SPATIAL DATA INFRASTRUCTURES - LESSONS TO LEARN FROM GOOD PRACTICE AND DIRECTIONS FOR INDIAN NSDI

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ABSTRACT:

An attempt has been made to study Spatial Data Infrastructures (SDIs) that have initiated all over the world, picked up the good practices among them, made comparisons and suggested the approach to be followed those seems to be fit for India as felt by the authors. NSDI of USA, ANZLIC of Australia & New Zealand and Global Monitoring for Environment and Security (GMES) of European Commission are the three such good SDI practices have been examined with particular reference to different policies approaches. In case of NSDI of USA it is open and free policy, it is open and free but copyright restrictions in case of ANZLIC, Australia and New Zealand. However it is open access but with certain cost to recover incurred in case of GMES policies. NSDI developments in India have been studied to suggest appropriate policy guidelines for implementation.

Financial outlay from the Government for the hard infrastructure (road, rail, bridges, telecommunications and electricity etc.) and soft infrastructure (i.e. NDSI, Remote Sensing, GIS, IT etc.) was compared from India's 10th Five Year Plan document and observed that a meager financial support is provided for soft infrastructure in comparison to hard infrastructure.

1.0 Introduction

Spatial Data Infrastructure (SDI), also called soft infrastructure as it plays similar role of hard infrastructure like roads, rail and bridges etc. for economic development and progress of country or region. National SDI (NSDI) is a kind of soft infrastructure to be built at the national level for coordination, acquisition, processing, storage, distribution and improved utilization of spatial data. This is sought to be achieved primarily by leveraging the data assets of major data generating agencies through the process of standardization, creation of metadata and Internet enabled access.

Realizing the importance of SDIs, many countries around the world have initiated the process of establishing it. A decade ago, hardly 11 countries have established SDIs; now, within ten years, majority of countries (120 No.) are at different stages of SDI development and implementation (Ian Masser, 2005). This is due to the fast growth of Information and Communication Technology (ICT), its affordability and acceptance at decision-making level. Significant contributions and major players for the development and implementation of SDI are: Australian Land Information Council (ALIC) in 1986 (later evolved into ANZLIC (Australia and New Zealand Land Information Council in 2000), British government's initiation for Geographic Information (Department of Electronics, 1987), Federal Geographic Data Committee (FGDC) by Office of Management and Budget (OMB), USA in 1990, European Umbrella Organisation for Geographic Information (EUROGI) in 1993. Executive Order 12906 by President Bill Clinton for National Spatial Data Infrastructure (NSDI) is a turning point for real growth of SDI. Setting up of Global Spatial Data Infrastructure (GSDI) in 1996, INfrastructure for SPatial InfoRmation in Europe (INSPIRE) in 2001 that have set up the tone for SDI world over. However, these developments were limited to developed and rich countries except very few developing countries Malaysia and Indonesia.

In India, it is observed that there is no dearth of data or infrastructure; it has a good institutional infrastructure for GIS growth. There is a huge network of institutions collecting geographic information on every conceivable socially and scientifically relevant subject. The National Natural Resources Management System (NNRMS), Survey of India (SOI), Geological Survey of India (GSI), National Atlas and Thematic Mapping Organization (NATMO) and National Informatics Center (NIC) are some of the major government agencies, which are not only the generators of geographic data, but also the one of the biggest consumers of GIS software, hardware, Geo-Information and services. Planning for establishment of National SDI conceived in 2001 with establishment of Task Force consisting scientists, geographers, GIS experts, administrators drawn from the surveying, mapping, RS area to prepare a Strategy and Action plan (Georgiadou, 2005). It has progressed well by way of demonstrating its potential and willingness to participate; still lot more has to be done to see the light of implementation (NSDI Task Force, 2002, NSDI workshops 2001, 2002, 2003, 2004, 2005; Coordinates, 2005).

