GIS IN INDIA- AN OVERVIEW

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Abstract - *This paper tries to cover the overview of GIS in India. Starting with basics about the Geographic Information System, its history, application area, moves towards actual rollout happening. Countries who understood potential of GIS and started investing & encouraging its implementation are actually paving their way ahead among other nations, so GIS is must theme. It further elaborates the various efforts & initiatives taken by Government of India, National GIS Programme, and GIS Packages for various ministries. Paper also expounds Need of Comprehensive Evaluation of the GIS implementation to optimize cost, effort & correction towards movement of GIS projects in right direction. Paper also throws light on Typical GIS industry specific to India, Private sector GIS implementation and GIS Education.*

Key Words: GIS, Geographic Information System, GIS in India, Overview of GIS, What is GIS, National GIS, GIS Technology, India Reform
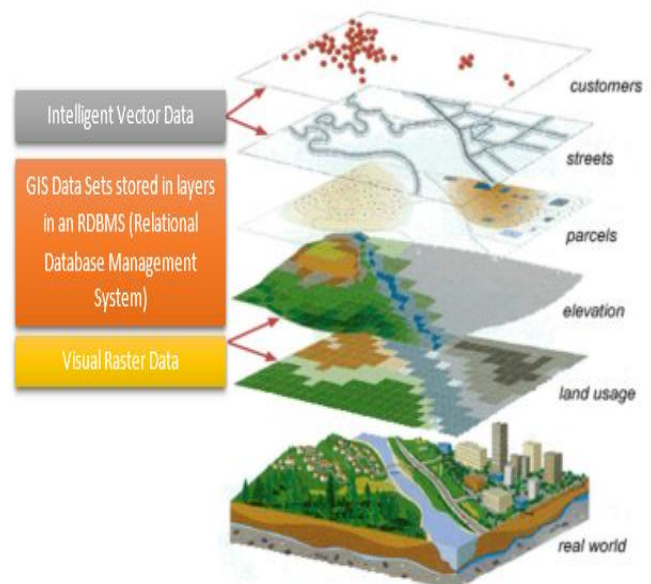
Figure 1- Layers in GIS

1. INTRODUCTION

Abbreviation GIS stands for Geographic Information System. In technical term a system which

- Store, retrieve, display, manipulate and analyse geographic and other traditional data linked to location
- Consists of 4 components: Hardware, Software, Data and People.
- Various types of Data sets
  - Landbase, Road networks and other urban data like building, wards etc.
  - Telecom, Electric, and other Utility data etc.

...all tied together geographically to provide spatial context. In Software world GIS applications can be envisaged in as usual three categories viz. Web based apps, Desktop based Client Apps and now a days most demanding apps (Usually downloaded from famous "Play Store") i.e. Mobile/ Tab based apps.

GIS is inherently integrative in its ability to combine information from different systems collected into location bound databases, displays and analyses. A power of a map, through a systematic analysis of Geo data, a mind blogging outputs & superb problem solvency. What makes difference, the geographical, spatially referenced dimension to your regular tabular database? In lay man's language, a canvas where you sketch your map with information & then query the canvas for solutions you are looking for. It is not a distance dream that almost every single human being will be captured in GIS & will have its whole lot of information. Just imagine virtual 3D world.

GIS is the candid fit for India's IT development. Evolvement of GIS in R-APDRP (Restructured Advanced Power Development & Reform Program) now started paying output in several states. May it be Electrical Transmission & Distribution Network Optimization or New Customer Request or some electrical Fault tracing or some Electrical theft? All these problems now has geo graphical based solutions available and GIS has paid a lot. This is not an end in fact a great start.

