SWOT analysis of geographic information: The case of India

Ravi Gupta

Centre for Spatial Database Management and Solutions (CSDMS), A-13, Sector 22, Noida 201 301, India

Geographic information is today being extensively used in decision making processes because it has become a fundamental element to provide better understanding about one's surroundings. Sustainable development relies on the control of the consequences of public decisions regarding natural resources, people and the involved interrelationships. More importantly, geographic information is a tool of democracy, which must be used in public debate as it enables visualization of the impact of planning decisions on society and to explain the rationale behind a particular decision. Today, most of the countries are set to exploit the potential of mapping technology. The present paper provides a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis of the Indian geographic information situation using the international scenario as a backdrop.

1. Introduction

Geographic Information Systems (GIS) promises greater efficiency in commerce, improvements in environment, health, safety, increased convenience for consumers, more citizen participation in governance and improved public and private decision making in general. But, legal regimes for protecting and managing compilations of digital spatial data are underdeveloped and unclear all over the world. The concepts of ownership of digital spatial data, protection of privacy, access rights to spatial data compiled and held by governments, and information liability are still evolving in the context of GIS and spatial data.

GIS may be defined as a tool that uses the location at which an object exists or an activity occurs as a unifying concept across which information in a variety of forms may be merged, referenced, sorted, and analysed. Reality is represented by a set of mapped space where every attribute or event of concern has either a direct or indirect locational element. GIS enable the planned systematic collection, maintenance, and management of location-based information and the automated processing of that information. The computerized integration of information through spatial links has the ability to greatly enhance decision making across a wide range of applications[1].

Governments are spending billions of dollars on collection of geographic information knowingly or unknowingly. For example, US spends more than 4 billion dollars per year on geographic data acquisition[2]. In France, the public financing of geographic information projects represents 0.17% of public development aid[3]. Other countries are also spending huge amount of money for data generation, acquisition, documentation and dissemination. Recent estimates show that the worldwide investment in GIS technologies by government and private sector ranges from US $3.3 billion[4] to more than $8 billion[5,6] with annual growth rate reaching nearly thirty per cent.

And surely these investments are not without reasons. A report by the Economic Studies and Strategies Unit of Price Waterhouse on the economic benefits arising from the acquisition and maintenance of the nation's land and geographic information has estimated that for the period 1989–94 approximately $1 billion has been spent in Australia on investment in geographic data. This investment produced benefits within the economy in the order of $4.5 billion. The study also found that this investment has saved users approximately $5 billion. This implies that there is a saving of $5 on the investment of $1. The study concluded that the existing infrastructure for supplying data had provided information to users at low cost than alternative methods. If this infrastructure had not been in place, and users had been forced to meet their data requirements from other sources, their costs would have been 6 times higher; if the benefits are to continue, an additional investment of 30% of existing funding levels will be required to meet the growing demand for data usage[7]. Thus it is clear that governments all over the world realize that geographic information is an important infrastructure for a nation's development. The government is the biggest geographic data generator. It happens to be the biggest consumer also. In India, for example, out of Rs 14.30 crore revenue of National Remote Sensing Agency (NRSA) from sale of remote sensing imagery in 1998–99, 83% revenue was from the government departments themselves[8].

e-mail: Ravi.Gupta@csdms.org

2. International trends in geographic data collection and dissemination

In the era of information revolution, information is playing the key role for the growth and development of a country. The international community sensed the global shift in capital-intensive economy to knowledge-based economy long back. In addition, many countries have realized the importance of geographic information for economic growth and environment sustainability and its relationship with the knowledge-based economy. Several countries which took the initiatives in developing their geographic information infrastructure include not only the developed ones such as US, UK, the Netherlands, Canada, Australia, Japan but also Qatar, Korea, Portugal, Malaysia and Indonesia (Table 1). These countries have varied kind of administrative set-ups. Most either already have or are fast building up well-defined systems for geographical data collection, documentation and dissemination. For example, in US responsibilities related to geographic information have been delegated to over 80,000 separate state and local government agencies. In some countries with non-federal systems of government, most of the geographic information is handled centrally. There is no economic similarity among these countries that prompted them to take initiatives for geographic information. Some of the countries are big in size like Canada, Australia and US while others are small like Qatar, the Netherlands, Portugal and Korea. Some of the countries are very rich and some are poor. Probably, the driving force pervading all across the spectrum was the realization of the potential of geographic information in development planning and economic growth[9].

Let us discuss some of the initiatives.

