TOWARDS A SPATIAL DATA INFRASTRUCTURE: BRAZILIAN INICIATIVES

O uso da infra-estrutura de dados espaciais: iniciativas brasileiras

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ABSTRACT

In the mid 1980s, the use of conceptual models, common standards, and metadata as well as high level designed GISs became more common. Together with concepts such as data warehousing, these advancements led to the idea of Spatial Data Infrastructure - SDI (known inside Brazil as *Infra-Estrutura de Dados Espaciais - IDE)*. SDI have allowed efficient design of frameworks for managing spatial data and provided a more comprehensive view of how spatial data can be distributed and used. Ideally, access to SDI should be easy and global, connecting users that produce and manipulate the data, whether in business or government sectors, academia or in the general population.

This paper contains an overview of the SDI concept. Also are examined are components of an SDI and its hierarchy of structures. These concepts are then connected to SDI experiences in Brazil. This paper will highlight some of the more prominent Brazilian experiences, although other SDI efforts are also underway.

Keywords: Spatial Data Infrastructure, components, hierarchy of structures and experiences in Brazil.

RESUMO

Em meados dos anos 80, o uso de modelo conceitual, padronização de dados e metadados bem como o alto nível de SIG tornaram-se mais comuns. Juntos aos conceitos como o de armazenamento, esses avanços lideraram a idéia do que mundialmente é conhecido por Infra-estrutura de Dados Espaciais (SDI). O Brasil adotou a sigla IDE para representar a Infra-estrutura de Dados Espaciais. O SDI tem permitido o design eficiente de uma estrutura de gerenciamento dos dados espaciais e promovendo uma visão mais compreensiva de como esses dados espaciais podem ser distribuídos e utilizados. Idealmente o acesso ao SDI deveria ser fácil e global, conectando usuários e produtores de dados, sendo estes do setor privados, governamental, acadêmico ou do publico em geral.

Este artigo descreve uma visão geral sobre a definição do SDI. Também foram examinados alguns componentes do SDI e sua estrutura hierárquica. Estes conceitos foram contemplados neste artigo em forma de experiências brasileiras. Embora que apenas algumas dessas experiências foram contempladas, muitos outros projetos de SDI estão em andamento e outras já em grande sucesso.

Palavras chaves: Infra-estrutura de Dados Espaciais, componentes, estrutura hierárquica e experiências brasileiras.

1 INTRODUCTION

Spatial information is and has been an important element for supporting decision-making. In the past, maps showed where people and objects were located. Today the concept of spatial information has evolved to a relatively sophisticated environment with complex databases, high-resolution imagery, satellite position information, internet delivery and many others advancements (WILLIAMSON et al., 2003).

The term Spatial Data Infrastructure (SDI) relates data sources, systems, networks, standards and governmental issues with spatial data information which is delivered to the potential users through different means (COLEMAN *et al.*, 1997).

Giff and Coleman (2003) simplify the meaning of SDI when they describe that SDI should provide an efficient, effective framework, which is easy to work with, easy to use, and manageable by users. The SDI must facilitate the user's quest for spatial data.

During the 1980s when a large part of the private and the governmental sector started to develop GIS in Brazil, the biggest developmental struggle was to integrate those systems. Each department created their own local system (inter and intra), and duplication of information in the same agency was common.

In the 1990s some of these entities developed their conceptual models of it GISs and the use of metadata began to appear. The use of GIS and spatial data began to be shared among departments and the information and applications became more available to the user.

Recently, Brazil has begun to recognize the importance of dealing with spatial information as a fundamental part of information infrastructures, and not simply as a collection of digital maps. With this goal in mind, some standardization has began and international projects have been helping Brazil to build a National SDI through an exchange of experiences.

2 SPATIAL DATA INFRASTRUCTURE – SDI

In defining Global Geospatial Data infrastructure, Coleman and McLaughlin (1998) define the term information infrastructure. Their definition included a collection of various media, storage components and physical infrastructure used for information delivery. They declare that the fundamental element in a information infrastructure is the data content and how it flows.

Masser (2002) adds that infrastructure is also related to all kinds of materials, technologies and people that are necessary to acquire, store, process and distribute information into different ways to satisfy different user's needs.

