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Achievements and Developments in Geographical Information in Addressing National Issues in India*

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Achievements and Developments in Geographical Information in Addressing National Issues in India

(Maj Gen Manoj Tayal, Surveyor General of India)

1. BRIEF HISTORY AND TRADITIONAL ROLE OF SURVEY OF INDIA (SOI)

Survey of India, The National Survey and Mapping Organization of India under the Department of Science & Technology, is the OLDEST SCIENTIFIC DEPARTMENT OF THE GOVT. OF INDIA. It was set up in 1767 and has evolved rich traditions over the years. In its assigned role as the nation's Principal Mapping Agency, Survey of India bears a special responsibility to ensure that the country's domain is explored and mapped suitably, provide base maps for expeditious and integrated development and ensure that all resources contribute with their full measure to the progress, prosperity and security of our country now and for generations to come.

The history of the Survey of India dates back to the 18th Century. Forerunners of army of the East India Company and Surveyors had an onerous task of exploring the unknown. Bit by bit the tapestry of Indian terrain was completed by the painstaking efforts of a distinguished line of Surveyors such as Mr. Lambton and Sir George Everest. It is a tribute to the foresight of such Surveyors that at the time of independence the country inherited a survey network built on scientific principles. The great Trigonometric series spanning the country from North to South East to West are some of the best geodetic control series available in the world. The scientific principles of surveying have since been augmented by the latest technology to meet the multidisciplinary requirement of data from planners and scientists.

Organized into only 5 Directorates in 1950, mainly to look after the mapping needs of Defense Forces in North West and North East, the Department has now grown into 18 Directorates spread in all parts of the country.

As the National Mapping Agency, SOI provides and maintains the basic map coverage and foundation dataset including the national spatial reference frame, the national DEM, the national topographic template, administrative boundaries and toponymy required for the development of the country. Its technology, latest in the world, has been oriented to meet the needs of defense forces, planners and scientists in the field of geo-sciences, land and resource management. Its expert advice is being utilized by various Ministries and undertakings of Govt. of India in many sensitive areas including settlement of International borders, State boundaries and in assisting planned development of hitherto under developed areas.

Its specialised Directorates such as Geodetic and Research Branch, and Indian Institute of Survey and Mapping (IISM) have been further strengthened to meet the growing requirement of user community. The department is also assisting in many scientific National programs related to the field of geo-physics, remote sensing and digital data transfer.

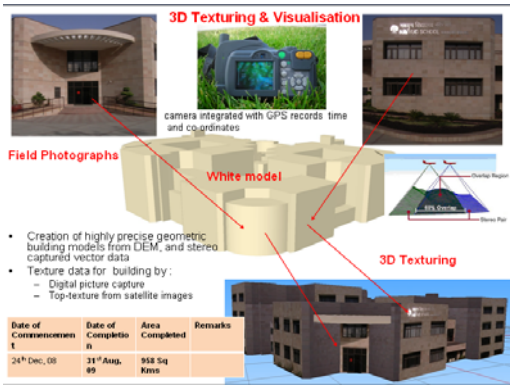
2. VISION AND MISSION OF SOI

The vision and mission of SOI have been re-defined consequent to the New Map Policy of Government of India which came into being in 2005.

The vision of SOI is to take a leadership role in providing user focused, cost effective, reliable and quality geospatial data, information and intelligence for meeting the needs of national security, sustainable national development and new information markets.

Survey of India dedicates itself to the advancement of theory, practice, collection and applications of geospatial data, and promotes an active exchange of information, ideas, and technological innovations amongst the data producers and users who will get access to such data of highest possible resolution at an affordable cost in the near real-time environment.

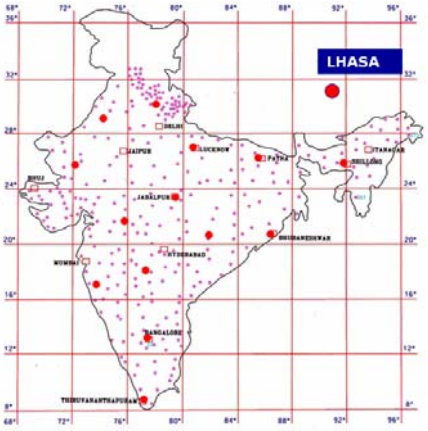
3.SURVEYING AND MAPPING



From hand-drawn maps to the 3D walk-through – SOI has witnessed complete metamorphosis in the science of cartography. With the announcement of new National Mapping Policy-2005, the country is on the verge of completing Open Series Maps (OSM) and Defence Series Maps (DSM) on 1:50K scale. While OSMs primarily support the developmental activities of the country and are unrestricted after one-time clearance from Ministry of Defence, the DSMs mainly cater to the needs of defence forces and national security requirements.