US

In 1994, the National Spatial Data Infrastructure (NSDI) was signed by President Clinton, directing the federal agencies to carry out certain tasks to implement the NSDI. The Executive Order created an environment within which new partnerships were not only encouraged, but required. More importantly, it raised the political visibility of geographic data collection, management and use nationally and internationally. The NSDI Executive Order mandated that federal agencies use all FGDC-adopted standards. A data clearinghouse was made operational. Achievements have been made in formulation of standards and creation of clearinghouse of metadata[10].

The objectives of NSDI initiative include the following[11]:

- To identify both users and providers of spatial data. Only in this way it is possible to create an infrastructure which meets everybody's needs.
- To encourage the development of partnerships, and/or consortia for creating geographical data for the various programmes in government, academic institutions and the private sector.
- To provide a forum for users to share their interest. In this way, hopefully through consensus, an appropriate infrastructure can be established.
- To promote information interchange through seminars. The task of undertaking such a development requires that there be a full understanding of the needs of all parties.
- To encourage connections between federal state and local governments, as well as the private and educational sectors, etc.

Table 1. The first generation of national geographic information strategies[9]

Australia	Australian Spatial Data Infrastructure
Canada	Canadian Geospatial Data Infrastructure
Indonesia	National Geographic Information Systems
Japan	National Spatial Data Infrastructure
Korea	National Geographic Information System
Malaysia	National Infrastructure for Land Information Systems
The Netherlands	National Geographical Information Infrastructure
Portugal	National System for Geographic Information
Qatar	National Geographic Information System
United Kingdom	National Geospatial Data Framework
United States	National Spatial Data Infrastructure

UK

In 1995, the National Geospatial Data Framework (NGDF) was designed in UK as a facilitator with a mission 'to develop an over-arching UK framework to facilitate and encourage efficient linking, combining and widespread of geospatial data which is fit for the purpose'. The objectives of NGDF are to facilitate and encourage collaboration in the collection, provision and use of geospatial data; and facilitate access to geographic data. NGDF will set a framework for defining business-driven standards, best practice and specifications of data and services, drawing on existing national, European and international work[10].

Australia

The Australian Land Information Council was set up in 1986 by an agreement between the Australian Prime Minister and Heads of State Governments to coordinate the collection and transfer of land-related information between different levels of government and to promote the use of that information in decision making. When

New Zealand joined the council in 1991, the council was renamed as the Australia New Zealand Information Council (ANZLIC). The ANZLIC is promoting actively the concept of Australian Spatial Data Infrastructure (ASDI) to provide fundamental data needed to support decision making. ANZLIC ASDI model comprises four linked core components – the institutional framework, fundamental data sets, technical standards and protocols to ensure compatibility, and clearinghouse networks[7].

Europe

EUROGI – the European Umbrella Organization for Geographic Information, was set up in November 1993, with the aims of promoting, stimulating, encouraging and supporting the development and use of geographic information and technology at the European level; and representing the common interest of the geographic community in Europe. The members of EUROGI are national associations for geographic information and pan-European organizations working with geographic information. Many of its 17 national members are very active in the development of their national spatial information policies and infrastructures[12].

The situation is fast changing in most of the European countries. Norway is a country that has the jurisdiction with a general freedom of information legislation. This gives any member of the public the right to access the 'documents' of a specific case, and by regulations this right was in 1985 extended to computerized files, using an analogous document concept. In Germany, traditionally, public agencies have been unwilling to give free access to geographic information for commercialization. The situation has changed as private sector has realised the potential of geographic data and has brought pressure on the government to make geographic information available. Also, government agencies themselves realized that geographic information may be a source of revenue. The Geological Institute of Hungary has initiated a national programme for systematic generation of aerial data acquisition and utilization. The proposal has been integrated as part of the modernization programme of the government. The programme proposal emphasizes the need for a co-ordinated development of a national, integrated system for the distribution of databases, information sharing and a public service for easy access to metadata through a data clearinghouse service including efficient searching capabilities. In the Netherlands, the government regularly supplies data to the private sector, while for geographic information the revenue almost exclusively is generated from the sales[13].

As is clear from the above, the countries with the most developed geographic information markets are also those where there is a particularly strong intermediary sector of service or value-adding companies. This intermediary sector is developing using the raw materials constituted by reference data, on the two-fold condition that they exist and are accessible. A much more open circulation policy – with a programme for the production on demand of maps originating in the Ordnance Survey's data bases by private companies under licence – enables British companies to tackle new application sectors and to reach clients who are unknown to the national agency[7].