Though best practices has evolved for SDI development, all these practices are not applied equally in all countries because of organizational, technological, and financial differences (Tatiana, 2005). Government's commitment and motivation, politician's vision plays a major role apart from the technology.

The study involves comparative study of SDI developments world over and deriving good practices, how Indian NSDI has evolved over the last five years, progress of NSDI in India and what are the are the difficulties and gap areas to be plugged for full fledged implementation.

2.0 SDI Initiatives World Over

Three SDI initiatives with Good Practices namely, FGDC-NSDI (USA), ANZLIC-ASDD (Australia) and GMES, Europe have been taken-up for this study. The choice of these countries was because of the different policies they are following and also the existence of SDI literature through internet-online literature, published books and journals.

2.1 FGDC- NSDI, USA

The Federal Geographic Data Committee (FGDC) is an interagency that promotes the coordinated development, use,

sharing, and dissemination of geospatial data on a national basis. This nationwide data sharing effort is known as the National Spatial Data Infrastructure (NSDI). Revised OMB circular A-16 (2002) affirms the Administration's commitment for building the NSDI, and describes the effective and economical use and management of spatial data assets in the digital environment for the benefit of the government and the nation. The National Spatial Data Infrastructure represents a broad consortium of government agencies and non-government organizations that work together to promote more cost effective production, ready availability and greater utilization of geospatial data across a wide range of disciplines. The NSDI Cooperation Agreements Program (CAP) was established by FGDC to help form partnerships among organizations to implement the NSDI. Since 1994 the FGDC has provided funding and assistance to over 500 organizations to implement the NSDI. Federal agencies responsible for spatial data themes are required to be members of the FGDC. In August 2001 FGDC conducted a survey 15 Federal civil agencies to characterize near-term agency requirements for remote sensing ____ork. ____sed

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NSDI Data Layers

Relative use of NSDI Framework Data Layers

Geodetic Control………………….. 51%
Ortho-imagery…………………….. 77%
Elevation………………………….. 62%
Transportation…………………….. 67%
Hydrology…………………………. 65%
Government Units……………… 50%
Cadastral……………………… 33%

Percentage of Business Functions using Multiple NSDI Data Layers

5 or more layers ……………….. 38%
3 or 4 more layers …………….. 40%
2 or fewer layers ……………….. 22%

Using one or more layers potentially derived from remote sensed data ….50%

Source: Civil Imagery and Remote Sensing Task Force, Ropoer to the Administration: Value of Civil Imagery and Remote Sensing, FGDC, Oct. 2002

2.2 ANZLIC, Australia

Australian Spatial Data Infrastructure (ASDI) was initiated in 1996, under support of Australian and New Zealand Land Information Council (ANZLIC) an umbrella body that represents different levels of government. The ASDI facilitates the identification, sharing and usage of spatial data across Australia and New Zealand in both the public and private sector arenas.   The broad approach taken by ANZLIC is to maximize the benefit to the community by providing better access to holdings of spatial data, at marginal cost of transfer, in order to maximize the net economic and social benefits arising from use of the data. These benefits are maximized when 'the community has easy, efficient and equitable access to spatial data in an environment where technology requirements, data formats, institutional arrangements and contractual conditions do not inhibit use' At the end of June 2003, there were 25 repositories with in the ASDD (Australian Spatial Data Directory- which provides platform for integration of data from various sources) with a total of 33,173 datasets for search and retrieval. To assess the progress of ASDI, Geoscience Australia published web statistics and repository records in its quarterly technical reports

indicate that there is increase in visitors and usage of repositories (Hetal A. Patel, 2003). Refer to the table 3 for details:

Criteria	1st Quarter 2003*	1st Quarter 2006**
Total page views (Access of a page as a whole e.g. html):	71,594	124,893
Total visitors:	4,770	5,739
Total days covered:	89	90
Average page views per day:	804	1,388
Average visitors per day:	94	64

Source: * Hetal A. Patel June 2003, GIS@Development, India
**Geoscience Australia quarterly technical report, January-March 2006.