Technology has no end. It always generate base for newer revolutions, thus GIS is no exception. Started as a specialized field for few science mind, now reaching masses. Thanks to Google map, now fingers pointing map on android devices are easily seen & quite commonly observed activity. Google started generalizing it with "Google Map" service or Google navigation app. Just set your map device in a car / mobile &

just follow the direction, that small device not only answer you the way to go, it will show how much time required to reach destination, traffic update on road highlighted in different colors, nearest places like Restaurants, Hotels, Offices etc.
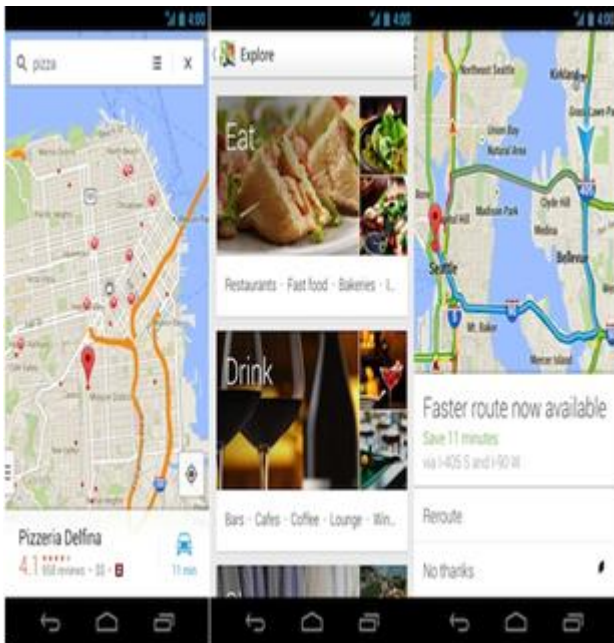

Figure 2- Navigation using GIS Application

Here is the small list, where GIS solutions can be worked out.

Table 1 Application Areas- GIS

Advertising	Local Government
Air Traffic	Logistics
Agriculture	Manufacturing
Architecture	Military/Defense
Automated Mapping	Natural Resources
Banking	Oil and Gas
Business	Pipeline
Cadastral/Tax Mapping	Property Management
Census	Public Health
Community Development	Public Information
Construction	Public Safety
Crime Analysis	Public Transit
Defense	Publishing
Demographics	Railway Engineering
Direct Marketing	Real Estate
Education	Redistricting
Emergency Services	Retail Siting
Engineering	Route Planning
Environmental Management	Target Marketing
Epidemiology	Tax Assessment
Facility Management	Telecommunications
Financial Services	Tourism
Fleet Management	Transportation
Forestry	Travel
Health Care	Trucking
Hotel Marketing	Utilities
Insurance	Water/Wastewater
Intelligence	Wildlife Management
Land Management	

The Canada Geographic Information System (CGIS) Ottawa, Ontario, Canada: In 1960, this is the first place where application of GIS used by the federal Department of Forestry and Rural Development, by Dr. Roger Tomlinson. It was used to store, analyze, and manipulate data collected for the Canada Land Inventory In order to determine the land capability for rural Canada by mapping information about soils, agriculture, recreation, wildlife, waterfowl, forestry and land use at a scale of 1:50,000. Utilization of GIS has increased very fast but its full potential is yet to be used thoroughly. Those nations who have understood this potential of GIS and started investing & encouraging its implementation will definitely march ahead of other nations.

1.2 GIS in India

If we refer to history of GIS in India, GIS technology is widely used over the period of time & substantial knowledge base is created. We are the forerunner in using modern spatial technologies and started its tryst with satellite images. In 1990's we had our own Indian Remote Sensing satellites and image based mapping and have been creating GIS databases and applications. In fact we marched ahead to build National Spatial Data Infrastructure during start of last decade.