Geographic information infrastructure makes sense when the data documented are disseminated also. However, information dissemination strategies are different in different countries. We can take the two extreme examples. In US, most of the data generated by the government agencies becomes part of the public domain whereas in UK, all the data generated by the government comes under Crown copyright and comes to public domain only after the expiry of copyright. In US, the data are available at the cost of dissemination or less whereas the UK government insists on cost recovery from the end user (Tables 2 and 3). The data dissemination strategy in many other countries lies somewhere in between these two extremes[14].

3 SWOT analysis

3.1 Strengths

3.1.1 Good geographic information acquisition infrastructure

India has a good institutional infrastructure for geographic data collection. There is a network of institutions collecting information on every conceivable socially and scientifically relevant subject. The Survey of India and the Indian Remote Sensing Satellites are the most important generators of geographical data.

Survey of India. The Survey of India (SOI), which was established 232 years back in 1767, is responsible for all topographical and development surveys in India. India, with an area of 32,87,263 km^2, is covered by both topographical maps and geographical maps. The topographical maps are on scales of 1:25,000,

Table 2. Departmental revenues from Crown Copyright in 1996–97 (ref. 13)

Type of revenue from information service	Million £
Direct sales	128
Royalty	4
Licensing	25
Data supply	40
Total	197

Table 3. Expenditure, revenue and % cost recovery for various UK government information providers in 1994–95 (ref. 10)

	Expenditure (£m)	Revenue (£m)	% Cost recovery
Central Statistical Office	49.5	1.9	4
Office for Population Censuses and Surveys	70.0	38.0	54
Meteorological Office (includes research revenue)	141.0	57.0	40
British Geological Survey (includes research revenue)	40.0	24.0	60
Hydrographic Office	37.9	22.0	0
Ordnance survey	74.8	58.6	78
Registers of Scotland (cadastral organization)	29.6	31.5	106
Her Majesty's Land Registry (cadastral organization)	197.4	235.6	119

1:50,000 and 1:250,000, which are ideally suited for the professional work of geologists, geographers, foresters, engineers, planners, tourists, trekkers, mountaineers and others.

India is covered by nearly 385 toposheets on 1:2,50,000 scale and these are also called as Degree Sheets. Each degree sheet has 16 toposheets of 1:50,000 scale and at present the entire country is covered by 1:50,000 rigorous metric surveys in more than 5000 toposheets. This is undoubtedly an impressive record for any country in the world. Each 1:50,000 scale sheet contains four 1:25,000 scale sheets. More than 35% of the country has also been covered on 1:25,000 scale. Therefore, there is no dearth of modern toposheets[15].

Indian remote sensing programme. The satellite based remote sensing was established in the country with the launch of the first operational Indian Remote Sensing Satellite, IRS-1A in 1988 which was followed by the successful launch of IRS-1B in 1991. IRS-1A and 1B satellites provide imagery with spatial resolution of 72.5 m and 36.25 m respectively. These satellites have been providing data for monitoring and management of our natural resources and environment. IRS-1C and IRS-1D launched in 1995 and 1997 respectively incorporate enhanced capabilities in terms of spatial resolution, spectral bands, stereoscopic imaging, Wide Field Coverage and revisit capability. They provide 5.8 m spatial resolution in panchromatic mode. India also launched Oceansat in 1999 with Ocean Colour Monitor (OCM) and a Multi-frequency Scanning Microwave Radiometer (MSMR) on its board. India plans to launch Cartosat with 2.5 m panchromatic data resolution by the year 2000. This satellite will have a cutting-edge technology in terms of sensor systems and provide state-of-the-art capabilities for digital terrain modelling, contour mapping (~5 m contour levels) and many specific needs of cartographic applications. The data provided by Cartosat will be useful for giving cadastral level information.

The Indian Remote Sensing programme has been a major factor for the growth of importance of geographic information in India. The National Natural Resource Management System (NNRMS) programme by the Department of Space has played a key role in using the capabilities of the Indian Remote Sensing satellites for the benefit of the masses[16].

Other institutions involved. Many other agencies and initiatives of the government like Natural Resource Data Management Systems (NRDMS) and National Atlas and Thematic Mapping Organization (NATMO) under the Department of Science and Technology, National Informatics Centre have played an important role in geographic data generation in the country. Hosts of other organizations under various central and state governments are also involved in geographical data acquisition in the country. A summary of the main data producers is provided in Table 4. Moderate estimate of the total budget of the listed organizations in the table is more than Rs 2,000 crores per year, which is comparable to spending done by Australia or US, if we take the operating costs in these countries are nearly seven times that of India.