The concept of spatial data infrastructure (SDI) in early 1990s was developed to support accelerating exchange standards for geographic information and to facilitate collaboration on the design of national mapping programs. Nation-wide spatial information in developed countries such as United States, United Kingdom, Canada, and the European Community were models for countries with less integrated system (COLEMAN and MCLAUGHLIN, 1998).

Warnest (2005) defines SDI according to a knowledge hierarchy (Figure 1). He says that "SDI is concerned with the realm of spatial data and the transition to information. Decision support systems build upon SDI to interpret, compare and analyze the cumulative spatial information to produce knowledge, with lessons and trends learnt over time resulting in collective wisdom."

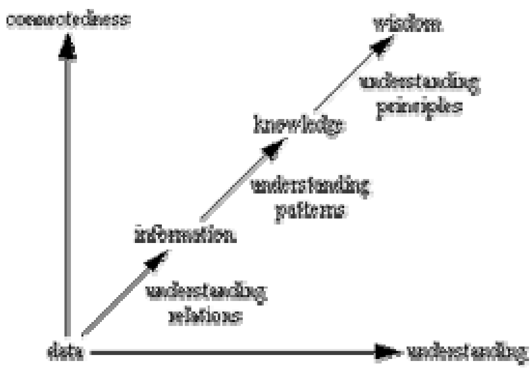

Figure 1 – Show the knowledge hierarchy: data to wisdom (BELLINGER *et al*., 2004)

2.1Components SDI

Warnest (2005) describes the components of SDIs. These components are strongly related and normally overlap. Figure 2 shows these components.

Data - It is the central component. Data is identified by several datasets (WARNEST, 2005).

People - SDI at any level involves stakeholders, both in the private sector and outside (WARNEST, 2005). Stakeholders fund the SDI; the private and public sector is responsible for collection, maintenance, and provision of spatial data; the academic sector is responsible for education, training and research in SDI; and the user determines what spatial data is required and how it should be accessed (WILLIAMSON *et al.*, 2003);

Institutional – The institutional component is composed of policy, legislation and coordination. From the policy perspective, the custodianship, the pricing and the licensing have important roles (WARNEST, 2005).

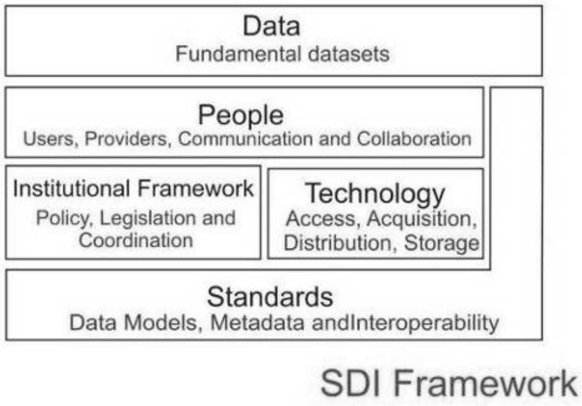

Figure 2 – Components of an SDI framework (after WARNEST, 2005)

Custodianship is responsible for ensuring that fundamental data sets are collected, maintained according to specifications, standards and policies defined by the SDI in order to be use to a variety of user (MASSER, 2002). Custodianship also eliminates unnecessary duplication, manages information, assists the creation and management of spatial information products, and facilitates the acquisition of information products (THOMPSON *et al*., 2003).

Pricing and licensing provides the commercial and legal means to safeguard the interests of both providers and users alike. Licensing spatial information is undertaken to ensure effective management of risk associated with the use of spatial information, in addition to detailing the terms and conditions for its use (THOMPSON *et al*., 2003).

Liability of the information is important not just to producers, but also to intermediaries and final users; since they can not be certain if the information delivered to them is complete or correct (KABEL, 2000).

Technology - It provides the physical and infrastructural needs for SDIs. Theoretically it helps to maintain, to process, to disseminate and to access spatial data (WILLIAMSON *et al.*, 2003). Technology also includes interdependent relationship between clearinghouses, metadata and standards (CROMPVOETS and BREGT, 2003).

The clearinghouse was developed to facilitate the electronic searching, viewing, transferring, and ordering, spatial data allowing dissemination of sources via the Internet (CROMPVOETS and BREGT, 2003).

Metadata is a collection of information about the data. It is collected in a standard format, which enables user to query the spatial information's interoperability with multiple organizations (CROMPVOETS and BREGT, 2003).