Table 2- Satellite Launches by India

S No.	Satellite	Date of Launch	Launch Vehicle	Status
1	IRS 1A	17-Mar-88	Vostok, USSR	Mission Completed
2	IRS 1B	29-Aug-91	Vostok, USSR	Mission Completed
3	IRS P1 (also IE)	20-Sep-93	PSLV-D1	Crashed, due to launch failure of PSLV
4	IRS-P2	15-Oct-94	PSLV-D2	Mission Completed
5	IRS-1C	28-Dec-95	Molniya, Russia	Mission Completed
6	IRS-P3	21-Mar-96	PSLV-D3	Mission Completed
7	IRS 1D	29-Sep-97	PSLV-C1	Mission Completed
8	IRS-P4 (Oceansat-1)	27-May-99	PSLV-C2	Mission Completed
9	Technology Experiment Satellite (TES)	22-Oct-01	PSLV-C3	Mission Completed
10	IRS P6 (Resourcesat-1)	17-Oct-03	PSLV-C5	In Service
11	IRS P5 (Cartosat 1)	05-May-05	PSLV-C6	In Service
12	Cartosat 2 (IRS P7)	10-Jan-07	PSLV-C7	In Service
13	Cartosat 2A	28-Apr-08	PSLV-C9	In Service
14	IMS 1	28-Apr-08	PSLV-C9	In Service
15	Oceansat-2	23-Sep-09	PSLV-C14	In Service
16	Cartosat-2B	12-Jul-10	PSLV-C15	In Service
17	Resourcesat-2	20-Apr-11	PSLV-C16	In Service
18	Megha-Tropiques	12-Oct-11	PSLV-C18	In Service
19	RISAT-1	26-Apr-12	PSLV-C19	In Service
20	SARAL	25-Feb-13	PSLV-C20	In Service
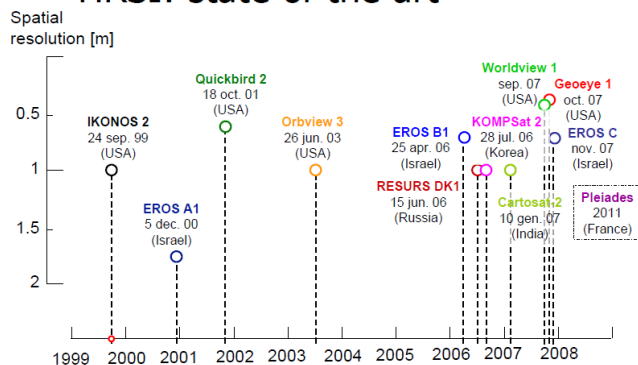
Figure 3- High Resolution Satellite Imagery: State of the Art.

Source: History of GIS, Laboratorio di Geomatica

Yield of GIS implementation is going to be far paid than as expected. In near future, linkages of Aadhhar to Bank accounts to PAN Cards, to credit records, to land records, to address will create such big canvas filled with a tons of information. Government bodies/ ministries can easily understand uneven distribution of services, facilities, gap between requirements & supply based on locality, density, income spread, and expenditure patterns etc. May it be planning of Road Network Annex or Health care facilities or Educational institutes, a sound base will be available through

GIS solution. **Management of Urban Transport to Port Transport, Land Record Management** or **Smart City (100 smart cities as planned by central government)** planning or Electricity Distribution or Crop yield patterns or India's **National River Linking Project,** GIS is going to simplify the visualization of such vast demography. GIS with its advent E-governance is going to be much more enhanced.

In October 2011, Ministry of Earth Sciences submitted "Establishment of "National GIS" under Indian National GIS Organization (INGO)" National GIS- Programme & Vision document to planning commission. Nation GIS documents were created after a lot of meetings, brainstorming, and sessions with Subject Matter Experts (SME) including Industry experts, researchers, scholars & professionals from academics from India's well as from abroad. The National GIS vision document can be accessed at www.moes.gov.in/writereaddata/files/national_gis.pdf

Figure 4- Vision Statement from National GIS

Below is the list of some of the major GIS initiatives.
- Natural Resources Information System under National Natural Resources Management System (NNRMS);
- National Spatial Data Infrastructure (NSDI) of Department of Science and Technology (DST);
- Bhuvan Image Portal of Department of Space (DOS);
- Delhi State Spatial Data Infrastructure (DSSDI) of Delhi State;
- National Urban Information System (NUIS) of Ministry of Urban Development (MUD);
- Establishing G2G GIS by National Informatics Centre (NIC);
- Recent efforts at modernization of land records under NLRMP;
- Restructured Advanced Power Development & Reform Program (R-APDRP)
- Various City GISs (example Mumbai, Bangalore, Kanpur, Kolkata and many others) and many other have been implemented.

In addition, various GIS initiatives of the states have helped bring good examples of state-wide applications of GIS. Some private sector agencies have also been successful in implementing GIS solutions and in providing GIS services.

