmir.

4.5.2.1 Karnataka Geo-Portal. Karnataka Geo-portal (Fig.2) is envisaged to be a centralized single window access mechanism for all spatial data held and acquired by various agencies/line departments of the state. The modules in the Karnataka Geo-portal are categorized into:

- (a) Map viewer - Web Map Service (WMS)
- (b) Product catalogue/metadata - Catalogue Service on Web (CS-W)
- (c) Services specific service/feature data sets - Web Feature Service (WFS)
- (d) Simple Applications (Query based decision support)
- (e) Coverage services/images - Web Coverage Service (WCS)
- (f) Help/support



Fig.2. Karnataka Geo-portal.

4.5.3 Bhuvan, ISRO. ISRO's Geo-portal, Bhuvan (Fig.3) is providing visualization services and Earth observation data to users in public domain since 2009. Besides, the portal also services several users for their remote sensing application needs. Presently, more than 6000 map services offered by Bhuvan are being used under various applications. Bhuvan, as a platform, is open and being used by diverse users as per their requirements, enabling specific applications of their choice.

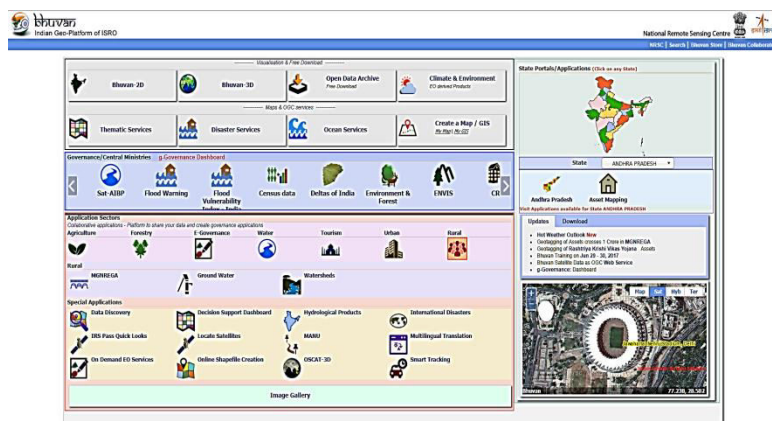


Fig.3. Bhuvan Geo-portal of ISRO

5. Application of Geo-information in different sectors of Governance.

Applications of Geospatial technology and information have great national relevance and can support governance activities, help prepare sustainable development strategies, involve citizens in participatory democracy, enable enterprises to manage business better and bring geographical knowledge to citizens. The Government of India has mandated the use of geospatial

technology for several national development projects. Some examples pertinent to the interest of UNGGIM are discussed below.

5.1 Application of Geo spatial technology for Flood monitoring during Chennai Flood, 2015. The city of Chennai and its suburb areas recorded multiple torrential rainfall events during November-December 2015 that inundated the coastal districts of Chennai, Kancheepuram and Tiruvallur, and affected more than 4 million people with economic damages that cost around US\$3 billion. Indigenous CARTOSAT and Risat-2 data (Fig.4) were used to identify inundated localities during the Chennai flood in December, 2015 and it helped in rescue activities.

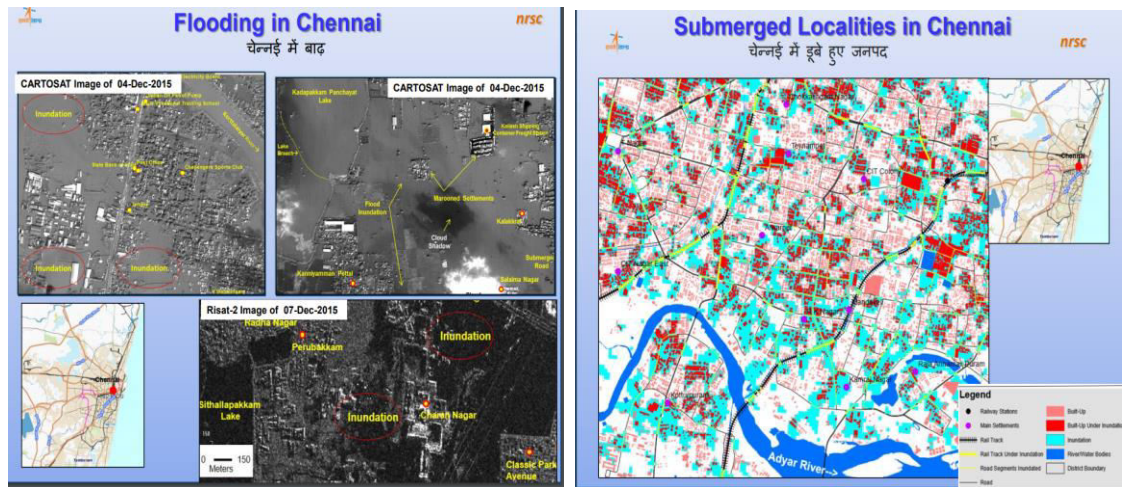


Fig.4. Identification of inundated areas in Chennai using CARTOSAT and Risat-2 data.