Standards – These permit the discovery, interchange, integration and usability of spatial information. Spatial data standards are composed of reference systems, data models, data dictionaries, data quality, data transfer and metadata (EAGLESON *et al.*, 2000).

2.2 SDI Justification and Funding

In developing an SDI framework, a benefit-cost analysis is usually required.. This is done to determine if the implementation will require large capital investments and if such an investment can be justified in terms of downstream financial or even social benefits (GIFF and COLEMAN, 2003).

Obermeyer (2005) classifies benefits and costs as being tangible and intangible. Normally the tangible components are quantifiable, mainly because they represent cost of products and services that are bought and sold in the free market, while the intangibles are sometimes impossible to accurately identify and measure although they may be estimated.

Some examples of tangible costs include hardware, software, training, new employees, and additional space. The benefits may be quantified as increases in revenues, new market services, more demand of some products and reduction of costs (OBERMEYER, 2005).

The intangible costs may be estimated by, for example, use of internal personnel, extra shifts, layoffs and so on. The intangible benefits can bring many improvements of services and products required or desirable for society. The benefits are associated with client relationship improvement, better decisions, morale improvement, socio-cultural benefits, etc. (OBERMEYER, 2005).

Time can be the most influential element regarding the level of risk and uncertainty among the benefits and costs of a design project. Often direct costs are immediate while intangible benefits may be longer term.

Giff and Coleman (2003) also address some elements which are necessary to maintain the SDIs on the micro level. These elements can be a challenging for many agencies:

- **Business Plan** – This should be designed to speculate on the nature of the spatial data information, its clients, and various uses; the potential stakeholders or sponsors and their responsibility; direct and indirect benefits cost analysis; return on investments; benefits and risk management strategies.

- **Pricing Policy** – This needs to identify who should pay and at what price. (Is there some distinction between institutional and general public users? Will the government subsidize part of the expenses? How the money collected by fees will be invested?).

- **Marketing of the Products** – This indicates how products will be seen by the potential clients. (How can we sell the image of the SDI products? How could we show that our product is better with the SDI than before?)

- **Funding Models** – These are perhaps the fundamental components because they indicate how the SDI will be implemented and maintained. An SDI needs to be self sustainable after a certain stage of the project. The SDI funding model guide the coordinating agencies on how to formalize, structure, present and source financing aid.

2.3 SDI Hierarchy

The hierarchical nature of SDI is well established in describing relationships between administrative and political levels. It is distributed such that each layer interacts with each other and also with the whole system vertically (inter-relationship) and horizontally (intra-relationship). These relationships among different levels of SDIs are complex (RAJABIFARD *et al*., 2003a and MCLAUGHLIN and NICHOLS, 1991). The Figure 3 illustrates the interconnected SDI hierarchy levels.

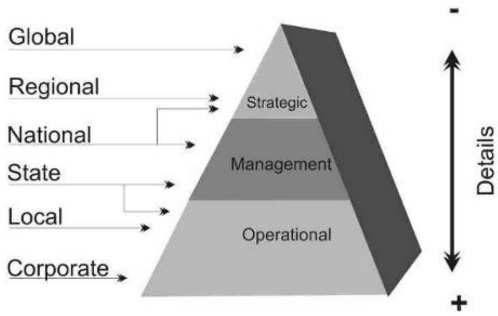

Figure 3 – Organizational Structure of the SDI Hierarchy (adapted from WILLIAMSON *et al*., 2003)

According to Williamson et al. (2003) the organizational structure of the SDI has a direct relationship with the hierarchy levels. The Global and Regional SDIs are responsible for the strategic tier. The National SDI has more influence in management, although some strategic tiers are used. State SDIs are defined between the managerial and operational levels. And finally, the local and corporate SDI just takes care of operational structure.

The role and some example of benefits of each SDI hierarchy are explained in the Table 1 (COLEMAN and MCLAUGHLIN, 1998; GRANT and WILLIAMSON, 2003; RAJABIFARD, 2001; RAJABIFARD *et al*., 1999; RAJABIFARD *et al*., 2003b)

TABLE 1- DEFINING THE SDI'S HIERARCHAL LEVELS

SDI	Role	Benefits
Global	A Global SDI is composed of policies, technologies, standards and human resources that collect, manage, access and deliver data at the global level.	- Promote economic development and environmental sustainability, and stimulate better government.