If we further refer to National GIS Vision Document, The major elements of the National GIS platform include following specific activities:

National GIS Infrastructure as a GIS Platform and the computing and networking infrastructure for the National GIS. The National GIS platform would be developed, hosted, and based in India. As part of the National GIS infrastructure, it is planned to position National GIS Dashboards for key dignitaries such as PM Office (PMO); Planning Commission and Cabinet Secretariat for high-level reviews/meets etc. and promote the GIS usage to key dignitary-levels.

National GIS Asset has organized geodatabase of the National GIS Asset and maintaining it. The National GIS Asset is proposed to be organized at two-levels - Seamless, nation-wide GIS content equivalent to 1:10,000 scale and pockets of "geostitched" city-level larger scale GIS Asset (wherever and as and when available). National GIS Asset includes ~41+ GIS Features and a wide range of ~15+ sectorial geo-tagged attributes/tabular data from census, demographics, planning and development, infrastructure and other sectorial datasets of ministries/states. It is also proposed to allow crowd-sourced geo-tagged data content into the National GIS as an additional "citizen layer" where citizens can populate their datasets grievance points etc. on the GIS frame.

Below is the list of GIS based solutions for various ministries.

Sr.	GIS Packages	Description
1	Plan-GIS	Plan-GIS for Planning Commission supporting the planning, monitoring and reviewing plans and development.
2	GIS for Public Services	GIS for Public services as part of PIII services in various areas.
3	Rural- GIS	Rural-GIS for various rural development programmes of the Ministry of Rural Development.
4	City-GIS	City-GIS service to planning, management and development of ~5200 urban areas for Ministry of Urban Development.
5	Roads-GIS	Roads Monitoring service for PMGSY as well as a Roads-GIS for NHAI/Ministry of Surface Transport
6	Health-GIS	Health-GIS service as part of support to the Ministry of Health & Family Welfare
7	Water Resources-GIS	Water Resources-GIS for water resources management of Ministry of Water Resources
8	Agri-GIS	Agri-GIS service for the Agriculture and Farm sector through Ministry of Agriculture
9	GIS for Disaster Management Support	GIS for Disaster Management Support for supporting management of disaster for NDMA
10	GIS for Infrastructure sector	GIS for Infrastructure sector be they in roads and highways, rail systems, airport infrastructure or other social infrastructure.
11	Env-GIS	Env-GIS for Environment and Climate Change monitoring of Ministry of Environment and Forests
12	GIS for Aadhhar	GIS for Aadhhar integrated with UID
13	Census-GIS	Census-GIS for Registrar General of India
14	Weather-GIS and ES-GIS	Weather-GIS and ES-GIS for IMD/MoES.
15	GIS for Security	GIS for Security as a support for the security programmes of Ministry of Home Affairs.
16	NE-GIS	NE-GIS for meeting the GIS data and DSS needs of MONER
17	Coal-GIS	Coal-GIS for Ministry of Coal for supporting coal mining activities
18	Heavy Industry-GIS	Heavy-Industry-GIS for Department of Heavy Industries

19	New Energy-GIS	New-Energy-GIS for Ministry of New and Renewable Energy
20	Tourism-GIS	Tourism-GIS for supporting Ministry of Tourism
21	Panchayat-GIS	Panchayat-GIS in support of Ministry of Panchayati Raj
22	Stat-GIS	Stat-GIS for the Ministry of Statistics and Programme Implementation
23	Power-GIS	Power-GIS in support of Minister of Power
24	Steel-GIS	Steel-GIS in support of Ministry of Steel and its mining PSUs
25	Defence GIS	GIS data access applications for use for Defence GIS requirements.
26	Private sector GIS applications	Provide for private sector GIS applications to be hosted and published on the National GIS.
27	Simple GIS	Citizen access to National GIS would be enabled through simple GIS Applications and integrated e-services.

