SECOND UN WORLD GEOSPATIAL INFORMATION CONGRESS
#IYEHYDERABAD, INDIA | 10-14 OCTOBER 2022 | TOWARDS GEO-ENABLING THE GLOBAL VILLAGE
UNWGIC

Department of Science and Technology
Government of India

Azadi Ka Amrit Mahotsav

GEO ENABLING THE GOVERNANCE:
AN INDIAN EXPERIENCE

Introduction

India is an example of continuity, change and progress. Over the centuries, continuity can be observed with changes which have led to progress. Different combinations of these three components have produced interesting results. India has a robust ecosystem in the Geospatial field with most apex organizations which play a vital role in Governance, Socio Economic benefits, Agriculture, forestry and wildlife management, Terrestrial, Aerial and Marine Navigation, Disaster Management and other various applications in multiple sectors. According to India Geospatial Artha Report 2021, the Indian geospatial economy is currently valued at Rs 38,972 crore and employs approximately 4.7 lakh people. The report states that the use of geospatial information and technology in India is still highly driven by archetypal sectors like Defence and Intelligence, Urban Development and Utilities which account for the largest share of the geospatial market pie in 2021, i.e., 37.98% of the total geospatial market.

Evaluation of Indian Geo Spatial Sector

The tradition of map-making is as old as human civilization. In case of India, if we want to investigate our cartographic tradition, we can divide it into two broad divisions: (a) land-based, and (b) sea or ocean-based. In the ancient literature, there are descriptions of the territories or Bharatavarsha or Jambu-Dvipa or different regions of India, named as janapadas, khanda, and dvipas. The descriptions are fairly correct and have relevance even today, particularly to understand India as a concept. There is an ancient Indian concept of the spherical world with the Jambu-dvipa (i.e. India) as the central part and Mount Meru (Kailas) as the centre of the world. In Vedas, Puranas, Buddhist and Jain literature, there are references about time, longitudes, latitudes, rhumb lines and the like. In Puranas (500 BC to 700 AD), particularly Brahman Purana the concept of map scale, and generalization of geographical features were realized. Preservation of collection of maps in the form of atlases has been mentioned in Padma Purana. In Kautilya's Arthasastra (4th Century BC), the significance of village boundaries and methods for land measurements have been described. The accounts given by him about the Siva Purana and Panini's sutras indicate the importance given to geodesy, cadastral surveys, plans and sketch maps for army movements.

References to regions and places with the help of astronomical calculations were included in traditional Indian system. Ujjain was considered the oldest prime meridian much before Ptolemy. The main source of traditional Indian

cartography is Sata Patha Brahmana which gives account of the concept of earth in the 5th and 6th centuries. Aryabhat's astronomical contributions are well known, particularly in calculating the diameter of the earth, its axial rotation, position of planets in space, and planetary orbits in 5th century AD. The land surveying manuals were part of Sulba Sutras (science of mensuration). In Vedic texts, apart from the description of physical features like mountains, rivers and plants, there are sutras for trigonometry, co-ordinate and solid geometry, analytical conics, calculus (differential and integral), equation of straight lines and even Pythogoras theorem. Some of the above sutras of Vedic mathematics have relevance in modern surveying and mapping as well. It is said that trikonamiti is what we understand in the form of 'triangulation' today. This forms the basis of modern map-making, including geodesy.

During the early Pathan period, Sher Shah Suri was instrumental in preparing revenue maps in northern India. Later, Raja Todar Mal, a minister in Emperor Akbar's court, made valuable contributions in preparing revenue maps for a larger part of the country. In the south, Rajaraja, the Chola king (985-1001 AD), carried out and revenue assessment survey of his territory. Further, plans, sketches, religious maps, concept maps, route maps, charts, *parikrama* maps and the like were very popular. The layouts of palaces, forts, cities, tombs and gardens were based on topography, directions and astronomical calculations. Sun light, position of moon, wind directions, seasonal variations, calculations of geographical co-ordinates (as mentioned in *Ain-i-Akbari*), etc., were included in the plans which cannot be done without proper knowledge of the geographical space. Even today we can find these traditional materials in old cities like Allahabad, Mathura and Varanasi. A lot of materials have made their way to the libraries and collections in the West.