From conventional plane-tabling method to Digital Photogrammetry and mobile mapping system, from tapes and chains to Total Stations and GPS, from conventional fair-mapping/scribing to Digital Cartography, from offset printers to Digital Map Publishing Systems – state of art technology has permeated all aspects of map-making in Survey of India.

4. REDEFINITION OF HORIZONTAL AND VERTICAL DATUM



Geodetic and Research Branch (G&RB) of SOI has taken up the task of re-defining the Indian Geodetic Datum, based on observations of newly observed GCPs in ITRF system. The first phase of establishment of 300 monumented GCPs 250-300 km apart has been completed. The second phase of establishment of 2200 GCPs at a spacing of 30km is underway. These monumented GCPs will have packets of geodetic information such as co-ordinates in ITRF, height above MSL, gravity values in IGSN71 Datum, total geo-magnetic force and vertical force of earth's magnetic field. These stations will be used to transmit differential corrections to GPS users for obtaining positions within 1-2 m in real time.

In order to meet the requirements of cm-level vertical accuracy in many developmental projects, disaster management projects and inundation mapping, G&RB has taken up massive task of redefining the vertical datum based on geo-potential numbers and Helmert Orthometric heights.

More than 100,000 km stretch of country has been accurately levelled with gravity observations with an objective to

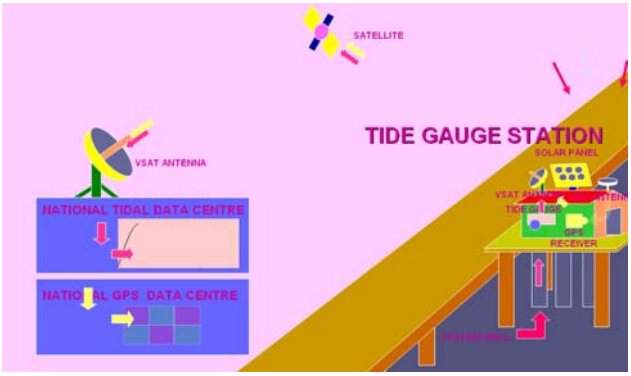
- Provide dense network of precise benchmarks having geo-potential numbers, Helmert Orthometric heights, and gravity values.
- Connect BMs to National GCP Library for provincial governments to use in their irrigation, cadastral and utility mapping.
- Connect BMs to all tide-gauge BMs so that sea level variation, inundation mapping and port management activities can be taken up more accurately.
- Set up a reference frame for scientific studies like landslides, crustal movement and seismotonics.
- Development of high resolution Geoid Model 'INGEOID' by combining available long wavelength Global Geo-potential Model with high frequency gravity data to obtain orthometric heights accurate to ± 5 cm from GPS measurements. Efforts are also on to develop a 'Hybrid Model' combining gravemetric geoid undulation and geometric geoid undulation details.

5. MODERNIZATION AND EXPANSION OF INDIAN TIDE-GAUGE NETWORK

State-of-art digital tide gauges co-located with the dual frequency GPS receivers have been installed at strategic locations all along the Indian coastline and its islands. GPS receivers have been deployed to segregate the sea level rise from that of possible subsidence or upheaval of land mass.

Both tidal and GPS data is being transmitted in real time from the remote locations and received through dedicated VSAT network at the central hub installed at National Tidal Data Centre (NTDC)/National GPS Data Centre (NGPSDC) located at G&RB and is being spliced before sending it to NTDC or NGPSDC respectively. GPS data is being encrypted at remote locations and decrypted at the central hub.

5.1Tsunami Warning System



The tidal and GPS data is analyzed in real time to identify any possible signatures related to tsunami and storm surge. In the event of tidal heights crossing a preset threshold, the information is passed on to Tsunami Warning Centre established at Indian National Centre for Ocean Information (INCOIS), Hyderabad, which has been equipped with all the necessary computational and communication infrastructure to enable reception of real-time data from all the sensors, analysis of the data, generation and dissemination of tsunami advisories.