Figure 5- Source: "Programme & Vision document, Establishment of 'National GIS' under Indian National GIS Organization (IGNO)" October 2011

If we keep an eye on the National Informatics Centre's web (http://www.nic.in/services/Remote_Sensing_and_GIS_Division) National GIS, largest repository of spatial database in country which incorporates images from Foreign and Indian satellites with different spatial spectral resolution along with the maps developed from survey. This National Spatial Database (NSDB) caters the need of GIS services of various sectors like rural development, watershed management, ground water, agricultural marketing, Panchayat mapping, emergency environment planning, demography and village amenities, and election management and so on. Based on "Framework Service Oriented Architecture" National GIS website not only allows sharing of data from multiple sources but also allows customized Specific GIS services as per the needs of various stakeholders involved in planning and e-Governance process.

http://gis.nic.in/ hosts various

1. **Government to Citizens GIS websites** like Village level mapping of Demography & Amenities, Sports facilities in Delhi, Mapping of Rural Postal Offices, National Atlas, Parliamentary and Assembly constituency maps;

2. **Government to Government GIS websites** like N.S.D.B, National GIS Web portal -I, National GIS Web portal-II
3. **GIS Projects** like Total Sanitation Campaign, Coastal Zone Management, Agmarknet GIS, I.S.B.D.I.E, NHWIS etc.
4. **Open Source GIS**
5. **Other links**

One more thing can be concluded here is that India is going to witness a large chunk of GIS Rollout ahead in both government & private sector and during the stipulated span India will require the human resource base i.e. skilled, semi-skilled in GIS domain. This can be viewed as one of the major challenge which needs Awareness among the Peoples & Education about the GIS. Primary knowledge about GIS must be treated as basic cognitive skill like math & must be started teaching in secondary school itself.

GIS is already garnering fast from 2D to 3D mode. It should not be surprise for us if for 15 story building whole Electrical or firefighting planning work is happening in 3D model itself & at the same time in some other Telecom/TV company, business teams are placing their distribution boards virtually in the very same building at every three or four floors for their capacity planning using some GIS application, even though engineering is on & construction is halfway for the high-rise in consideration.

2. Comprehensive Evaluation of the GIS implementation

Rolling out GIS is really great thing but should we check/ audit its implementation??? Yes of course. With the help of highly specialized consultants & subject matter experts (may be from renowned institutes or universities) this job can be done. This simple check can thoroughly check

- Whether implementations are as per Existing Best practices?
- Whether implementation meeting the intended objective or deviated from expectations?
- Where is the Area of Improvement?
- Checks Design Scalability, Aberration or Anomaly in process / workflows if any
- Or some time, it may suggest to better shut down the roll out etc.

This step is as much as imperative as beginning a new reform. Preventive action is always better than cure. Thus this simple measure can save our lot of efforts & will put our movements in right direction.

Existing Status

- What is the status of
  - Configuration
  - Data
  - Process
  - Infrastructure

Deviation

- Expectation from GIS
- Deviation in comparision with Current status

Transition Plan

- Plan for how to move from "As-Is" condition to "To Be" condition

Figure 6- Comprehensive Evaluation of the GIS implementation

3. GIS implementation by Private players in India

Over the period of time private organizations also implemented GIS for optimizing their business need in India. GIS has a capability to visualize, manage, and analyze any business asset may it be personnel or clienteles or facilities. Companies in key business segments like Telecom, Oil & Gas, Energy & Power generation, Infrastructure, Automobile, Insurance & Banking, Retail and Logistics & Warehousing sector are taking advantage of GIS technology. Listing of the end user entities will be very long as it covers from small institution to university to Conglomerates like Reliance, Essar etc.

There is one feature of GIS which makes its more adaptable i.e. "Integration with other Enterprise Systems". Various companies are developing & using integrated GIS solutions with their other IT systems like SAP, CRM (Customer Relationship Management), Documentation Management Systems, Finance & Accounting software's, Various Engineering software's etc. Several companies have adopted integrated GIS solutions for making robust Management Information System (MIS). This type of integration is most seen in companies working in supply chain categories.

With latest technology inventions in GIS, This system is becoming more & more versatile e.g.

