GEO INFORMATION - THE EMERGING SCENARIO IN INDIA

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ABSTRACT

India can improve its per capita income ranking through better management of its rich resources by the use of Geo Information technologies. GIS, Remote Sensing, GPS, Cartography and other related technologies have emerged as highly complementary tools of providing integrated and total solutions. Liberalisation process started in 1991 and the initiatives of Department of Space in granting recognition to a host of private companies provided a boost to privatisation in GI field in India. Massive investments in cadastral surveys thematic mapping infrastructure and agriculture sectors are expected to generate over 21,000 million rupees worth of GI related work in the coming 5 years. Beginning from 1927 the use of Arial Photography evolved from simple manual techniques to the modern softcopy systems. Photogrammetry served the country in mapping on standard scales of 1:25,000 ; 1:50,000 and 1:250,000. GIS applications are operational both in the government and private sectors, thanks to the indigenously available IRS data with spatial resolution of 6 meters with stereo ability. However there are several issues which need to be tackled at policy level to improve the operationalisation of GI technology. Restriction on maps and map related data has impeded the applications. Absence of standard grid for common use on the maps is coming in the way of creating seamless data particularly for large scale maps. Management of spatial digital data bases is another major issue.

1 INTRODUCTION

India situated between latitudes 8° 0' N and 37° 06' N is the seventh largest country with one billion population and a coastal line of over 6000 km. It is endowed with rich natural resources. Yet India ranks low in terms of per capita income. Some countries like Germany, Japan and UK have more density of population than India while their per capita income is 30 to 50 times more than India. Amongst the main factors for this situation are improper/inadequate infrastructure facilities and management systems. GI technology has solutions to improve the situation. It is generally accepted that the biggest gap between rich and poor relates not to capital but to knowledge. Singapore is an example, which has become richer than their formal colonial masters within 3 decades. Considering the revolutionary developments in digital and communication technology, a developing country like India has a phenomenal opportunity to catch up with developed countries by the efficient use of GI technology.

This paper attempts to review the GI scenario in India with a view to identify the emerging trends

2. GEO INFORMATION TECHNOLOGIES

Geo Information (GI) Technology includes disciplines like Cartography, Photogrammetry, Satellite Remote Sensing, GIS, Land Surveying (including GPS) and other earth related technologies. For centuries, these disciplines grew in a manner which gave each of them special identity. Professional bodies were formed related to each of these disciplines. In the recent past, particularly in the last decade of the previous century the borders between various disciplines related to earth sciences showed fading signs. The emergence of the professional body, Indian Society of Geomatics (ISG) in 1993 is an example. Professional bodies related to Cartography, Remote Sensing, Geography, Geomatics, Land Surveying, Geology etc., are hosting conferences, which include papers on GI technologies.

2.1 Mapping & Photogrammetry

Ancient Indian Astronomers Aryabhatta and Lallacharya calculated the diameter of the earth as early as 6th century AD which agrees well with the modern figures. There are references to Greek Geographers (3 rd century BC), Ptolemy (2nd century AD), European Cartographers, Arab & Persian Geographers (9-13 century AD), Dutch cartographers (16 century), Italian cartographers (16 century), English cartographers (17 century) preparing maps of Indian sub-continent.

Survey of India is the first governmental organisation established by the British in 1767 to map the territories under the control of the British. This is a clear indication of the appreciation of the importance of maps for good governance at that time. Legendary figures like Col Lambton and Sir George Everest were involved with the Great Trigonometrical Survey (GTS) started in 1802 to provide control frame work for topographical mapping in India. In 1905, mapping on 1 inch to a mile was taken up.

Earliest survey through aerial photography dates back to 1927 when Chittagong hilly tract was covered. Upto 1950's, simple manual methods (Air survey) were used. Using a set of aerial photographs with postpointed ground control points covering a block, overlapping areas were surveyed and contoured. The standard scale of mapping of one inch to a mile was replaced by 1:50,000 when switching over to metric system in 1956.The first analogue plotter was introduced in 1950. The addition of high precision plotters in 1955 set the pace for the beginning of the modern photogrammetric technology.

The ground/air survey method took about 50 years to cover the country on 1inch to a mile scale. Through photogrammetry it took nearly 25 years on 1:50,000 scale. Through soft copy photogrammetry it may take much less. In 1993, Survey of India developed a system to convert analog instruments into digital systems. There are about 100 analog stereo plotters which can be converted into digital mode and the task is in progress. Most of the existing topographical maps on the three standard scales are overdue for revision.