5.2 National Database for Emergency Management (NDEM). National Database for Emergency Management (NDEM) is a web based geo-spatial national repository of data (Fig.5) coupled with a set of decision support tools to assist the disaster managers at various levels in decision making for managing emergency situations. NRSC/ISRO implemented NDEM for Ministry of Home Affairs (MHA). Subsequently NDEM Version 3.0 with improved features was launched on internet domain with secured access. Value added products are hosted on NDEM portal for major disaster events since 2013 onwards.



Fig.5. National database for Emergency Management (NDEM).

5.3 National Land Records Modernization Programme (NLRMP). For modernization of land records system in the country, the National Land Records Modernization Programme (NLRMP) has been started since 2008- 09. The activities being supported under the Programme, *inter alia*, include completion of computerization of the Records of Rights (RoRs), digitization of maps, survey/resurvey using modern technology including aerial photogrammetry, computerization of registration, training and capacity building of the concerned officials and functionaries, connectivity amongst the land records and registration offices and land records management centers at lower units of administration viz. tehsil/taluk/circle/block level. Under the programme, significant progress has been made with the completion of computerization of land records in 31 states/Union territories, computerization of registration process in 30 states, digitization of revenue maps in 10 states and updation of land records through survey/ resurvey in 16 States. An example of integration of land records with cadastral map in a taluka (lower administrative unit) of Punjab is in Fig.6.



Fig.6. Integration of land records with cadastral map in a taluka of Punjab

6. Indian Geospatial Market and role of Private Industry. Geospatial technology has made inroads across various sectors in the public as well as private domain in India. As stakeholders across sectors realize the utility and long term cost effectiveness of using geospatial tools and technologies, the geospatial industry is set to progress by leaps and bounds in the coming years. Currently, overall size of Indian Geospatial Industry is \$ 4 billion and by 2025 it is estimated to contribute \$ 20 billion (5% of the total GDP). Until a decade ago in India, government departments and agencies were the only source for geospatial information. Opening up of mapping data and information by the State has enabled enhanced private sector participation in this sector. Several businesses and industries are now using geospatial services in India for analysis of demography, competitiveness, expansion, risk management, target oriented marketing, planning of route etc. The major sectors using geospatial technology in India are: agriculture, telecommunications, oil & gas, environmental management, forestry, public safety, infrastructure, logistics etc. In recent years, the Indian geospatial industry consists of two distinct but mutually supporting segments viz.

(a) The domestic segment, which provides geospatial capabilities to the Indian data providers/users. This segment is funded, managed and controlled largely by the national and state governments. A number of Indian firms are contracted to provide services for government initiatives.

(b) The international segment is geared to provide geospatial data and software development services for international organizations, primarily in North America and Western Europe.

India offers several advantages which enhance the prospects for the Geospatial industry manifold. Most importantly, the growth of the geospatial sector has been supported by the Federal as well as State Governments in India. Secondly, India is recognized throughout the world for its IT skills and space programmes. Additionally, it offers an excellent infrastructure and expertise for collection of geospatial data. The development and escalation of geospatial industry in the region has been significant with mature players having marketed the benefits of geospatial information over the past two decades. India's reputation as an outsourcing destination has enabled the development of significant technical expertise in the geospatial sector. As a result, major trans-national geospatial companies have a strong presence in India. The geospatial industry is presently witnessing tremendous opportunity within the country as the Federal Government has initiated reform projects in several infrastructure segments like rural development, power, land and natural resources and mandated the use of geospatial technologies in these projects. Besides, there are various other fields such as, schemes for construction and maintenance of roads, railways and waterways, civil aviation, public utility

services, education, health, command area development, flood management programme, flood control, urban renewal, urban water supply, rural water supply, Integrated Watershed Management Programme etc. for spatial planning, management and decision making. With a shift from E-governance to G-governance, the geospatial industry is set to assume a greater and significant role in the Indian economy.