Regional	Regional SDIs provide institutional, political and the technical basis to support the regional consistency of content to meet regional needs with regard to sustainable development and environmental management.	- Reduce costs of data production by sharing data; - Provide better data for decision-making by using standardized data and easy tools; - Perform applications and analysis in jurisdictional areas;
National	A National SDI is responsible for integrating the upper to low levels of the SDI pyramid. National SDIs are intended to create an environment for potential users to access, update and secure national datasets. They also support the improvement of the exchange of data among countries.	- Reduce cost of data production by avoiding duplications; - Provide improved data for decision – makers; - Develop standards for data, guidelines, tools, and applications.
State	Based in maps of medium to large scale, State SDIs are the level of SDI usually most the closely tied to land administration and natural resources management in federations.	- Aggregate State data to generate National maps; - More access to large scale cadastral and topographic dataset. - Support to emergency services.
Local	This level includes the most detailed spatial data. The construction of Local SDIs requires not only funds and technology, but also sustaining policies and institutional support.	- Develop common solutions for discovery, access, and use of spatial data in response to the needs of local user groups;
Corporate	Lastly this level, although similar to the local SDI, differs in its ability to find information with more detail. Also it is where users and developers share data resources.	- Low cost of data production and more accurate data; - Decentralized information production, but easy maintenance of the data through shared database; - Gain of network business managers/ data custodianship.

3 SDI FRAMEWORK BRAZILIAN EXAMPLES OF COMPONENTS

The following subtopics show specific Brazilian examples of each component of the SDI framework (see Figure 2 for clarifying general SDI framework). These components were chosen by their successful implementation, especially by how well the use of the spatial data was distributed to all kinds of users. Many other examples could be highlighted under these subtopics.

3.1 The Data Component

CBERS-2 Satellite Imagery

The China-Brazil Earth Resources Satellite (CBERS) is the second of a series of five remote sensing satellites launched by China in the period 1988-2011. CBERS-2 CCD has 4 bands of 20m spatial resolutions in the visible/near-infrared wavelength regions and 1 pan band of 20m spatial resolution. These bands (except pan) have the same spectral zones as Landsat7 ETM+ multispectral bands (WU *et al*., 2004).

Each image covers 120 x 120 km2 with 100 Mb size. These numbers make Brazil the world's largest distributor of remote sensing imagery. From May 2004 to May 2005, INPE delivered more than 100,000 CBERS-2 CCD images, which are available free to Brazilian users by Internet access (CÂMARA *et al*., 2005)

<http://www.cbers.inpe.br/en/index_en.htm>.

3.2 The People Component

Fator-GIS and Mundo-Geo

Fator-GIS is a media company that started out in 1993 publishing a small magazine on GIS. From the magazine, Factor-GIS (see http://www.fatorgis.com.br/) started a very successful user conference series called GIS-Brasil. MundoGeo, is another company which has a portal, a paper magazine, and its own user-conference series, *Geo-Brasil*, which has been held annually since 2000 (CÂMARA *et al.*, 2006). (See http://www.mundogeo.com.br/index.php?lang_id=3)

These portals act as a place where companies and researches can meet and share their GIS experiences between themselves and among other kinds of users. Today, these are the most important media companies with interests in GIS in Brazil.

3.3 – Institutional Framework

Hyman et al. (2003) identify that the 2003 Brazil GSDI survey indicates that more organizations are participating in the SDI activities each year.

For example, the Brazilian Institute of Geography and Statistics (IBGE) has launched map servers showing environment and demographic information (Website: www.ibge.gov.br).

The National Institute of Space Research (INPE) has been developing standards formats, metadata, tool and freeware available at the internet to the community (Website: http://www.dpi.inpe.br/).

The Ministry of Health Information Service made a health system unified and based on the principle on free access for all. It is the DATASUS. DATASUS is responsible for processing data concerning health indicators, including all heath services claims. Its datasets are spatially-related information and a simple mapping tool is used (TABWIN). (More information at the Website: www.datasus.gov.br)

The Brazil's Geological Survey (CPRM) collects and disseminates spatial data sets. CPRM uses the Federal Geographic Data Committee (FGDC) metadata standards. Some data sets on its website:
http://www.cprm.gov.br/ingles/index.html.