The other source of cartographic traditions is sea or ocean based. The rich Arab traditions and their knowledge of stars and related information, the skills of Portuguese cartographers and experiences from Egypt, China and Japan (particularly calligraphy and artistic designing), Mesopotamia (Iraq), and other colonial powers contributed to the Indian cartographic traditions as well. Navigational charts, route charts for land and sea were commonly used in this part of the world. Compass lines and related navigational details were included in such charts. Nevertheless, the Indian knowledge of sea, oceans, other neighboring countries and coasts, navigation skills etc., was excellent. *Markandeya* and *Bhagavata Puranas* have references to sea-borne trade and commerce. In the *Rigveda* and *Satapatha Brahmana*, there are references to navigation in *purva* and *paschim samundra* (Bay of Bengal and Arabian Sea). *Raghuvamsa* records the presence of a strong naval force.

The Cholas, Oriyas, Marathas and Gujaratis used their own navigational charts. Indians had direct port to port established routes in the Indian Ocean Realm. Trade and commercial links with Oman including Muscat, the East African coast including Zanzibar, Sofala coast and different islands and territories in south and Far East Asia are well known. When the Portuguese appeared in the Indian Ocean, they were surprised to see that the Indian pilots were using compass and charts. These charts were good enough to navigate through the ocean. Such charts or maps included relevant information, such as islands, reefs, shoals, ports, cities, pole star, latitude co-ordinates, and depth of water, lighthouse, and distances expressed in *zams*. But, with the emergence of colonial powers in the Indian Ocean, this tradition got affected. The idea of a computer with keyboard was perceived nearly 1400 years ago (Fig 1).

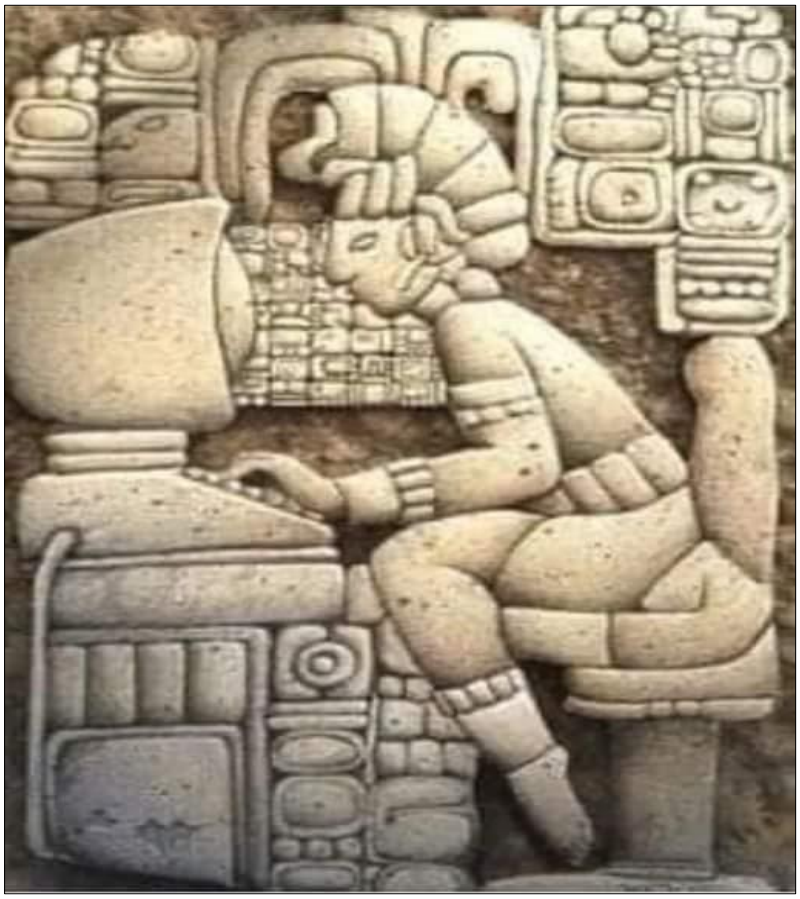

Fig. 1 About 1400 years ago in the Lalgiri Temple constructed by Raja Pallav Narsingh, the Second, the idea of a computer with keyboard was carved on the walls

How the development of traditional Indian cartography was benefited from either of the two sources, or from their combination, is a matter for further research. How the rich traditions of understanding of space, the concept of

India, depiction of information in the form of maps or charts got lost? Is there any continuity from the traditional Indian cartography to colonial cartography and finally to modern map making? These questions have to be answered in the years to come. The colonial traditions nevertheless persist. Today what we see in India is the extension of the colonial cartographic traditions which is in a way at the cost of traditional Indian cartography. It should lead to more research in similar areas for which the Indian cartographic community is anxious to know more.