- Insurance or banking sector uses GIS applications for tapping their potential customers, ATM planning based on locality, average income, density etc.
- Similarly Telecom companies uses GIS not only for Network planning & engineering but also for mapping their potential customers, outlets & service Centre on similar ground of locality, average income & density.
- Retail companies or Logistics companies are using GIS applications for their distribution network optimization & supply chain.
- Also with the advent of online marketing portals like Flipkart, Snapdeal, Amazon, Myntra or Jobong GIS solutions eases their operational loads of customers, suppliers, warehousing and courier or shipment which are all distributed geographically.
- Even a private cab service providers like Tab Cab or Meru cab etc. in Mumbai or Delhi use GIS apps for tracking & managing their cabs

Typical structure of GIS Industry has following five main arms, who implements the GIS technology.

Consulting & Technology services providers

- Technology Consulting to Customer incl. Requirement Assessment , Arch & HLD
- Consulting to Platform providers, Dataset Provoders and client facing Apps & service provider.

Platform

- GIS Software Platform Providers
- Platform on which Apps can be developed

Dataset

- Data Providers
- Data Production & suppliers

Apps

- Apps Devp & service providers
- Develops web, desktop or mobile applications for customers

Customer

- Goverment, Unversities or Institions
- Private organization

Figure 7- Typical GIS Industry

In India all types of domestic as well as international GIS service providers are available & growing with the awareness & benefits of GIS. International Technology provider like ESRI, GE Smallworld, Bentley, Intergraph, and Autodesk who directly or indirectly provides GIS platforms to End users (Both government as well private sector). Indian IT majors like TCS, Infosys and Mahindra Satyam also provided end to end GIS solution. This end to end solution can be consultation services covering Requirement Assessment, High Level Design (HLD) to Applications Development, Platform Management, Database Management to Back end support to Annual Maintenance Contract (AMC) etc. There are also several small & medium sized GIS companies, which are developed over the time & mostly caters the need of Data.

Below is the small list of GIS companies in India

Table 3- Small List of GIS companies in India

Aadi IT Solutions Pvt. Ltd.	Infotech Interprises
ADCC Infocad	Intergraph
Autodesk	Mahindra Satyam
Bentley	ML Infomap
CMC	Multimind Creations
Cybertech	NIIT-GIS (ESRI India)
Digital Globe	Nokia
DSM Soft	Pitney Bowes Software
ESRI	RMSI
Excel Geomatics Pvt. Ltd.	Rolta
GE Smallworld	Tata Infotech
Genesys International Corp	TCS
HCL	TomTom
IBM	Wipro
Infosys	

4. GIS Education in India

One of the listed constraint & really important aspect for ensuring GIS in building India is awareness about GIS, knowledge about GIS. "Skilled Manpower" / "Professional" / "Subject Matter Experts" / simply "Human Resources" are the key & vital part for implementation & Roll out any program or project or Reform. GIS so far looks like special field with limited educational institutes for running Diploma level, Graduate level & Post Graduate level programs in India. Exception of few IITs & some premier institutes like Symbiosis etc. there are hardly as such special bachelor or PG level courses are running. List of institutes & their programs in GIS can be seen at http://www.gisinindia.com/directory/gis-training-institutes-in-india

In fact, GIS should be taught as a cognitive skill like math & must be imparted to each engineering graduate, MBA student irrespective to their branch. Even graduating students irrespective of his specialization like Arts, Science or commerce etc. must have primary knowledge of GIS.

In China responsibility for building national GIS database was given to various Universities, India also perceive this approach. In any university, during learning period if students are encouraged to work on /hands on live GIS projects, over the period of time & with technological revolution most fabulous results can be seen in Geo Database creation, correction, update & analysis with case studies.

Indian scholars have published several papers in national & international journals. There are quite few journals & magazines which are published in India like GIS India, Journal of Indian Society of Remote Sensing, GEO Informatics, Geospatial World, India Geospatial Digest, Coordinates etc. But still there is scope for encouragement of National level GIS events, summits, seminars &

conferences. More & More National level show cases can be sponsored by Universities / government ministries etc. Such events not only exchanges the knowledge base but also encourage the small Indian GIS companies in their capacity building.

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