The University of Campinas, Institute for Informatics (UNICAMP) and the Center of Research and Development in Telecommunications and Technology of the Information - CPqD Telecom & IT solutions. This group has focused on decision support systems and Workflows, also on ontologies and interoperability (Web address: www.ic.unicamp.br/~cmbm).

3.4 – Technology Component

SPRING – Brazilian GIS Software

SPRING is a Brazilian GIS and remote sensing image processing system with an object-oriented data model which integrates spatial analysis, map algebra, digital terrain modeling and image processing and has been available on the Internet since November 1996 (Câmara et al., 1996). Developed by the National Institute for Space Research – INPE, it is widely accessible freeware for the GIS community, although it is not open source. The Brazilian open source software is called TerraLib (INPE/DPI, 2007b).

For Câmara et al. (2006) the idea of using SPRING instead of commercial GIS is to have the same tasks for less cost (i.e., no capital investment for software, no support or maintenance fees, and free technical support in Portuguese) that can support students in undergraduate and graduate courses in GIS in many universities in Brazil. Moreover SPRING provides answers to the following requirements:

- **Operability** – easy to use and the tools and tutorial are in Portuguese.
- **Training** – a SPRING tutorial was designed in three different models “Introduction to GIS”, “Spatial Analysis” and “Spatial Databases”. This material is freely available on the Web. Moreover in Portuguese help documents are available in the software and through phone help.
- **Demo Availability**- more users have been trying out the full powers of the system without incurring significant economic costs.

SAGRE - Sistema Automatizado de Gerência de Rede Externa (SAGRE)

Developed since 1991 by CPqD Telecom & IT solutions center, the SAGRE system for telecom network management responds to 1 million geographical queries and 4 billions of requests in its database each month, serving 12 million customers, and supporting 1,300 major engineering projects (CÂMARA *et al.*, 2006).

SAGRE integrates outside plant management and provisioning that stored spatial data in a relational database (ZEISS, 2007). For example, when a new phone line is required by the user by phone, the operator sees automatically on their screens the possibilities to install the phone line, including the network structure and location and send back information to the client.

The Geospatial Information & Technology Association (GITA) nominated Telecom S.A. was the recipient of the 2007 GITA Excellence Award for the telecommunications sector. The award recognizes the dedication, insight, and high degree of initiative in the outstanding application of geospatial technology (HENTON, 2007).

3.5 Standards Component

GEOBR- Intercâmbio de Dados Geográficos no Brasil

Developed by INPE, this data format is characterized by the use of an object-oriented data model, the inclusion of a minimum set data requirements, ontological support, and procedures for geographic analysis. This information is subdivided into sections such as ontology, metadata, data_model, projection, layers, relationships and analysis (COSTA, 2005) More details can be seen at http://www.dpi.inpe.br/geobr/

TerraLib – Open source software components library for Geographical Information Systems

INPE/DPI (2000) explains that TerraLib has been used with success in the GIS industry in recent years. TerraLib enables quick development of custom-built applications, by providing direct access to a spatial database without unnecessary middleware. This open source software was developed by INPE and the Laboratory for Technology on Computer Graphics, at the Catholic University of Rio de Janeiro (TECGRAF/PUC-RIO).

Additional tools for interoperability of spatial databases are being produced using TerraLib. These tools include the development of the GeoBR format for the interchange geographical information (see www.terralib.org for further details).

4 BRAZILIANS' GEOSPATIAL APPLICATION ACHIEVEMENTS

The Brazilian government is a very large current and potential user of spatial information. By the articles 21 and 22 of the Brazilian Federal Constitution of 1988, the government is responsible for management and maintenance of the county's mapping service (BRASIL, 1988). Today these maps are mostly in digital format.

By the end of 1990s, research centers started to realize that digital mapping had more potential than simply displaying geographic location. The definition of SDI asserts that digital maps should be connected to technologies, policies and institutional infrastructure to facilitate the delivery and access of geospatial data. As the SDI began to be developed in Brazil, it came to be known as *Infra-Estrutura de Dados Espaciais (IDE).*

The Brazilian Government has initiated a number of National Programs such as GEOMA, PPBio, LBA, PROARCO, BCDAM and many others, and State programs such as REBATE in Bahia. These projects aim to meet the most pressing needs in each sector by coordinating federal and state institutions (CAMPOS, 2005). The goals of these programs are to promote the standardization of metadata, to provide geospatial data framework, and to develop tools/information for information management.