3.1.2 *Growing demand for GIS*

The first system of geographic information appeared in India perhaps in the late 1980s. By late nineties the demand picked up and a market for GIS-related software, data and services came into existence.

The technological developments in computer hardware and software contributed greatly to the growth of GIS market in the country, with the market really taking off with the development of powerful desktop PCs. This evolution was encouraged by political and administrative decisions, like the Prime Minister's Task Force on Information Technology, e-governance initiatives by many states of the country, decentralization initiatives, etc.

According to International Data Corporation (IDC), a leading IT-related market research organization, the GIS market in India is expected to grow from Rs 29.0 crore in 1996–97 to Rs 79.0 crore in 1999–2000. The relative share of the GIS market in the design software

Table 4. Status of data policy/practice indicators in data and data-generating agencies in India

Data type	Name of agencies involved	Ministry of	Paper data	Digital data	Web site	Use of web site for data dissemination
Meteorological data	Indian Meteorological Division	Science and Technology	Y	N	N	N
Environmental data	Central Pollution Control Board (CPCB)/National Environmental Engineering Institute (NEERI)/WWF/Forestry Survey of India	Environment and Forests	Y	N	N	N
Mapping data	Survey of India	Science and Technology	Y	N	N	N
Remote sensing data	National Remote Sensing Agency	Space	Y	Y	Y	Y
Information on buildings (at national or local level)	Local Government	Rural Areas and Employment/Urban Affairs	N	N	N	N
Cadastral registers	State Government	Rural Areas and Employment/Urban Affairs	N	N	N	N
Geological data	Geological Survey of India (GSI)	Mines	Y	N	Y	N
Botanical data	Botanical Survey of India	Agriculture	Y	N	N	N
Agricultural data	National Bureau of Soil Survey, All India Soil and Land Use Survey	Agriculture	Y	N	N	N
Thematic mapping	National Atlas and Thematic Mapping Agency	Science and Technology	Y	N	N	N
Census data	Census of India	Home	Y	N	Y	Y
Watershed data		Agriculture	N	N	N	N
Data on river basins	Central Water Commission	Water Resources	Y	N	N	N
Oceanographic data	National Institute of Oceanography	Ocean Development	N	N	Y	N
GI laws	Defence	Defence	N	N	N	N
Ground water data	Central Ground Water Board	Water Resources	N	N	N	N
Statistical data	CSO (Central Statistics Organisation)	Planning and Implementation	Y	Y	Y	Y
Information systems	National Informatics Centre	Planning Commission	N	N	Y	Y

market is expected to increase moderately from 16.1% in 1996–97 to 19.1% in 1999–2000. According to NRSA, the sale of its data products grew from 5.83 crores in 1994–95 to 14.30 crore in 1998–99, an increase of more than 100%. The industry projects the GIS industry growth at 35–40% during the next few years[17].

Development of the geographic information market in the country has contributed to the creation of a new group of companies dealing in software, value-added data, and services. The initiatives by NRSA and Space Application Centre (SAC) in vendor development have been creditable. More than 100 companies mainly in Hyderabad, Bangalore and Delhi are into this business. The GIS service industry is expanding at 10–15% per annum[18].

India is also fast emerging as a data conversion centre for GIS. The GIS companies from USA, Europe, Japan, Australia have either started operating directly or are subletting work to Indian companies. This has created enormous employment opportunities in the sector, which is leading to proliferation of this technology.

4. Weakness

4.1 Data access to the public is not easy

In India, it is extremely difficult to access any government-generated data. Moreover, existing datasets have been collected to different specification making it difficult to integrate the data collected from different sources. Very often, the agencies collect and utilize their own data as part of their institutional mandate and therefore are less concerned with the problem of access to public domain data and it is unlikely they provide data to other major players. Most of data-generating agencies do not have the mandate for data dissemination. This results in *ad hoc* arrangements that benefit neither the government sector as a whole nor the private sector, which functions in a climate of extreme uncertainty. As mentioned in Table 4, very few data generating agencies have websites and even fewer of them put any worthwhile information on their sites. This reflects the poor appreciation of these organizations about the

Table 5. A comparison between India and international scenario

Parameters	India	International*
Mechanics of data access	Paper data sale through SOI offices	Clearinghouse nodes, websites, E-commerce, etc.
Private sector involvement in data generation, dissemination	Nil	In most of the countries
Digital data availability	No	Yes. Now vector data being also provided in addition to the raster data
Public domain datasets (available for free)	Nil	Few in most of the countries. US is an exception.
A strategy for national spatial data Infrastructure	No	Yes
Metadata	No	Process going on in most of the countries.
Data clearinghouse	No	Yes in many of the countries
Data standards	No	Yes
Core data accessibility	No	Yes
Access to govt. information	No	Yes
Data dissemination policy	No	Yes
Data pricing policy	No	In some of the countries
Driving force for spatial data infrastructure	No focussed programme One of the agendas of Indian Remote Sensing Programme/IT Task Force	Focussed initiatives for geographic information
Information economy	Poor	Rich
Freedom of information	No	In some of the countries