2.3 GMES, Europe

The initiative on Global Monitoring for Environment and Security (GMES) is aimed to be established by 2008 of a European capacity for the provision and use of operational information for monitoring and management of the environment and for civil security (Figure 1). There are three key elements for making the European Capacity developed by 2008. One among the element is assessing the current capabilities, organizational elements and policies required for the supply of information and to determine how effectively they allow meeting the requirements under the project called DPAG (Data Policy Assessment for GMES). GMES serves two main policy requirements for Europe in terms of the need for geo-spatial information services. Firstly, it provides independent access to information for policy and decision makers to advance European and national agendas related to environment and security. Secondly, it federates European contributions to the international Global Earth Observation System of Systems, GEOSS, which was established at the Third Earth-Observation Summit in Brussels in February 2005.
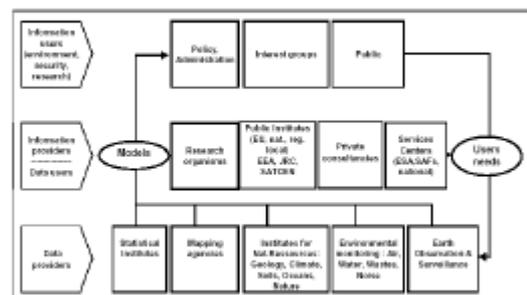

Figure 1: The overall structure envisaged in GMES for fostering the dialogue between the data suppliers and the information users.

Source: Data Policy Assessment for GMES draft final report. Oct. 2003

The DPAG project was established to document the data policies of the variety of information foreseen for GMES, identify the obstacles, and make recommendations on actions to improve data policy coherence. It is vision of European Union concerning for environment and security (further plans to extent to many other aspects), an ideal approach considering capacity building for any country/region and Globe as a whole. As part of the Spatial Data Infrastructure requirement for integration of data from various

sources at different levels (local to global), INSPIRE (Infrastructure for Spatial Information in Europe) initiative is launched by the European Commission and developed in collaboration with Member States and accession countries. INSPIRE aims at making relevant, harmonized and high quality geographic information to support formulation, implementation, monitoring and evaluation of Community policies with a territorial dimension or impact. INSPIRE is at heart a legal initiative of the European Union that will address technical standards and protocols, organizational and coordination issues, data policy issues and the creation and maintenance of spatial information. INSPIRE fits under the overall objectives of GMES program.
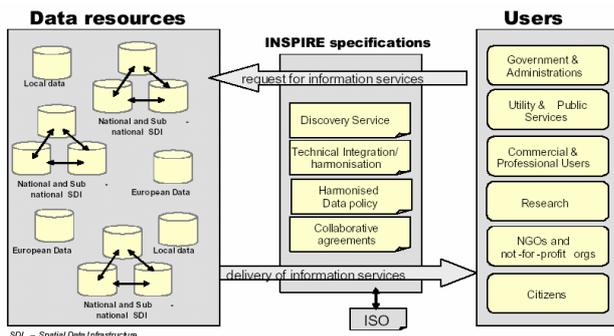

Figure 13: The INSPIRE structure and information flow. Source: GMES Forum 2, ESTEC, The Netherlands, January 2003.

Source: Data Policy Assessment for GMES draft final report, Oct. 2003

Comparison of the above the three SDI initiatives has been made for data ownership, distribution and dissemination of data *Appendix 1*. The summary clearly indicates different policy approaches followed by them.