The following figures give an idea of the magnitude of topographical mapping in the country

Scale of mapping	**Number of Sheets**
1:250,000	394
1:50,000	5,091
1:25,000	19,710

In India, aerial photography is classified as secret resulting in its isolated growth only in Survey of India and recently in National Remote Sensing Agency. Department of Space has been using private companies to use aerial photography and photogrammetry to generate maps and digital data. But an interesting development has emerged in the last few years with the operationalisation of soft copy photogrammetry. Private photogrammetry companies have come up in several cities of India who are processing scanned aerial data from other countries. The prediction by some professionals in the past that photogrammetry may get replaced with satellite imagery as its resolution improves has been proved wrong. When It comes to large scale mapping, there is no substitute to photogrammetry in terms of spatial accuracy and height accuracy. Using Aerial Photography of 1:5000 scale 2.5 cm planimetric accuracy and 7.5 cm height accuracy has been achieved With 1;20,000 scale photography the corresponding figures are 10 cm and 30 cm. In the catalogue of Space Imaging of February '99, there is no clear indication of spatial accuracy and height accuracy of 1 meter resolution IKONOS data

2.2 Remote Sensing

The use of Infra Red (IR) imagery taken from Hasselblad camera from an aircraft for study of coconut disease in Kerala (India) in 1970 can be considered as the first efforts to use Remote Sensing as different from aerial photogrammetry. India's first indigenous scientific satellite Aryabhatta was launched in 1975 marking the beginning of satellite remote sensing. Bhaskara I & II were the two experimental Remote Sensing Missions during 1975-82, before launch of series of Remote Sensing satellites IRS-1A in 1988 , IRS -1B in 1991, IRS-1C in 1995 and IRS-1D in 1997.

Establishment of Natural Resource Data Management System (NRDMS), a multi-disciplinary programme in 1982 mainly for R&D in GIS and National Natural Resources Management System (NNRMS) in 1983 aimed at optimal utilisation of India's natural resources using RS technology can be considered as major steps towards the development of applications of RS technology in India. Regional Remote Sensing Centres and State Remote Sensing Application Centres came into existence for accomplishing the goals of NNRMS. A major aim was to develop an efficient coordination mechanism between space segment, the associated ground segment (for data acquisition, processing and

dissemination) and the user segment spread over the entire country from national level to the sub-regional levels. For this purpose six Standing Committees on Agriculture & Soils; Bio-resources & Environment; Geology and Mineral Resources ; Ocean Resources; Water Resources; RS Training & Technology were formed. The standing committees help in generating national programmes, operationalisation strategies and in improving methodologies. Waste Land Mapping Atlas brought out by National Remote Sensing Agency (NRSA) in 1989 and Integrated Mission for Sustainable Development (IMSD) initiated in 1992 are two major programmes of RS applications. Under IMSD, over 150 Districts have been selected for comprehensive study through GIS based approach combining spatial and non-spatial data/information. Over 700 nodes of Natural Resources Information System (NRIS) have been formed catering to the decision making needs at various levels of administration with net-working already achieved in some States.
In 1980's Department of Space (DoS) initiated an innovative step of encouraging technocrats (including those working in DoS) to start own private enterprises. This marked the beginning of privatisation in the field of Geomatics resulting in more than one hundred active companies in Geomatics.

The spatial resolution level of 36 metres with IRS 1A & 1B reached 6 metres with IRS1-C & D. IRS 1-C carries three imaging sensors - (a) Panchromatic (PAN) camera with spatial resolution of 5.8 metres; (b) linear Imaging self-scanner-III, a multi-spectral camera operating in visible & near-IR spectral bands with spatial resolution of 23.5 metres and a short wave IR (SWIR) band with a resolution of 70.5 metres and (c) Wide Field Sensor (WiFS) operating in visible and near-IR region with a spatial resolution of 188.3 metres and a wide swath of 810 km. IRS satellite data remained the world's best resolution data commercially available till 1 metre resolution data of IKONOS from Space Imaging became available in 1999. OCEANSAT launched in 1999 for exploring marine resources, using indigenous launch vehicle is another mile-stone. India has plans to launch Cartosat with 2.5 metres spatial resolution within the next two years. Availability of indigenous high resolution data in panchromatic mode along with multi spectral data has given a boost to the remote sensing application activity in India. Number of users and applications in the government and the private have been growing rapidly over the last 2 decades.