*International: It refers to US, major European countries, Canada, Australia, Japan, Korea, Qatar, Indonesia, Malaysia.

importance of information dissemination. Most of the organizations are plagued with severe 'vision crunch' in terms of the importance of the data for the people outside their organization.

4.2 The geographic data

Coming specifically to the status of geographic data, the situation is worse. Maps of restricted areas are not easily accessible. Aerial photography is virtually banned. Digitization of Survey of India toposheets can be done by only a few government agencies. Digital data are not available with most of the data-producing agencies and at times even analogue data are not accessible.

The situation is grim compared to most of the developed countries (Table 5). The differences between India's and others' approach to geographic data are discussed below:

- *Mechanics of data access, i.e. the technical and organizational mechanisms through which spatial data are made available to the citizens:* In India, except for the selected paper data sale by few agencies like Survey of India (SOI), Geological Survey of India (GSI), National Atlas and Thematic Mapping Organization (NATMO), etc. there does not exist any system for data accessibility. In most of the countries, discussed in the section 2, there is a system, which is either well placed or taking place for data accessibility.

- *Role of private sector, i.e. involvement of private sector in data generation, and dissemination:* In general, throughout the world, the private sector participation has been envisaged for the growth of GIS industry. In US, even small vendors get ample opportunity to flourish by getting at low or no price government data and by claiming their copyright after doing value addition[2]. In Canada, private sector works in partnership with government in data dissemination. In UK, private sector can access the data, after paying for it[14]. In India, data are not accessible to private sector and surely not for commercial purposes.

To illustrate the difference between the opportunities for private sector in India and abroad, we take the case of US. Unlike SOI, the United States Geological Survey (USGS), 1:24,000 scale topographic maps are the basic scale maps for the USA and are not protected by copyright. They comprise some 57,000 sheets. Projections for integrating and updating them into coherent digital topographic database do not foresee completion until the early 21st century. It is technically and legally feasible for a low-labour cost developing nation to purchase the maps and digital files at minimal cost, update them from commercially available remotely-sensed imagery according to market priorities (there would be no need for them to deal with remote and sparsely populated areas unless it was profitable), and resell the maps now claiming commercial copyright[19]. In India, such

a situation is unimaginable. We have rules and regulations that discourage market forces.

- *Digital data availability:* It is important to have the data in digital form as it can be circulated and exchanged at high speed. It can be duplicated without deteriorating and combined with other information to create new information, etc. Most of the countries are introducing amendments to their existing legislations to incorporate the provision of the supply of digital data. For example, in Norway, analogue data are exception and digital data is the rule[13]. In India, digitization of maps can be done only by some of the government agencies and NGOs working with them. Commercialization of digital data is not allowed.

- *Public domain data sets, i.e. digital spatial data sets that are available to anyone without licensing or intellectual property restrictions at no cost or little cost:* Anyone can take these data and use it and even customize it as per the requirement. In US, most of the government-generated data are in public domain and these data are available either free or at the cost of dissemination. To the contrary, in UK, government-generated data come to public domain only after the expiry of copyright. In India, huge amount of valuable data sets have the potential to go to public domain[20]. But at present, only few data are available in public domain. Some of the data may be available at price but in general data are not available in public domain[21].

- *National geographic information infrastructure:* Several countries have been evolving a system for their spatial data at their central/national level. These systems envisage proper data collection, documentation and dissemination. For example, the uniqueness of the NSDI (in US) is based on the idea that it is impossible for a federal committee to muster the resources necessary to build a national data infrastructure by itself, and that it is necessary to bring together the appropriate organizations and the individuals who generate, or use geographic information in order to expedite this onerous task[11]. In India, it is understood that SOI is planning to evolve a centralized digital geographic information infrastructure. Given the enormity of the work involved, probably it should involve other players in developing geographic information infrastructure as it may not be possible for a single agency to complete the task in the near future.

- *Metadata, i.e. information about what kind of data is available, where it is available and with whom it is available:* In US, a system of clearinghouse, from where various kinds of (spatial) data is disseminated, is operational[10]. Most of the countries are striving to develop the metadata of their datasets. In India, there is no such effort so far.