Further evidence of current GIS and SDI use in Brazil governmental agencies will be explored in the following subtopics.

4.1 Global SDI

PMRG - Projeto Mudança do Referencial Geodésico

The Project *Mudança do Referencial Geodésico* – PMRG or Project for Changing the Geodetic Reference System in Brazil, promotes the adoption of a new geocentric reference system called SIRGAS2000.

The main propose of the PMRG is to have a modern and an unique reference system in order to make the information compatible with technologies, such as GPS (Global Positioning System), and on international level. PMRG has been underway in Brazil since October 2000 under IBGE's leadership**.** More details can be seen at http://www.ibge.gov.br/carografia

4.2 National SDI

PROARCO – Programa de Prevenção e Controle de Queimadas e Incêndios Florestais na Amazônia Legal

In May 1998, the INPE started the PROARCO project. The goal was to combat and prevent large scale deforestation by forest fire, in the *Amazônia Legal* (Silva, 2003). PROARCO is coordinated by the Ministry of Environment - Ibama/MMA, but many others partners have some responsibilities, such as Regional Secretary, Federal Policy, Military Department, Estate Environmental Agency, NGO's and INPE (IBAMA, 2007b).

Câmara et al. (2006) comment that INPE established its Image Processing Division in 1984 with the following aims: (a) local development and dissemination of image processing and GIS systems in Brazil; (b) establishment of a research program in Image Processing and GIS, and (c) pursuit of co-operative programs with universities, government organizations and private companies.

As part of PROARCO, INPE is responsible for developing applications for monitoring forest fires and to design a methodology to improve the quality relevance the information began used. The integration of the data (topography, vegetation, temperature, rain, and etc.) has been allowed by the SPRING software (INPE/DPI, 2007a). Information about forest fire is available directly by INPE website:

(http://www.dpi.inpe.br/proarco/bdqueimadas/) or under the IBAMA website:

(http://mapas.mma.gov.br/i3geo/aplicmap/geral.htm). Figure 4 illustrates the Ibama/MMA clearinghouse.

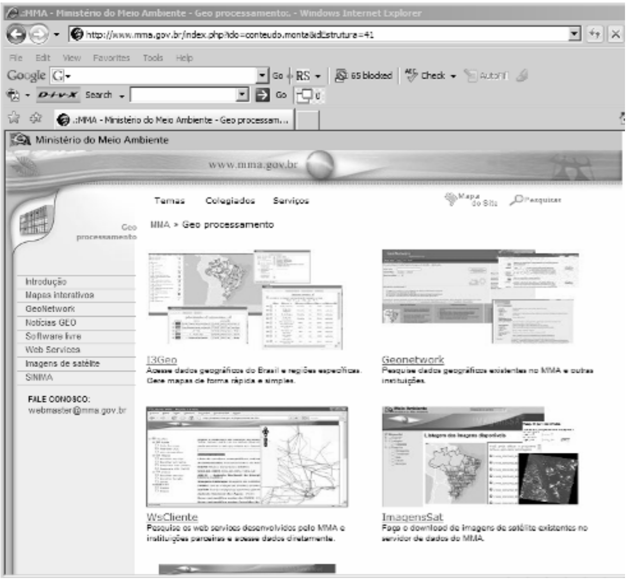

Figure 4 - Ibama/MMA clearinghouse available to the community (IBAMA, 2007a; http://mapas.mma.gov.br.)

PIGN - The National Geospatial Framework Project

Funded by the Canadian International Development Agency (CIDA) and the Brazilian Agency for Cooperation (ABC), PIGN started in 2004 when IBGE together with University of New Brunswick (UNB) and several bilateral partners developed this project (AZEVEDO *et al*., 2007)

The main goal of this project is to support the development of the Brazilian geospatial data infrastructure based on satellite positioning technology (AZEVEDO *et al*.., 2007). PIGN is helping IBGE to improve and to increase the national geodetic reference frame, at the same time that they are monitoring and coordinating the adoption of a new datum called SIRGAS2000 (PIGN, 2007a).

Also this project will give support to land reform (including traditions territories such as indigenous and ex-slave communities), environmental management and sustainable natural resources development (PIGN, 2007b). More detail is given at the http:// www.pign.org .