The real-time data from seismic stations from the national seismic network of the Indian Meteorological Department (IMD) and other International seismic networks, tide gauges from SOI and Bottom Pressure Recorders are analyzed together following Standard Procedures for dissemination or issuance of alerts. Indian Space Research Organisation (ISRO) has made an end-to-end communication plan using INSAT. A high level of redundancy is being built into the communication system to avoid single point failures.

6. VILLAGE INFORMATION SYSTEM

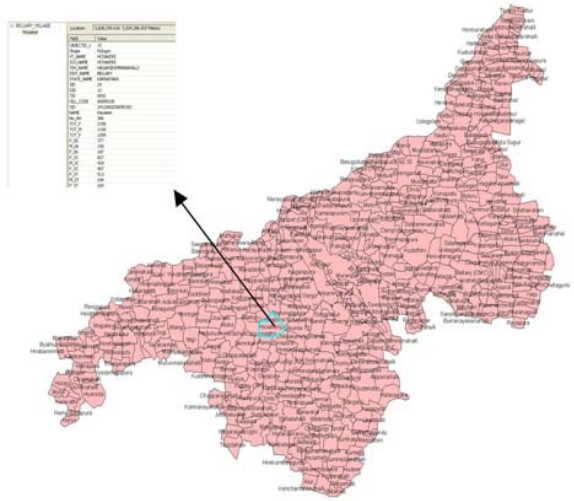
A majority (74%) of Indian population live in approx 600,000 villages (lying in near approx 600 districts), scattered throughout India. The rural population in India forms the core of Indian society.

The Planning System in India is undergoing rapid changes with the enactment of the Seventy-third and Seventy-fourth Constitutional Amendments in 1992 and 1993. The present emphasis is on devolution of greater authority and responsibility to Panchayati Raj Institutions (PRI) at the local level (Zilla Panchayat, Panchayat Samiti, and Village Panchayat), with district as the identified unit of planning. Specific items like land improvement, soil conservation, drinking water, fuel and fodder, health and sanitation, education facilities etc. (29 items are included in the Eleventh Schedule of the Constitution) have been identified where institutions of self-governance in the rural areas are required to prepare and implement integrated development schemes.

The Ninth Plan (1997-2002), in this context, re-emphasizes the need for integrating various sectoral programmes of soil and water conservation, forestry, minor irrigation, agriculture and other departments for drawing up integrated local area development strategies. Elaborating the approach, the Ninth Plan Document suggests “the poverty alleviation programmes should be more effectively integrated with area development programmes and the various sectoral programmes within the umbrella of Panchayati Raj Institutions (PRIs) which will function as effective institutions of local self-government. These institutions should prepare and implement the plans for economic development and social justice”.

Preparation and implementation of such integrated schemes/programmes is a complex and information-intensive. One of the major bottlenecks to this information-intensive task is PRIs' inaccessibility to relevant village level spatial data (maps) and attribute (textual) information.

There has been a need to upgrade the existing data system prevalent at the districts to make it amenable to quick retrieval, integration and analysis. The Government has therefore, encouraged programmes aimed at developing and inducting appropriate scientific and technological tools in the task of upgrading the databases and improving data management procedures at the districts. Natural Resources Data Management System, (NRDMS), is one such initiative of the Government, launched by the Department of Science & Technology with a distinct focus on development of spatial data management tools for local level planning.



In a major g-governance initiative DST and SOI have taken up the task of providing web-based Village Information System. Survey of India has already captured ground verified village boundaries for 452 districts to which attributes pertaining to demography, infrastructure and natural resources from the Census Department have been attached.

In order to demonstrate the utility of emerging Geo-Information & Communication Technologies (Geo-ICT) in providing access to such information, a prototype of a web-based village information system has been developed for the villages of Uttarakhand. Capable of sharing village level information on natural resources, demography, and infrastructure from a central server, the prototype helps depict textual data sets from Census in the form of thematic maps as per the needs of the end-user. The prototype permits a quick grasp of implications of possible interventions in terms of spatial variations. The methodology used in the prototype is potentially helpful in supporting provision of e-government services at districts, blocks or panchayats.

7. NATIONAL URBAN INFORMATION SYSTEM (NUIS)

As per 2001 Census, India has 4378 Urban Agglomerations (UA) comprising of 5161 towns and cities. The constant transformation of urban areas into complex entities has brought forth new challenges and opportunities for Planners to design and implement a variety of activities in spatial terms. There is a need to address problems and issues in the right perspective to assist cities in coping up with economic realities and coming up with better urban policies and solutions. Thus, in order to address these issues in a holistic manner, Ministry of Urban Development has launched NUIS Scheme, in March 2006.