3.0 Evolution of Indian NSDI

Indian NSDI has been initiated with the formation Task Force on National Geospatial Data Infrastructure (NGDI) by DST during October 2000 under the Chairmanship of Surveyor General of India drawing the members from various map-generating agencies at national level. NSDI Strategy and Action Plan was launched in 2001 through NGDI workshop conducted at Delhi, under overall umbrella of second Map India conference 2001 by inviting experts from all over the world, supported by Department of Space and Department of Science and Technology. The NSDI strategy and action plan defines the direction for the Indian NSDI and focus on creating national repository of digital warehousing of map data and facilitate access to digital spatial information. Since then, vigorous efforts are going on by various organisations to establish their respective NSDI node. In addition, NSDI Task-Force is going ahead with developing national standards for metadata, exchange format, content standard etc., A Proto-type NSDI was developed and demonstrated covering a full-fledged Metadata Server (with the sample data from the premier data generating agencies like NNRMS, SOI, GSI, FSI and NBSSLUP) and demonstration-level NSDI (with Data, Applications and Portal).

Subsequently, NSDI workshops are held every year at different geographical locations covering the whole country; 2002-Ooty, 2003-Agra, 2004-Lucknow, 2005-Hyderabad. It was a good beginning for large country like India as such type of spatial database availability and access in the network environment was also a rare facility even among many developed countries.

In the 2nd workshop at Ooty, it was concluded that he NSDI should emerge as an empowered apex authority for making and administering policies with reference to spatial data, definition and evolution of NSDI standards, designing and implementation of NSDI Servers, define mechanisms for spatial data quality for NSDI, define rules and guidelines for NSDI Access, define rules/guidelines for agency participation in NSDI, constantly widen the scope of NSDI and ensure support for better governance and socio-economic development.

In the 3rd workshop at Agra, emphasized on map policy but not addressing the availability of digital map data from national mapping agency promised a year earlier. Instead recommending are stakeholders to be ready according to NSDI metadata standard (Version 3.0) and adopt NSDE exchange standard, without specifying the time limit. The initial idea of Indian NSDI to follow it's own standards but recommended to follow international OGC and ISO standards.

The fourth NSDI workshop was held at Lucknow in November 2004 that has emphasized the immediate need of national map policy, stakeholders to populate the data, make the metadata servers available, public-private participation, effort to standardize according to international standards like OGC, ISO etc.

The 5th workshop held at Hyderabad, voiced the need for expedite the NSDI operationalization. Also, urged the NSDI Task Force to continue the standard definition process for NSDI and further define Standards for Content, Design, Spatial Framework, Quality, Exchange and Services etc.

4.0 Indian NSDI approach

Initially, the Indian NSDI is following the top-down approach, drawing the contributing agencies from the National level. Union Minister for Science and Technology Mr. Kapil Sibal unveiled a proposal for the creation of a NSDI as considered and approved by the Union Cabinet and a resolution to be issued shortly. (Yahoonews, 2006). The activities of the NSDI will be coordinated with the help of a two-tiered structure, the National Spatial Data Committee (NSDC) and the Executive Committee (EC). The "Resolution" defines the composition, functions and powers of these committees for the smooth implementation and functioning of NSDI. The NSDC - the apex policy making body of spatial data, shall be headed by the Union Minister of Science and Technology. The EC while managing the day-to-day functioning of the NSDI will also assist the NSDC.

5.0 Indian Map Policy – boom or bane for Indian NSDI

Much awaited National Map Policy (NMP) has come into existence finally on May 19, 2005. Survey of India is responsible to produce, maintain and enable dissemination of spatial data to users with appropriate access policies, not jeopardizing national security. Under the new NMP Survey of India (SOI) announced to produce Dual Series Maps. Defense Series Maps (DSMs) with Everest datum / polyconic projection and are separated from Open Series Maps (OSMs) with WGS 84 datum / UTM projection. The DSMs will be with highest possible accuracy in comparison to OSMs. SOI will obtain one time clearance from Ministry of Defense (MOD) for OSMs. Users are free to have value addition, share with others while the information of such sharing will require to be logged in the map transaction registry. Another significant highlight of new NMP is that the users are allowed to publish either hard print or in digital form and in the web. Large

scale maps for different cities that are being generated by SOI will be made available in public domain which is a welcome move.