The colonial cartography started with the formation of the Survey of Bengal in 1767 which ultimately led to the establishment of Survey of India. During last 250 years or so, it undertook mapping of different territories ranging from northern Africa in the west to Hong Kong in the east, apart from undivided India. Further, after independence, the National Atlas Organization, now renamed as the National Atlas & Thematic Mapping Organization or NATMO was founded considering the requirements of development and planning of the newly formed nation. In the same continuation, the Indian Space Research Organization under the Union Department of Space, and the National Informatics Centre in the Ministry of Electronics and Information Technology (MeitY) undertook major geospatial projects having benefit of having strong technology background. The office of the Registrar General of India and the Census Commissioner included preparation of pre- and post-census mapping using modern geospatial technologies. Other national survey organizations, like Geological Survey of India or the Forest Survey of India, included preparations of maps for their respective areas of specializations.

Geo Spatial Programs for Sustainable Development

The Department of Science & Technology under its National Geospatial Programme (NGP) has been Promoting Geospatial Science and Technology, Policy, Solution, capacity building, entrepreneurship and International cooperation for sustainable socio-economic development at all levels of Governance.

National Geospatial Programme (NGP) - (earlier NRDMS)

Natural Resources Data Management System (NRDMS) Programme was conceived and launched by Department of Science and Technology (DST) in 1982 as a set of pilot studies to develop and demonstrate the methods and techniques for spatial planning at district or sub-district level. During 1986-1990, based on the mandate of the Planning Commission, the DST demonstrated the efficacy of computer-oriented databases as pilot projects

in 10 districts located in different parts of the country. During 1991-1992, with the adoption of the 73rd and 74th Constitutional Amendments, emphasis was laid on local level planning. Planning Commission mandated to demonstrate the utility of the NRDMS approach in local level planning, accordingly the vision of the NRDMS Programme evolved as "Enabling people, communities and institutions of local-self Governance with requisite databases and S & T tools for informed participation in local self-governance". Understanding the above requirements of this programme was initiated by DST in 1982 is a multi-disciplinary and multi-institutional R & D initiative with vision to provide appropriate scientific and technological inputs for eight operationalizing the concept of decentralized planning. The goal was to develop scientific database approach to support the local level planning. At the end of the first decade of the programme, 73rd and 74th constitutional amendments came into being and with the entry of computers at district level and GIS in India during late 1980's the goals of NRDMS programme were evolved to develop spatial data management technologies for integrated rural development planning and demonstrate it in the local level decision making. NRDMS is supporting several academic and R&D institutions through grant-in-aid projects. The focus has always been on technological and institutional capacity building in a multilevel framework, so that people can plan their own development, utilizing the local resources.

NRDMS is an interdisciplinary research programme which promoted R&D in emerging areas of Geospatial science, technology and providing Geo spatial solutions to area specific problems. Over the years, NRDMS has successfully demonstrated utilities of Geospatial Technologies in decision making and developed capacity for geospatial data and information management at state, district, and local levels at pilot scale. Since the proof-of-concept phase being over, NRDMS has now evolved into National Geospatial Programme with following vision, mission and objectives:

Vision: Catalyzing the National Geospatial Ecosystem

Mission: Promoting geospatial science and technology, policy, solutions, capacity building, entrepreneurship and international cooperation for sustainable socio-economic development at all levels of governance.

Objectives :

1. Promotion of R&D in emerging areas of geospatial science and technology.

2. Development of geo-spatial solutions for sustainable socio-economic growth in alignment with *Sustainable Development Goals* (SDGs) and national developmental priorities.

3. Build knowledge and adaptation capacity of geospatial technologies at various levels of governance in collaboration with academia and user agencies.

4. Stimulate the growth of geospatial technology innovation.

5. Develop the national capacity for geospatial science and technology development, acquisition and transfer through international cooperation.

New Initiatives and Sub programs

The New Initiatives of NRDMS include Indo-US Space Borne Gravity Observation Collaboration, Geodesy, Coastal Hazard and Risk Assessment. The sub programs include State Data Infrastructure (State SDIs), Health GIS, Village Information System, Revival of Village Ponds, Landslide forewarning System, Large Scale Geological and Geotechnical Mapping from Rishikesh to Kedarnath in Uttarakhand and National Geotechnical Facility.