The NUIS Scheme comprises two major components as given under:

Urban Spatial Information System (USIS) – includes development of GIS based multi-hierarchical database, with application tools, to support Master/Zonal plan preparation; Urban Local Bodies (ULB) administration and utilities management.

Data sources such as Satellite Imagery and Aerial Photographs are being used to generate a comprehensive 3-tier GIS database on the scale of 1:10,000 for Master Plan and 1: 2,000 for Zonal Plan and 1:1000 for Utilities Plan.

National Urban Databank and Indicators (NUDB&I) – includes designing and establishing a comprehensive data bank and integration of these parameters to support planning and derive indicators for National Urban Observatory (NUO) for monitoring the health of urban settlements. The key indicators of this project are:

- Socio-economic development
- Infrastructure
- Transportation
- Environmental management
- Local authorities
- Housing

The source and methods in the development of National Urban Databank and Indicators (NUDB&I) would involve the following:

• The NUDB&I database for each town to support planning and management in relation to actual departmental functions will be generated/compiled by the ULB to be linked to the spatial database. Contents of NUIS scheme shall be at 3 levels:

Master plan (1:10000 scale) Zonal plan (1:2000 scale) Utility mapping (1:1000 scale)

• The data so generated from the spatial attributes will be processed to derive indicators to support NUO.

The NUIS Scheme has been taken up in a National Mission Mode commencing during the Tenth Five Year Plan in a phased manner.

Phase-I covers **137** priority towns to develop GIS database as well as Urban Databanks. Further, develop indicators under National Ur ban Observatory (NUO) for **152** towns, and Utility Mapping using Ground Profiling/Penetrating Radar(GPR) for **22** towns. The efforts during this would largely focus on developing test-bed procedures and standards to facilitate implementation for later phases.

• **Phase-II** expand the scope to cover another 1500 towns

• **Phase-III** expand and cover the balance towns (about 3000)

Given the widely varying range of tasks in the NUIS Scheme involving multiple agencies including Central, State, Local Bodies and Private Sector, the implementation mechanism becomes fairly complex. The magnitude of the work being very large, there will be need to involve not only multiple government agencies, with technical expertise, but also the involvement of competent private sector, who can contribute specific services in the field of GIS and Remote Sensing.

SOI, the National Mapping Agency, has taken up the responsibility of providing spatial data required for NUIS viz. at 1:10K and 1:2K scales and also for survey of underground utilities using GPR. The status of spatial data generation is as follows:

1:10,000 scale: Satellite Imagery collected for 142 towns. 10 towns have to be covered by fresh cloud free imagery. Mapping completed - 54 towns. Remaining under progress.

1:2,000 scale: Aerial Photography completed - 80 towns. Mapping completed – 7 towns. Mapping under progress – 12 towns. Ground Control under progress – 33 towns

1:1,000 scale (GPR Survey): Firm has been identified

8. CENSUS

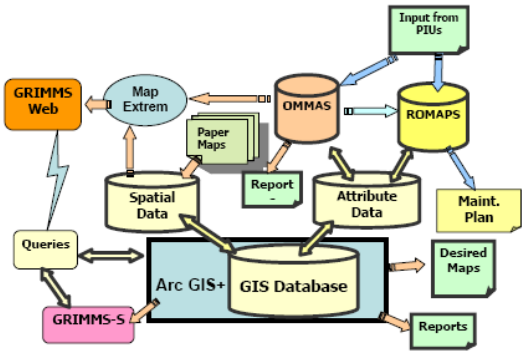
In a major initiative to spatially enable the government, SOI, the National Mapping Agency of India is working in collaboration with the Department of Census. Large scale spatial data (1:2000) is already available for 7 Cities of India viz. Delhi, Mumbai, Kolkata, Chennai, Hyderabad, Bangalore and Ahmadabad. Large scale maps with resolution upto building level are being prepared for the remaining 22 State Capitals of the country with the help of very high resolution satellite imagery. The next census operations of all these cities will be based on these spatial data for collection of house-hold level data

9. DEVELOPMENTAL SCHEMES

The development of any country depends on the infrastructural facilities available therein. Good road network facilities plays major role. Realizing this fact an ambitious and biggest ever infrastructure development project in India (expected cost of $26 billion) named as Pradhan Mantri Gram Sadak Yojna (PMGSY) under ministry of Rural Development was conceptualized and launched on 25th December, 2000. The objective is to provide basic access by way of all weather roads to the all habitations having population "250 or above in desert and tribal areas" and "500 or above for the rest of habitations" in phased manner.