To better management the PIGN, it was divided into three sub areas of activities:

- Technical – Dealing with definition and transformations of the SIRGAS2000;
- User interface - Involving user requirements (direct or indirectly) and dissemination of the information (as shown in the Figure 5). IBGE into its website (www.ibge.gov.br) is distributing free tools to change coordinate in the old datum to SIRGAS2000. IBGE is making the SIRGAS2000 adoption easier for the community.
- Evaluation of the impacts – These activities inside the PIGN struggle with all cartographic, legal, environmental and social impacts existed with the changing of the datum.

Figure 5 – PIGN Website (PIGN, 2007a; www.pign.org)

4.3 Regional SDI

PRODES - Monitoramento da Floresta Amazônica Brasileira por Satélite

Coordinated by INPE, the PRODES deforestation assessment program is the largest forest monitoring project in the world. Using remote sensing imagery, the database has been updated yearly since 2000. PRODES maps are available on-line at:
< http://www.dpi.inpe.br/prodesdigital/prodesd.html >.

4.4 Local SDI

Belo Horizonte's GIS project

Started in 1989, this urban GIS project is managed by Prodabel, Belo Horizonte's information technology company locate at the capital of Minas Gerais State. The main efforts were focus towards creating the geographic database, the development of the necessary human resources, and the search for partnerships within the city (CÂMARA *et al*., 2006)

The GIS project has received national and international recognition for providing applications that deal with important social needs, including education, health, transportation, traffic, and environmental control, as shown in the Figure 6 (CÂMARA *et al*., 2006).

Figure 6 – ***Belo Horizonte's GIS*** Portal (PRODABEL, 2007; http://portal.pbh.gov.br/pbh/index.html?idNv1=91&idConteudoNv1=&emConstrucaoNv1=N)

4.5 Corporate SDI

MMA's ecological and economical zoning projects

Brazil's Ministry for the Environment (MMA) has produced two major spatial database sets, which support its initiatives for ecological and economical zoning into Brazil. One is called *ZEE Brasil* and the other *BCDAM - Projeto Bases Compartilhadas de Dados sobre a Amazônia Lega*l

It is a consortium of public institutions, which include IBGE, EMBRAPA (Agricultural Research Agency), CPRM and INPE. The first database set covers the caatinga biome in Brazil's semi-arid Northeast region the second covers the Legal Amazon area, which includes the rain forest and neighboring areas These databases include all publicly available information for these regions (CÂMARA *et al*., 2006; BCDAM, 2007).

The Figura 4 illustrates the MMA's Portal where all these projects can be found.

REBATE – Rede Baiana de Tecnologias de Informação Espacial

Started in 2000, this technological cooperation has partners inside the public (governmental and municipal), private (electrical power company) and academic (Federal University of Bahia) sectors.

The goal of this project is to better disseminate information on environmental conditions and to make use of the geotechnologies between private and governmental institutions, through an organized data framework (PEREIRA and ROCHA, 2004). REBATE also foresees the use of a GeoPortal for the Bahia State. It will give easy access to information for the population and maximize the social benefits of its investment.

The coordination with the State level is made through the Secretary of Economic and Social Studies of Bahia (SEI). It is responsible for producing the mapping of Bahia State. Bahia's Urban Development Agency (CONDER) will produce the mapping of the municipalities (ROCHA, 2003.)

5 CONCLUSION

When a SDI is designed, the first requirement is to understand the spatial information needs of the users. Understanding the social system that a SDI will operate in is critical, s well as the technical environment that will be supported by involved agencies.

There is not a standard SDI, each country has it own problems and policies, and these can even be different from state to state. Each country has its own initiatives at various levels of development. Each country also has political, administrative and cultural components have different priorities therefore a specific SDI model is sometimes not easily adaptable from one country to another.

Promoting spatial data infrastructures is a challenge that Brazil is dealing with at the moment. Many projects are going on, some of them with certain overlaps. The challenge is still how to coordinate all these sub-systems' interoperability.

Since a huge volume of data has already been collected (such as the datatset from the *Amazônia Legal*), it would be pertinent for Brazil to adopt geospatial data standards to avoid resurvey and reacquire all lost information.

The standardization of the geospatial data at this moment is crucial to Brazil for integration horizontally and vertically of all subsystems created up to now. It will reduce duplication of information and will cut down the costs to the federal government to develop SDI. With this, the maintenance of the data could have longer term benefits.

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