- *Core data accessibility:* There are some basic data which government provides either free or at cost. There exists at least a strategy in several countries to make these data available. In India, even if these data are available, people are not aware of them and at times the custodians of these data themselves are unaware about their existence.

- *Access to government information:* In US, government information is available at or less the cost of dissemination, free of cost or at the cost of dissemination. In UK, government information is available at a price. Situation in other countries lies in between UK and US. In India, government practices data secrecy policy[14]. In fact, the fundamental issue that needs to be addressed to deal with the issues related to data accessibility is freedom of information. It is important to have this as a fundamental right. The Norwegians have enjoyed this right since long[13]. In India, such a proposal on Freedom of Information is in pipeline. Some of the state governments, such as Rajasthan, Goa, Madhya Pradesh and Delhi are in the process of implementing some form of right to information.

- *Data pricing policy:* Whether data should be priced at all and if yes, which document and at what price, needs to be defined. All these issues should be addressed in a data pricing policy. The pricing structure is essential for commercialization of geographic data. In India, there is no well-defined policy in existence.

- *Driving force for SDI, i.e. the dynamics of forces, which give the shape to spatial data infrastructure:* These forces may be the government, private sector, international pressures, etc. India after liberalization in economic policy is feeling the pressure for SDI development. The Indian Remote Sensing Programme and IT Task Force have played a positive role in creating a conducive atmosphere for SDI in India.

It is clear from the above that the major impediments to the widespread and successful use of geographic information in India are not technical, but political and organizational. There is a lack of concerted action and political critical mass at both state and national level. Attempts to develop a coherent information policy are likely to be opposed by sections advocating conflicting goals. There is no national mandate on geographic information. This retards development of information strategies and causes unnecessary costs, and stifles new

goods and services. Worse, there is lack of awareness among the decision-maker at all levels. Geographic information arena in India is still immature with broad set of issues yet to be resolved (as described in Table 6). There is no cohesive geographic information community that can take up these problems with the top echelons of the government.

5. Opportunities

India can benefit from a visionary policy on geographic information. Let us look at the available and emerging opportunities.

1. India has a well-developed software industry and skilled and well-trained software engineers. The GIS software industry can be used to reduce the cost of public service and increase efficiency.

2. According to India's National Association of Software and Service Companies (NASSCOM), IT-enabled services have emerged as the new 'big' opportunity for India after the Y2K services. These services are expected to generate over 1,000,000 new jobs and an export revenue of Rs 80,000 crores over the next 10 years. GIS is considered as one of the high 'value add' IT-enabled services. But, it has also to be realized that unless India moves quickly enough, we may lose out this opportunity to other low-cost service nations. According to an estimate, the total export market size of Indian geographic information is around US $40–50 million, and it is growing at a rate of over 40%[18]. Similarly, the opening up of the South Asian countries (Nepal, Bangladesh, Sri Lanka, Bhutan, Pakistan) to a market economy is giving rise to a high demand for geographic information. These countries are spending millions of dollars in programmes financed by the big international funding agencies every year. These markets represent essential political (extends the Indian presence in various countries and helps in improvement of relationships) and economic stakes.

The possibility for Indian companies and experts to participate in these important programmes very much depends upon the exemplarity of the national model and the capacity of companies to promote and sell it. Due to the small domestic market for GIS, there is no training ground for companies to experiment, learn from failures, take risks and innovate. Thus Indian companies are unprepared to take on international competition. The restrictive and unclear government regulations inhibit the growth of the domestic market, which in turn prevents Indian companies from showcasing their skills in the international arena. The lack of experience of Indian companies also dissuades foreign tie-ups in the domestic market, which discourages import of new technology[18].

3. The emerging market of geographic information opens up ample opportunities for the geographic information generating agencies such as SOI, NATMO, India Meteorological Department to exploit the market potential and earn revenue for their respective departments. They can become self reliant by selling the data after doing the value addition and making their data more user-oriented. As is clear from Tables 2 and 3, the UK experience shows that government can earn its investment in data generation. This model, if adopted in India, may motivate the data acquisition agencies for development of more user-targeted strategies for sale of data.

6. Threats

If we don't do it, someone else will

There is an urgency to act for the simple reason that if we do not start providing services to our countrymen, someone else will. For example, Microsoft has launched MapPoint, a desktop map visualization and analysis software at the cost of $109. And this includes US demographic data for 1980, 1990, 1999 and 2003. The data includes population, household sizes, household income, and median population by age. By 2000 MapPoint for UK and by 2002 MapPoint for Europe will be out. If the pace remains same, no doubt by 2005-MapPoint for Asia (including India) may be in the market, provided the government does not come in the way. The revenue which SOI or any other agency may have earned, will then be earned by someone else.