The role of Rural Roads is very important in a country like India where majority of the population resides in rural areas and the main source of their earning is based on agriculture products. Rural roads provide the access to basic amenities and means of transporting agricultural products to nearest market centers.

PMGSY scheme is a very popular among rural areas because of the specifications and quality aspect adopted for construction of roads. Although it is a Rural Road Connectivity Project but it has well designed working system, clear guidelines and stream lined efficient monitoring and execution strategy.



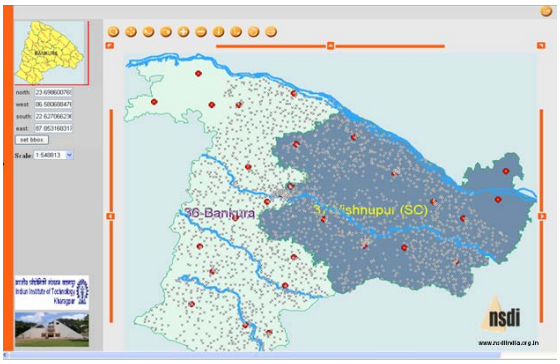
A 3-tier quality control system has been envisaged to enforce the quality of construction of roads.

- Contractors are bounded to set up a field laboratory at the work site. DPIU functions as the first tier of the quality supervisor, these DPIU are further supervised by the State Quality Monitor and National Quality Monitors
- The complete programme is monitored, planned using Online monitoring System called as Online Management, Monitoring and Accounting System (OMMAS).
- The use of Geographical Information System (GIS) for monitoring, management and building transparency in programme implemented in two pilot states i.e. Rajasthan and Himachal Pradesh

GIS technology is also being used for many other Developmental Schemes like Gramya Vikas Yojna and schemes for promoting use of non-conventional energy resources.

10. ELECTIONS

The spatial data of National Spatial Data Infrastructure was used extensively during the 15th Lok Sabha Elections held in 2009 in which more than 700 million voters participated.



GIS technology was harnessed for mapping the electoral process, redistricting, managing the logistics of holding elections, supplying information to voters both before and after an election, locating the polling booths, Election Day support and analyzing the results of elections.

Election Commission of India has also taken a number of IT initiatives in the last few years. Under the Electronic Election Data Initiative, it has opened up its databases. Entire country's Electoral rolls, in 15 languages, are now available on the internet. As part of putting "Find my name in the lists, and then tell me my polling booth" service on the net, ECI has put GIS based maps of some cities on the net, with a good name and location search facility.

Parliament and Assembly boundary maps, with various kinds of readymade analysis, are also available on the Commission's website www.eci.gov.in. As part of "open databases" initiative, even the SHAPE files, with attribute tables, are available on the website for the public to download and generate their own maps. The delimitation exercise, of redefining the entire country's parliament and assembly boundaries, using Census 2001 population data, is also being done using GIS village level maps rather than paper based maps. Since the Election Commission reaches every nook and corner of the country, it is believed that any countrywide GIS initiative by the Commission will spread the use and culture of GIS maps throughout the country in a big way.

11. SDI

NSDI in India has been created with a vision to provide a National infrastructure for a sustainable development

to ensure the availability of and access to organized spatial data

promote the use of infrastructure at community, local, state, regional and national levels

The objectives of NSDI are to:

- Develop and maintain standard digital collection of data
- Develop common solutions for Discovery, Access and Use of spatial data in response to the needs of diverse user groups
- Increase the awareness & understanding of the vision, concepts and benefits of the NSDI.

NSDI in India has been mandated to

- Provide an information infrastructure
- Provide framework to collate standardized information from many identified and selected sources
- Receive information from various agencies
- Promote generation of value added data for diverse user applications
- Transact business of spatial data with user bodies in open access public domains.
- Create a reliable and supporting environment to Access geographically-related information using a minimum set of standard practices, protocols and specifications.