2.3 Map Conversion & GIS

It is an established fact that the major component in any GIS project is the map conversion part. In India the major source of data is topographical maps of Survey of India which have standard scales i.e. 1:25,000. 1:50,000 and 1:250,000. Survey of India undertook digitisation of maps on 1:250,000 scale for the first time by involving private companies in 1992. It is understood that at that time the cost was around Rs.40,000/- for all the layers of each topographical sheet on 1:250,000 scale. Survey of India is contemplating digitisation of maps on 1:50,000 scale. There are several State and Central Government Organisations who have taken up digitisation and GIS. These include departments of Forest, Mining, Irrigation, Railways, Town Planning, Municipal, Highways and others.

Estimated value of GIS/map conversion in the coming 5 years is indicated below:

Discipline	Indian Rupees (Millions)
Cadastral Surveys	16,500
Topo map digitisation	450
Digitisation/Image Processing for thematic mapping	400
Digitisation of Municipal and town maps	450
Other Digitisation jobs	1,500
Digitisation jobs from foreign countries	2000
	21,300

3. CADASTRAL SURVEYS

In ancient Indian texts there are indications of maps and importance of spatial aspects in management of land and its resources. Reference to the concept of map scale and generalisation of geographical features is found in the ancient literary work *Brahmanda Purana* of 500 BC - 700 AD. *Padma Purana* refers to the custom of offering gifts of maps representing landed property engraved on sheets of gold. Similar references pertaining to town, boundary and construction surveys are found in other ancient and medieval Indian works.

During the reign of *Rajaraja,* the *Chola* King of South India (985-1011 AD), and during the reign of Akbar (16 century) in Northern India Revenue surveys were carried out. In almost all States of India the cadastral surveys are out of date by several decades. In 1970 a pilot project using photogrammetry with aerial photography on scale 1:6700 under UNDP was undertaken covering 8000 hectares. Though the results proved the technical and economic feasibility, the application did not take off due to other factors. In 1993-96, Angul-Nalco cadastral survey project was taken up in Orissa covering 400 villages with 108,000 hectares. Again the debate about the feasibility of using photogrammetry in Indian conditions has cropped up.

AP happens to be the first state in the country to initiate cadastral surveys with the objective of developing a comprehensive Land Information System. In the first phase 15 villages covering about acres (hectares) have been assigned to three different private companies. This is a clear indication of recognising the importance of LIS as well as the need for involving private agencies in a massive task of this nature. The state of Orissa has also initiated a programme of cadastral surveys by involving private agencies. Other states may also adopt this approach of involving private agencies as the task is massive. Some time back the cost was estimated to be around Rs. 2000 million in the coming 5 years for AP state alone. The cost for the whole country is estimated to be about Rs.16,500 million in the coming 5 to 10 years. Ministry of Rural Development, Government of India will share the costs to encourage the state governments to take up these vital surveys.

4. APPLICATIONS & EMERGING TRENDS

As generally observed imagination is the limit for applications in GI technologies. However, some recent application cases reported in newspapers and conferences provide an idea of the trends of applications.

Some examples of Andhra Pradesh (AP) state are quoted which are representative of the other states of India.

A vision documentation has been created for AP state involving various levels of administration and the people to use GI technologies for alround development. The government has identified 12 areas for development and formed sub-committees to monitor and achieve the targets. These areas include people's participation programs, natural resources development, infrastructure development, use of electronic media. Energy Department is undertaking GIS based programs for improving transmission and distribution. In the process, the government has to acquire lands. This stage involves identifying the type of land and comprehensive ownership details. So many other planning and development projects also need this kind of information which is obtainable only through GI technologies. The state has undertaken an ambitious program of releasing 700,000 gas connections in rural areas in a short period of time. Implementation and monitoring of such plans/ schemes are possible only through GI technology.

Telecom Circle of Andhra Pradesh has initiated introduction of GIS based project for their department. The State Survey Department has initiated experimental re-surveys in 3 different areas by entrusting the work of generating Land Information System for the first time in the country. This involved amendment in the existing Act. The state is also contemplating setting up a special authority for the development of Inland Water Ways along with tourism. These developments in the state of AP are indicative of similar trend in other states of India. AP , Maharashtra and a few other states have started using GIS/RS/GPS technologies in various fields like Forestry, Agriculture, Minerals, Rural development. Kerala Forest department has received a credit from IDA for developing forest management information system including GIS. Punjab Forest department is in the process of finalizing tenders for creation of GIS database and procurement of related hardware, software products. State Ground Water Departments all over the country are getting international aid for use of GI technology for building Information and Management Systems

Government of India has a proposal to establish National Water Grid for the balanced utilization of water resources in the country. Flood control measures, liaison with neighboring countries, water management, monitoring water resources development projects will also be covered under this program.