Announcement of NMP is welcome sign for all users who have waited much debated policy but found that it is not comprehensive enough because it did not take care of many issues such as types of map scales, permission to use aerial photographs, space policy and maps that have been generated by private sector etc (Ayon Kumar, 2005). According to Munnendra Kumar et.al, 2006, SOI is liberal to permit users to add value and resell but registration on buying /reselling may not provide real safeguard. They are also of the opinion that more clarity is needed in providing OSMs to private sector; most important one is overall product information along with metadata of products.

The objective of NSDI is to make available the data, access seamless manner and use it for many applications for overall development. With the announcement of NMP has helped one way or the other the stakeholders of NSDI. The NMP addresses only one type data. There are other type of data that will be part of overall theme generation such as use of satellite data, GPS data, aerial photographs, atmospheric and climatic data etc. which needs to be addressed at national level for development, progress and prosperity.

6.0 Importance of soft infrastructure (SDI) in India

A study has been done to compare the hard infrastructure (roads, rail, telephone, power etc.) with soft infrastructure (Spatial Data Infrastructure, Satellite Remote Sensing, GIS etc.) and signify the importance among both of them, using Tenth Five Year Document. It was found that a meager 0.0306 % budget is allocated for soft infrastructure as compared to 30% for hard infrastructure when compared infrastructure of eight ministries. (Table 1)

Table 1: Comparative study of financial support and importance of hard and soft infrastructures

Sl. No.	Ministry/Department	10th Plan Outlay (in M US $*)	Percentage
1	Ministry of Power	31445	16.00
2	Ministry of railways	13286	6.78
3	Ministry of Road Transport and Highways	13092	6.68
4	Department of Information Technology	1205	0.61
5	Ministry of Human Resources	6579	3.35
6	Department of Space#	2904	1.48
7	Department of Science and Technology##	745	0.38
8	NNRMS&SNRMS (NSDI, NRIS, Large Scale Mapping, Support to States, Aerial Survey)	60	0.0306

The amount specified is spread over for five-year period
*Note: The amount is calculated @ US $ 1= 45.6118 INR
\#   Organization that initiated the NSDI activity along with DST.
\## The Nodal Agency for creation, implementation and monitoring of Indian NSDI, but budget details are not indicated

■ Hard Infrastructure   ■ Soft Infrastructure

It may take considerable time and effort to study the complete document, for our need we have done selective study considering the few hard infrastructures and compared with soft infrastructure. It is agreeable that hard infrastructure needs huge investment for overall development of the country. But the soft infrastructure requires very little investment and less time to make it available. Spatial Data Infrastructure which require little cost, may be incorporated as part of overall infrastructure, that not only provide the much needed resources to flow towards SDI initiatives but would also guarantee the development of sound (hard) infrastructure (Georgiadou et.al, 2003).

7.0   Gap areas and suggested approach

7.1 Commercial and Legal Issues :

One of the important aspects of NSDI is protection of Data. It would be necessary to classify data in terms of economic value and in terms of regional security. Access would also have to be suitably regulated. It has to be recognized that data generation and information processing activities are becoming commercial. Data pricing is an issue and so is the safeguarding of intellectual property. Information for public good should be priced low or be made free and access also should be open. Information leading to economic gain should be priced and "watermarked" to prevent unauthorized duplication. Information of strategic importance should be restricted to a government-to-government (G2G) exchange at cost.

There is a need for a clear data policy which includes intellectual property rights, distribution mechanism and pricing of data. The availability of copyright protection, value additions on data, use rights custodianship versus ownership, transparent pricing and distribution mechanisms, confidentiality of commercially sensitive information, and liability on errors etc., needs to be considered while making NSDI policy.