Reduced international and global competitiveness

Yes, India does lose its global competitiveness by not making available core set of data to public. Like electricity, water, clean air, good human resource, information is also a vital factor for attracting investments, increasing tourism, boosting trade and improving quality of life of the masses. So instead of finding n number of reasons to hide data, we should try to look for $n + 1$ reasons to share data.

Continuation of adopting costly ad hoc solutions

In spite of the spending by India on geographic data acquisition being comparable to any other developed nation, the benefits have been relatively low. This will continue unless we develop synergy between various stakeholders.

Table 6. Micro-level issues in geographic information scenario in India – an analysis

Problem	Possible solution approach	Possible problems foreseen by the government	The escape routes in vogue	Implications of government not accepting the solutions
Digitization of SOI topomaps not allowed	Digitization may be allowed at least for non-restricted areas. A fee may be charged for commercial applications	Loss of control of data	People forced to digitize SOI maps 'illegally'. They don't acknowledge SOI name. Instead they acknowledge NRSA data/NATMO maps as the data source	SOI loses its moral right to be known as producer of the data
No clear-cut policy on import of Indian maps from outside India	A clear-cut policy on import can make life easier for map user	Assumes that no maps are available abroad	Users are getting the required maps secretly from abroad, which may not be accurate	People lose faith in the system
Restrictions on export of maps	Remove the restrictions	Government feels that maps exported will lead to increased security risks	Digitization and export of maps through Internet going on	Private agencies are making profits at government's expense
Maps of Restricted Areas	Ease restriction	Access to restricted maps will increase security risk	Restricted maps being imported from abroad	Indian scientists and private companies suffer because of restrictions
Geodetic Data Restricted	Soften the restrictions keeping in mind the data already available with foreigners	Access to geodetic data will increase security risk	Scientists forced to get data from abroad	Hamper the S&T growth in India
No Right to Information	Implement it	No political motivation to implement	Beg, borrow or steal principle for data access being used	Government loses the revenue it would have generated by selling data Public loses a chance to benefit from the information collected by its money
In all data dissemination activities only government considered as a consumer of data	Public should be the main consumer	Government runs the country. Not the NGOs or private sector. So no question of giving them the access	Beg, borrow or steal principle for data access being used	Lack of public participation in government decision making
Mandate for data dissemination	There should be mandate	Too busy in data generation to think of dissemination	Selective data leakage done by the government depending on its comfort	Duplication of costly data generation efforts

We lose like Europe

Although some of the European countries like UK and France were the first to be covered by classic cartography which gave them a strong position on a technical, scientific or commercial level, the move towards digitization of information was slow and her position among competitors fell[7]. Now the US companies have captured 80% of the European GIS market. The European companies have just 20% market share in European market and 5% in the global GIS market[22]. By this, can we say that nearly 100% Indian GIS product market is dominated by foreigners? We do not seem to be having a strategy to change this situation.

Lack of control of information on one's own territory

Although the Indian citizens are denied access to any border area maps, many of the old maps of these areas are available freely outside India. Is the same going to happen to the updated large scale maps of whole of the country? With the spy satellites hovering upon us and monitoring each and every minute's activity of the country, there is little left to hide. SPIN 2, the Russian satellite is already selling its 2 m resolution data on the web at www.terraserver.com. Indian Remote Sensing satellite with 5.8 m resolution and IKONOS satellite with 1 m resolution are already in place. Thus it is very difficult for countries to hide geographic information, and instead of being in a reactionary mode, we will have to adopt a pro-active approach regarding geographic data availability. The control of information describing one's own territory and the autonomy of decision models using this information are a major part of independent political decision making. India must endow herself with the means to surpass and be more dynamic than the global trends. Accelerating the process of quality digital data coverage of the territory and India's con-

trol of earth observation satellite technology are the primary means to guarantee autonomy in her choices.

Will the patent experience be repeated in case of maps?