Monitoring the activities along coastline is another important area of GI technology. The Supreme Court in 1996 banned all construction activity within 500 metres of the 6,000-km long coastline in the country.

One of the worst threats to fresh water bodies comes from discharge of sewerage, industrial effluents and surface runoffs. Under the National Lake Conservation Plan (NLCP), lakes particularly in the urban areas are to be identified not only to protect them but also to identify the ones suitable for tourist development.

National Informatics Centre (NIC) has undertaken a project of preparing detailed aerial maps of public utilities in various Indian cities to help planners in effective civic management. This project partially supported by Norwegian

Government includes mapping underground cable system, underground digital maps showing water pipes and sewerage lines. It is expected that various planning bodies will be able to share the data which may be made available through internet.

Another project in the area of water resource management involving people pertains to rain water harvesting. It is expected that a family of 5 persons with 100 sq mt of roof area would have got 1,15,000 litres of water during the year 1998 (based on the rainfall) with the storage capacity of 22,000 litres. In other words, about 250 days of water supply in a year can be available through rain water harvesting without much of investment.

Professional Bodies, government and academic Institutions organise several events with special themes every year. A review of the proceedings of these events clearly reveals that the applications in Photogrammetry, Satellite Remote Sensing, GIS, GPS and other GI technologies are rapidly growing. Department of Space has standardised specifications and prices for most of the standard jobs in GI field. This facilitated assignment of tasks to recognised companies without going through the formalities of tenders. The applications are widely ranging. They include - Land Use, Water resources, Forestry/vegetation, Command Area development in Irrigation projects, Integration of photogrammetry/satellite data/GIS, crop estimation, Microlevel planning, Urban studies, Sugarcane inventory, Tea-Estate management, Soil salinity, Telecom, Crime Monitoring and Business applications.

5. BUDGET & TRENDS OF DEVELOPMENT

Some examples are quoted here to give an idea of the monetary figures and areas of priority for development.

The Indian budget for the year 1999-2000 is about Indian Rs. 20,700 billions and for 2000-2001 it is Rs 33,900 billions. The component for infrastructure covering energy, transport and communications is about Rs. 11,170 billions. The allocation for Rural Infrastructure Development is Rs 450 billions. Government of India under National Slum Development policy for integrated development of slum areas will undertake construction of two million houses for the poor with allocation of Rs.500 billions. 40% villages do not have proper roads while 180,000 villages do not have primary schools within one km as per Planning Commission's norm. 450,000 villages have drinking water problem. Provision for improving the basic needs related to elementary education, drinking water, child health, housing, etc is around Rs 1300 billions. Most of the development activity is area related requiring GI technology support at various stages of planning and implementation. These figures are indicative of the massive investments involved in development activity and the need for generating GI technology based systems.

The Government of AP plans to invest Rs.110, 000 millions in the next 5 years on Tourism Development. The European Union and Birla Science Centre, Hyderabad have undertaken a pilot project related to ground water problem in the country under the Project " Europe and India past, present and future". The project cost is around $ 26millions. Forest Department of Andhra Pradesh has already introduced GI technology by combining the use of Maps, GIS, Satellite Remote Sensing, GPS. They have plans to improve forest cover with an investment of Rs.12000 millions borrowed from the World Bank. AP State has 69,732 habitations and 30,789 villages have been covered under drinking water scheme. More than Rs.50,000 million are expected to be spent in providing drinking water supply in the rural areas. 20,000 areas are included in the Water shed program of AP state each having about 5,000 acres. IDA is expected to provide a support of Rs.3000 million for this program.

The role of infrastructure is crucial in creating wealth in the digital economy. For example, a new highway between 2 locations is bound to increase the cost of surrounding land leading to wealth creation. In Andhra Pradesh the land value which was Rs.15 per sq yard for nearly 10 years shot up to Rs.3,000 per sq yard within a span of one year mainly due to the setting up of Hitech City in that area. According to Nobel Prize winning economist Prof. Amartya Sen, dissemination of information is the key to a successful program of decentralization of the economy which is one of the key factor of planning in India.

The Tamilnadu government has earmarked a massive Rs.75,000 million outlay for road development in the ninth 5-year plan. There is a separate project for construction of bridges. The Highways department of Tamilnadu has engaged private companies to undertake the road projects. The total length of state highways is 4,192 kms.

AP state has also plans for road works in 14 districts out of 22 districts at a cost of Rs.300 million.