Some of the key achievements of NSDI in India are:

- Development of consensus amongst data providers
- Development of National Standards for metadata, Data exchange
- Establishment of working relationship with OGC, GSDI, PCGIAP, ISCGM (Global Mapping)
- Development of tools for web enabled/ interoperable spatial data
- Development data model for high resolution spatial data sets
- Design of Elements like the NSDI – standards, meta data, nodes, search and access protocols and the electronic clearing house.
- Establishment of SDI at State, District and Village Level. SDIs have been established at the states of Delhi, Karnataka, West Bengal, North East, Kerala. Spatial Data Centres have also been established in 60 Districts and in 20 villages.
- Launch of OGC Compliant India geo-portal. Metadata and Product Catalogue of National mapping Organization, SOI were uploaded. Data at resolution of 1:1 M were uploaded and made available through India Geo-Portal. Interoperability and demonstrative Location Based and Business Services provided.
- Imparting training - two weeks training programme for PCGIAP countries at IISM, four weeks each Pre and Post Installation training on India Geo-Portal to all the Data provider Agencies , training of Army Officers in Collaboration with Defence Institute for Geo-Spatial Information & Training (DIGIT)

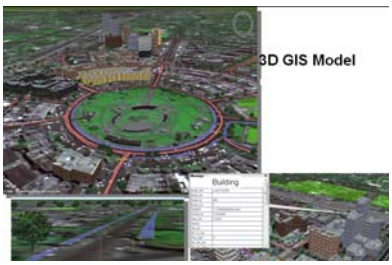
11.1 DSSDI

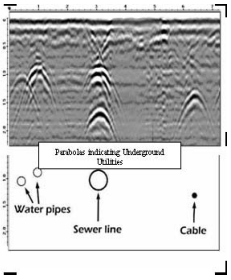
While policies, standards, institutional strengthening will streamline the SDIs, it is a hard reality that much of the data will need to be captured at desired accuracy and resolution to meet the expectations of the citizens and spatially empowering the government to deliver the solutions at root level.

One of the approaches taken up by SOI is to take up lead role in establishment of State SDIs with active PPP. The Delhi State Spatial Data Infrastructure (DSSDI) is one such major g-governance initiative taken up by jointly by Government of National Capital Territory of Delhi (GNCTD) and Survey of India.

In pursuance to its g-governance initiative , the Government of Delhi has signed an MOU with Survey of India (SOI), the National Mapping Agency under department of science and Technology, Government of India, in November 2007 for execution of a citizen friendly programme of Delhi State Spatial data Infrastructure (DSSDI) Project i.e. 3D Pictorial GIS, for

- Proper planning of city of Delhi thereby ensuring safety and security of its citizens
- Providing house-hold level information for building a GIs database for secure ownership and proper socio-economic planning
- Better management of all civic amenities like sewer, water, electricity, telephones, roads, parks, water-bodies.





The salient features of this flagship project of government of Delhi are:

- Creation of 3 Dimensional Geographical Information System (GIS). 3D Digital model of the entire city with Photo realistic 3D visualization and texturing ie a High-resolution, three-dimensional virtual walkthroughs of the NCT of Delhi
- Creation of Comprehensive Urban Information System- mapping of details up to manholes, light poles, traffic signals, signage, urban properties including boundary wall, gates, fence, classification and usage etc
- Creation of Comprehensive Land Information System and Property GIS with updated parcel boundaries and revenue records. Ownership/occupancy, population and flagging of changes in the existing and current information.
- Mapping of topographical features with about 350 feature classes on 1:2000 scale and 50 cm Contour Interval and establishment of 1500 monumented Control Points for future survey.
- Mapping of underground and over-ground utilities such as cables, pipes etc. with their accurate location, depth and size on 1:2000 scale using a mechanised Terravision.

- Wireless monitoring of the city with IP cameras for monitoring of illegal construction/ encroachments by establishment of 63 IP Cameras.
- Establishment of 2 Control Centres and 14 Monitoring Centres.
- Development, hosting / installation and operationalization of the Geo-Portal at the 2 Control Centres to function as a single window Web-enabled Enterprise GIS system through which the line departments will access information and decision support systems using user friendly and customized applications being developed for each department.
- Capacity building for Line Departments of GNCTD.

CONCLUSION

The Indian geospatial community is scaling new heights every day. The pressures of globalization, the need of timely and quality data have fostered collaborations between government departments and private enterprises in their mission to address the National Issues. The mapping policies and guidelines have been reviewed to promote usage of geographic data in every walk of life and spatially enable the government to improve the quality of life of its citizens for development of the nation.