Details of the various Geo Spatial Programs

1. Geospatial Science Programme

The main aim of the programme is to develop the fundamental and applied scientific knowledge underpinning the geospatial sciences to strengthen geospatial science research and education in line with international standards. The details of various sub-programs are as follows:

- National Programme on Geodesy
- Geo-statistics for Analysis of Geospatial Technologies
- National Programme on Assessment of Regional Hydrological Systems using Space Borne Gravity Observations

2. Geospatial Technology Programme

The programme aims at catalyzing the development of indigenous geospatial/location-specific technologies in the country. The main objectives of this programme are as follows:

- To improve the economic value of the existing Geospatial Technologies in practice
- To promote demand-based futuristic Geospatial Technology development

The above programme can be further divided into the following sub-programs where R&D projects in specific areas may be invited:

3. Geospatial Data Capture and Gathering Technologies:

The National Geo Spatial data capture and gathering technologies include Geodetic framework at large scale (sub cm. accuracy) viz. VRS, Large scale base maps, Spectral signature repository, Internet of Things (IoT), Dual frequency receiver for GNSS, Development of IRNSS compatible instrumentation, Nano satellites , High-definition maps, imaging and videography, Hyper spectral multi-platform data capture system development, Multi-sensor vehicle-borne including laser mapping system, Biometric based data capture, Unmanned aerial vehicles (UAVs), Robotics data acquisition systems and Research on unexplored wavelength region

4. Geospatial Data Management Technologies:

The Geo spatial data management technologies in the country include 3D/4D geospatial data management, BIM/GIS Integration at data, process and application Levels, Advanced topology for geospatial data management, Modelling and visualization of massive geospatial features on web platforms, Bridging of geospatial data management with data streaming libraries and "in-situ" geo-computing, Database support for big geospatial data analysis.

5. Geospatial Data Processing Technologies:

The Geo Spatial data processing technologies include CyberGIS (Enhancement in processing speed of different processes of data handling), Artificial intelligence, machine learning, deep learning, Cloud computing, edge and fog computing, Integration of data from multiple GS sources, Geospatial big data analysis, Analytics and workflow process integration, Geo-visualization through virtual reality modelling, Robotics data acquisition systems, Research on unexplored wavelength regions

6. Geospatial Solutions Addressing National Priorities and Sustainable Development Goals:

R&D projects for providing geospatial solutions to the stakeholders addressing the national developmental priorities and *Sustainable Development Goals viz.* disaster risk reduction (DRR), urban governance etc.

4. Geospatial Entrepreneurship Programme: This program is to stimulate the growth of geospatial technology innovation. It contains three sub programs.

- Academia – industry collaboration programme
- Geospatial start-up programme
- Geo-entrepreneurship development courses.

5. National Programme on Spatial Disaster Risk Reduction : The following Spatial disaster risk reduction programs have been adapted to perform necessary mitigation and measures

- Landslide research and hazard mitigation
- Coastal hazard risk assessment
- Urban floods
- National Centre for S&T in Disaster Risk Reduction and Preparedness

6. Capacity Building Programme:

- Training on geospatial science, technologies and disaster risk reductions
- Geo-innovation challenge for harnessing the new ideas in geospatial science/ technology

7. International Collaboration:

The aim of this programme is to develop the national capacity for geospatial technology development, acquisition and transfer aiming at partnerships/collaborations namely UN-Group of Geospatial Information Management (UNGGIM), Open Geospatial Consortium (OGC), Brazil Russia India China South Africa (BRICS), Indo-Africa collaboration but also provide geospatial solutions and new approaches to basic issues of human development.

Declaimer

The content that has been built under each chapter is acquired from the respective Organizational/ Institutional/ Industrial/Departmental/ Centre's websites. The sources of data collected other than the respective webpages are mentioned with in the corresponding heading wherever applicable. The data/information provided in the entire content under each document may not include the complete list of Indian Geo Spatial Organizations, Academia Industries such as other Startups. Nevertheless this content is created to the best of our knowledge covering a few major parts of the Indian Geo Spatial Sector of India.