7.2   Capacity Building:

This issue of building local capacity will to be a major constraint to the success of NSDI. An important barrier to change is an organization's capacity to adopt new standards and technologies. While the introduction of specialized software, for example for the creation of a geo-spatial catalogue, is relatively easy, its effective use depends on the technical capabilities as well as organizational support. Similarly introduction of GPS saves lot of effort in collecting the data, but the concerned personnel needs to be trained very well. Awareness creation of NSDI components should be considered down to the lowest level and with strong management support and leadership. Capacity development should be a prime concern of management.

7.3   Financial Aspects:

It was assumed that investment required for organizing the available data in the NSDI would be the part of the investment of the respective data providers. However, as envisaged, the implementation of NSDI would cost anywhere between   1000-2000 crores of Indian rupees (NSDI-TF, 2001). There is a need to work out the mechanism of obtaining the finance for the NSDI – which could be a mix of options ranging from Government funding, Public-Private Partnership funding, public investments, international aid/loans etc. However, it is envisioned that Government will have to take the lead and provide the enabling mechanism to generate the finances for NSDI. With a national commitment obtained for NSDI, each NSDI committing agency could build-up a NSDI fund base for its respective commitment.

7.4 Organizational Aspects :

The vital enabling of the NSDI has been done by the Government through the resolution passed in the cabinet. Initially, the Indian NSDI is following the top-down approach, drawing the contributing agencies from the National level. However, NSDI structure should aspire to be inclusive of all stakeholders say, state level scope such as Bhoomi Land Record System and corporate level scope such as Reliance Infocom Land Base. NSDI structure should also aspire to: - add value, build on, facilitate and support existing initiatives, support sustainable development, be flexible and adaptable to change, facilitate new initiatives especially those relating to the use and sharing of data, enhance decision making processes and engender partnerships.

In India, there is an excellent institutional structure to collect the data. Government is the biggest producer and consumer of spatial data like in any other part of the world. As a result there is a dependency between two organizations, but with limited interaction. Institutional arrangements and user/ provider relationships are still immature state and needs sustainable co-operation between these organizations. There is a need to lay down guidelines for commitment by different spatial information generating agencies and cover issues of the Organizational framework, custodianship guidelines and liabilities for use etc.

8.0 Conclusions

It is one decade or so since the evolution of Spatial Data Infrastructures world over and it has been realized the advantages and vast benefits. India began it's journey in this endeavor in 2001. Though the progress is satisfactory, lot more to be done to reach the implementation stage. The authors are of the opinion that we must adopt suitable approach of good practices of USA/Europe/Australia or an integrated approach that suits Indian conditions.

The Indian NSDI vision statement addresses availability and access to data but missed out completely the real use of it (i.e. applicability) due to lack of data accessibility from G to G and G to B.

It is time to build relationships among organizations and transition from national repository to national infrastructure with the availability of data and enable stakeholders and all users to access for further use.

Indian NSDI set up is of the opinion that NMP will remove hurdles for creation of SDI themes and hence availability for users. We have to wait and see the real benefits, though many felt happy about the new NMP but with certain apprehensions as it is not clear in many aspects.

(Note: Expressions made in this article are solely of the authors and do not in any way reflect the viewpoints of the organization employed with.)

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Comparison SDI Initiatives world over			
Data Policy Characteristics	NSDI, USA	ANZLIC, Australia	GMES, Europe
Ownership	Data produced cooperatively by organizations are shared among them. Data produced under publicly funded is regarded as publicly owned and made as widely as possible under FGDC	Ownership with data producer Mostly free access, if the owner protected (Govt. funded project) Restricted access for protected by confidentiality. Reclassify restricted data over time	Ownership of data is strictly maintained Sometimes restricted for security reasons
Distribution and Dissemination	No licensing and FGDC aims to disseminate data, maximize the usefulness of data and minimize cost to government and to public. Metadata is made available by each organization through federated clearing house	Spatial data freely available with license conditions and rights of all parties protected and understood Dissemination and distribution is controlled by individual agencies. Developing clearing house for quick access	Licensing governs distribution except few data with free licensing conditions