Important projects exist today, which aim to build up data bases of geographic information on South Asia, and also on the whole world. These are the Regional Geographic Information Infrastructure (RGII) project of UN, Earthmap projects of American institutional stakeholders, Japan's Global Mapping programme, etc. In spite of the Indian technological leadership in Remote Sensing and software technology, Indian organizations have been taking an increasingly limited part in international bodies. Whether it be the UN's specialized commissions, international standardization organizations like ISO, India's seat is empty or only symbolically occupied. However, an active presence within these bodies means preventing them from taking options which are prejudicial to the interests of national companies and gaining recognition of expertise, which is a first step towards intervention in the definition of the major international projects. Indeed, the limited presence of national experts' in the upstream phases of projects would appear to be one of the causes of the limited performances of national companies in terms of turnover. All the players must mobilize to ensure this presence and an organization, for instance the Department of Science and Technology or Indian Space Research Organisation initially, must be in charge of making sure that India is present effectively in all these bodies.

Our limited or no presence in international bodies can be illustrated by the following example. The international body ISO/TC 211 is working in the field of standardization of digital geographic information. In this organization the presence of India is only as an observing member along with Bahrain, Brunei, Darussalam, Columbia, Cuba, Estonia, Hong Kong, Iceland, Mauritius, Oman, Pakistan, Poland, Slovakia, Slovenia, Turkey and Ukraine. The point to be noted is that India is not a participating member of the organization whereas countries not only like Australia, Canada, UK, US are the participating members, but also are countries like Iran, Jamaica, Malaysia, Saudi Arabia, South Africa, Tanzania and Thailand. Do we need to be satisfied with the status of observer or we need to play more active role in these organizations[23]?

In the background of these several international initiatives, India cannot afford to be an isolated entity. It is essential to speak a global language if we want to participate in global projects. We should not forget how the patents of basmati, neem, turmeric, etc. by foreigners caught us unaware. Could we find ourselves in a situation where foreigners will sell us maps of Indian areas? The possibility must not be ignored.

1. Onsrud, H. J. and Robert I. Reis, NCGIA Initiative 16: Law, Information Policy and Spatial Database (www.spatial.maine.edu/1-16/papers).
2. Srikantia, S. V., *GIS@development*, March–April 1999, vol. 3.2, p. 25–34.
3. Lavakare, A., *Map India '99*, August 24–26 1999, New Delhi.
4. Tosta, N., Geographic Information Research at the Millennium GISDATA Final Conference, Le Bischenberg, France, 13–17 September 1997 (www.shef.ac.uk/uni/academic/D-H/gis/tosta/html).
5. *French Geographic Information in the Information Society, Present Situation and Proposals for Actions*, version 3.0, May 1998 (www.cnig.fr/lblangl.htm).
6. *Dataquest, 1995. Market Figures for GIS Industry as reported in Business Geographics. 4:1*, GIS World, Fort Collins, 1995, p. 12.
7. Market Intelligence Corp, Total GIS Software and Services Market: Revenue Forecast (World), 1991–1996, Computing Canada, January 1992, pp. 23.
8. Lopez, X. R., NCGIA Initiative 16: Law, Information Policy and Spatial Database (www.spatial.maine.edu/1-16/papers).
9. Commonwealth Position Paper on the ASDI (www.auslig.gov.au).
10. News Remote Sensing, *GIS@development*, March–April 1999, vol. 3.2, p. 10.
11. Masser, I., *Policy and Organisational Framework for a GSDI*, 17–19 November 1998, Canberra, Australia (www.gsdi.org/canberra/masser.html).
12. Rhind, D., Geographic Information research at Millennium GISDATA Final Conference, Le Bischenberg, France, 13–17 September 1997.
13. Barriers to the Use of Geomatics Data, by Inter-agency Committee on Geomatics, Working Group on Coordination and Cooperation, January 1996.
14. Masser, I., *GIS@development*, July–August 1999, vol. 3.4, pp. 36–37.
15. Bing, J., Commercialisation of Geographic Information in Europe (www.eurogi.org)
16. Lopez, X. R., NCGIA Initiative 16: Law, Information Policy and Spatial Database (www.spatial.maine.edu/1-16/papers)
17. *GIS@development*, November.–December 1997, pp. 11–18.
18. Verma, S., *Dataquest*, 31 August 1999, vol. XVII, p. 86–90.
19. Rybaczuc, K. and Blaemore, M., *Selling Government Information: A Comparative Perspective on UK and US Developments*.
20. Gupta, R., *GIS@development*, July–August 1999, vol. 3.4, pp. 42–45.
21. Survey of India's response to GSDI Survey www.umesve.maine.edu/harlan/gsdi/india.html
22. Harding, S. M. and Wilikinson, G. G., *A Strategic View of GIS Research and Technology Development for Europe*, (thalassa.jrc.it/dg3gis/exppanel.htm), 1996.
23. ISO/TC 211 Scope, Last updated 1999-03-11, (www.statkart.no/isotc211/scope.htm).