Losses due to droughts and floods in India are huge every year. In one state alone in 1999, the loss due to drought conditions is estimated to be over Rs. 2300 million (US $55 million approx.) This is a recurring phenomenon in several states every year. Besides reducing the loss, the use of RS and GIS based technology will also be saving human and cattle life.

Several States in India have set up Hitech cities and the estimated outlay is around Rs.15,000 millions for each Hitech City. Some Hitech cities are already functional. Foreign companies from the field of GI technology have also established their activities in collaboration with Indian counterparts in these cities. Several more plans of such collaborations are in the offing. Under the Software Technology Park of India, government and private companies are getting linked with other countries for receiving and sending digital data. These types of developments with focus on infrastructure facilities are paving the way for the growth of GI technology in India.

6. ISSUES

The rapid technological changes are imposing pressures on the existing systems. Periodical evaluations are needed to identify issues needing attention. To a great extent the conferences are serving this purpose. Some issues considered important are covered here.

6.1 Access To Data:

This is an issue, which is related to the issue of right of access to information. At present, there is no law regarding right of access to information. The Govt. of India is considering introduction of a bill related to this. Out of over 5000 sheets on 1:50,000 scale covering the country 2,560 are restricted. As far as the map data is concerned, there are several restrictions which include the following:

1) Ground control data is made available to an accuracy of half a minute and height data to 1 meter.
2) Guide maps in restricted zones need clearance from the Defence.
3) Maps with Lambert grid (gridded maps are restricted). Several committees and conferences came out with recommendations for liberalization of restriction policy in view of the changing scenario particularly in view of the availability of high resolution satellite data. An interdepartmental committee set up by Govt. of India, in its report submitted in July '89, gave several recommendations to improve the situation. One of the major recommendation was to bring out tailored maps on scale 1:250,00, 1:50,000, 1:25,000 and large scales for civil use.
4) Digital data of topographical maps.

6.2 Datums & National framework

In India the datum for horizontal control is Everest Spheroid (1880). This is not geocentric. Rigorous adjustment of control network has not been possible. Further, the control provided in the country suited scales upto 1:25,000 which is not suitable for large scale surveys. Indian vertical datum (MSL) was established in 1909 based on nine tidal stations around the Indian coast. The level net-work was adjusted without the use of gravity values causing errors of several centimetres from West to East coast. Thus there is a need for redefining horizontal and vertical datums. There is also a need to adopt a national grid (in metres) which has to be shown on all maps to maintain compatibility and to facilitate exchange of map data between various organisations for building reliable and uptodate digital spatial data bases for operationalisation of GIS.

6.3 Co-ordination

One of the problems of GI field is related to the management of the change brought about by the rapid developments. Most of the departments are involved in generating data bases and adopting GIS based approach. Sharing, ownership, storage, security and other issues have no ready-made solutions. There is no central coordinating body at national and sub-national levels. There is no system for validating digital data generated by various agencies from various sources/combination of sources. Under utilisation of available data including satellite data is another issue needing attention.

6.4 Training/Education/Research

In Tamilnadu, Anna University offers PG course in Geomatics. Survey of India and NRSA organise regular courses in Geomatics. Research is very limited. Most States have training Institutes for cadastral surveys. Thus there is a need to examine this issue and establish suitable facilities to meet the growing human resources needs in GI technology field.

CONCLUDING REMARKS

Liberalisation measures initiated in India in 1991 have brought about visible changes in the scenario which was predominantly monopolised by the government. A market driven economy supported by a political has catalysed development. Profit is no longer a dirty word. The country is moving towards an effective Public-Private Partnership(PPP). This will ensure in establishing a right balance between the profit motive and social objective. The IT revolution underway has GI as its major component. Leading international vendors of popular products in Geomatics are active in India for the last several years. Several Indian companies in GI field have tie-ups with leading international companies. A good indicator of steady growth in Geomatics in India.

For the massive investments envisaged in annual and five year plans, use of GI technology is essential. It is encouraging that government of India has a special IT Ministry supported by Task Forces. In fact, the use of GI technology should be made mandatory where appropriate as in the case of World Bank assisted projects.

Democracy and decentralisation go together. Information flow has to be free from hassles. In Andhra Pradesh State-wise Area Network with video-conferencing facility is already in operation. This kind of arrangement is at various stages of planning and implementation in other states. For deriving full benefits of the IT revolution, it is necessary that there is a law related to right of access to information. Steps are being initiated in this direction.

Remote Sensing, Photogrammetry, GIS, GPS, Cartography and other related technologies have emerged as complementary technologies providing integrated and total solutions to most of the planning and development issues. India is striving hard to derive and disseminate the benefits of GI technology in the larger interests of society.

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