Contents of the document

The current document contains the information related to the Indian geo spatial sector with respect to various organizations and institutes. It includes

the National/Central Organizations, State/Regional organizations, Central and State level Geo Spatial initiative programs, Academia and other education centers involved in Training and Capacity building, the Indian Geo Spatial Industries and Geo spatial journals and Societies. Each of this topic has been covered as a separate chapter in the document and the information provided consists of details of the organizations including vision, objectives, mission, developmental activities, projects taken up in Geospatial field of technology and a few case studies of the corresponding department. The first chapter "Introduction" constitutes the information related to the role of Indian Geo Spatial technology and it's Evaluation from the Ancient period. The detailed structure of the document is mentioned in the figure 2 below.

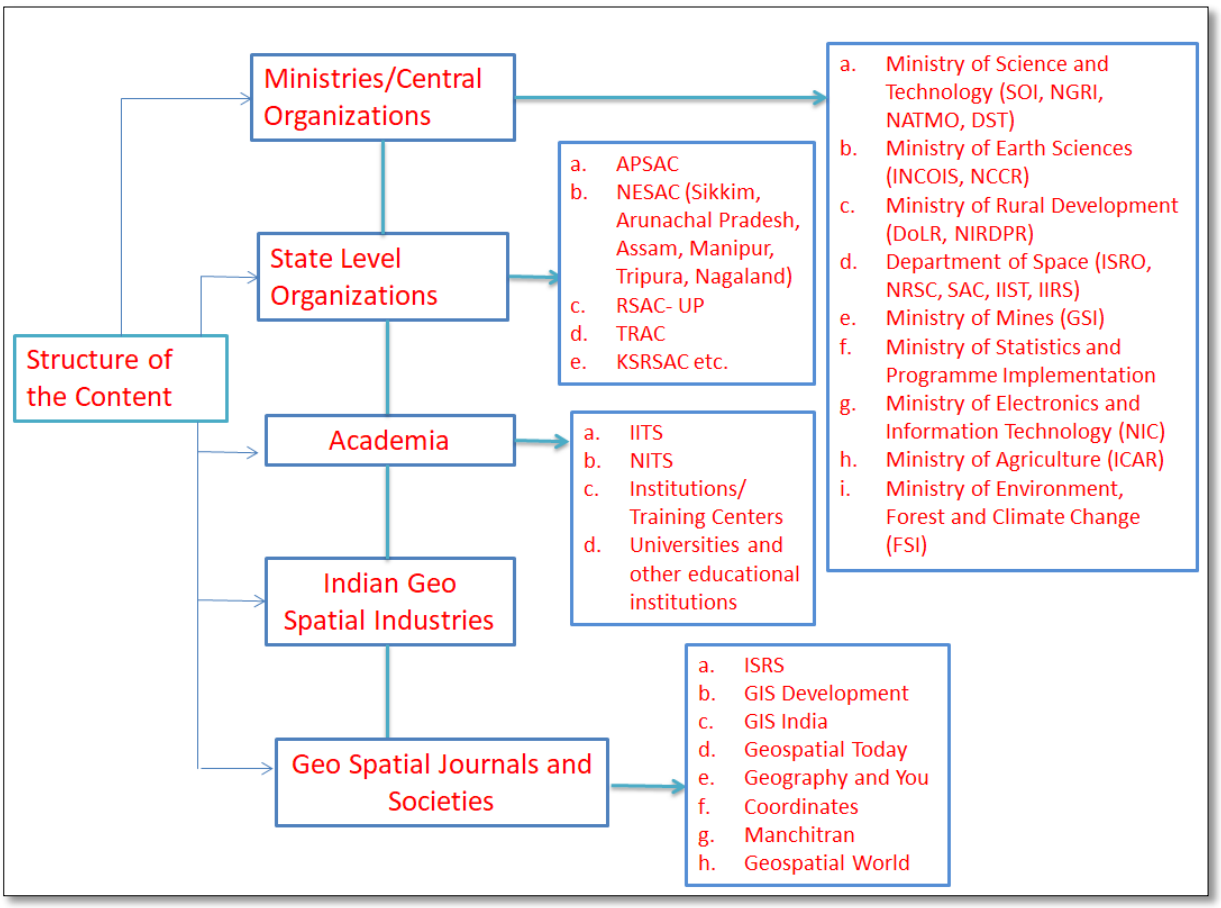

Figure 2: Structure of the Document and Content