SPATIAL DATA USABILITY IN THE POLISH SPATIAL INFORMATION SYSTEM

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ABSTRACT

The paper presents the core concepts of the Polish Spatial Information System, reflecting the results of investigations performed within the framework of the research project conducted at the Institute of Geodesy and Cartography. The architecture of the Polish Spatial Data Infrastructure with regard to data flow and data access is presented. Describing the System the author stresses the importance of data-sharing arrangements on spatial data usability.

Keywords: Data usability, SDI, Database, Geo-data warehouse.

1 BACKGROUND AND RATIONALE

At present, there is a rapid growth in the availability of digital spatial data and a growing need to use it for all kinds of GIS applications and to support the decision-making process. The development of communication technology makes it possible to collect datasets from a variety of sources and different types of applications. Data providers make data available to users via the Internet. It has also become possible for every user to share some spatial data, and not just to collect it. Sharing data requires, first of all, extensive information about the scope of the data, and the place where it is stored. Furthermore, translation from the original source of data onto the user's system and its adaptation to specific GIS applications is needed.

GIS allows mixing data of different origin, and accuracy, which leads to the assumption that all objects in GIS databases are of similar quality. The digital systems are capable of processing data more precisely than the analogue ones, but the final accuracy of data still depends on the accuracy of the source data. The final accuracy relies on the qualities of the original data input and on the precision with which that inputted data is processed.

Data usability means the effectiveness, efficiency, and satisfaction with which users can achieve goals using the data in a particular environment (Howe, 1993-2001). As user requirements are very diverse usability is a relative concept and can only be determined in the context of its use. Users always define the usability of certain applications to fulfil the goal of the GI system. For most users the usability means that data has to be in the form that can be handled with the tools that a user possesses. Users need to know what data is in the database and what its characteristics are. One of the most important questions is how should the data be stored, maintained and made available to users in order to be usable by different applications?

Interest in the problems of data usability in Poland has grown significantly. The first studies in this area were conducted as early as 1980. The demand for spatial data is very high in both the public and private sectors. Only recently increased efforts have been made to prepare data in a more usable form. The research project *"Polish Spatial Information System"* is just being completed at the Institute of Geodesy and Cartography (IGiK). The main goal of the project was to prepare the strategy on how to build the *Polish Spatial Information System* (*SIS)*, which is in fact the National Spatial Data Infrastructure. At an early stage of the project it was recognised that most of the quality spatial data was available at local and regional levels, but this data was difficult to exploit in a broader context for a variety of reasons. This was the reason why data sharing arrangements on spatial data usability were stressed.

Four aspects were considered, in the framework of the research project, to enable high data usability:

1) Methodological – a methodology for creating the GIS application (a conceptual, logical and physical project, with object definitions, and a data dictionary), metadata, standards for recording, storing and

transferring data, clear and available documentation for further development, reference system and reference data, data integration and harmonization.

2) Organizational and legal– rules for sharing data, an agreement between the actors of spatial data sharing.

3) Technical – computer communication technology, openness in software and hardware technology, interoperability.

4) Economic – cost-benefit, funding, implementation strategy.

2 POLISH SPATIAL INFORMATION SYSTEM – GENERAL ASSUMPTIONS

The *Polish SIS*'s mission is to maximize the use of spatial data for the benefit of citizens, good governance and commerce. It is an excellent example of joint governmental activities, which demonstrates a nationwide collaboration between central government and local authorities.

The *SIS* will collect the geo information that is needed at the national, regional and local level and will provide nationwide access to information. Data will be integrated and maintained by the people who are best placed to maintain the quality of the information. Spatial data will be used as a basis for spatial modelling and analysis to produce value-added information.

The core concept is to integrate spatial information at three levels of administration: local, regional and national. IGiK has developed a model of *Polish SIS* that has the following components: an institutional framework and legal regulation, an information infrastructure, technical assumptions and a cost-benefit analysis. It respects the demands of a wide range of users; the main one is being public administration. The *System* will communicate with other existing information systems and public registries. The range of cooperation between *SIS* and other systems and registers as well as policy and legal regulations was analysed in detail. The interoperability of *Polish SIS* will be achieved by the development of standards for the representation of information, service interface, and by applying the standards to the implementation of the spatial data services and software development.

All relevant aspects related to data policy and legal regulations have been considered. Proposals on the issues that should be addressed within the framework and daughter legislation, and the way they should be progressed have been elaborated. A regulatory framework to access public sector data and information as well as to license their commercial exploitation has been proposed. The legislative framework has to include a provision for protecting personal privacy. As the semantics of data is of paramount importance common definitions must be adopted in developing the framework legislation and in managing the data and information (Hhakimpour & Timpf, 2001). It is therefore recommended that the proposed Legal Act should create new definitions and apply them to all legislation within the scope of the new Legal Act. A distribution policy based on both public interest and a commercial approach is proposed. It should contain restrictions that should be included in the licences. When establishing a government-wide data distribution policy, pricing principles should be applied.

The organisational nodes of the Polish SDI will be the *SIS Centres*, which should come into existence with a responsibility to ensure that core datasets are collected and maintained according to the specifications and priorities determined by consultation with the user community. It is recommended that *SIS Centres* should be established on the basis of agreements between participants and be organized as joint undertakings. Agreements should form the basis for the relationship, defining the benefits and mutual commitments of the participants; it should be clear and unambiguous (SDI Cookbook, 2000). It is advisable to establish a national, inter-ministerial council for *SIS* and a scientific unit, for example the Institute of Geodesy and Cartography (IGiK), to undertake an implementation consultancy and coordinate the research and development on the *SIS* domain. A regulation for establishing such bodies exists. *Polish SIP* infrastructure should be consistently implemented and rigorously enforced. As the component parts of *Polish SIS* already exist, the concept intends to help the community define and describe more clearly the infrastructure as a coherent entity. Taking into consideration the fact that cadastre data is one of more important components of spatial data (ETEMI, 2000) and with regard to the necessity for building the National Land Information System and the National Cadastre System as well as the *SIS* databases, it seems essential that the same technical and organizational infrastructure (Wysocka, 2002) be used.

The economic model of *Polish SIS* was formulated taking into account a varied organizational and technical infrastructure, as well as implementation phases followed by a cost-benefit analysis. Hence, the cost –benefit

analysis for *Polish SIS* comprises two variants of organization and financing. The main assumptions of the economic model were based on experiences of Australia, USA and Germany (EPA, 2000; Burrough, 2000; PriceWaterhouseCooper, 1995). A significant part of the economic model was to define funding sources indispensable for the project's implementation, with various organizational models considered. It was obvious that the creation of SIS in Poland should be endorsed by both public and private funds, and a mix of options ranging from Government funding to public-private partnership, as well as international grants and loans were considered to make this possible.

The solutions proposed in the concept are in accordance with the government's strategy of information technology development, including its telecommunication strategy. Spatial information is considered to be one of the cornerstones of the information society, as is stated in the document "Aims and directions of information society development in Poland" (Council of Ministries). The results of the research conducted during the project's execution indicate that there are technical resources available, indispensable to data processing activities (collecting, storing, archiving, maintaining, retrieving, delivering and transferring), such as computer and telecommunication facilities as well as software in domain of databases, GIS tools and applications.

3 USERS OF THE *POLISH INFORMATION SYSTEM* AND THEIR NEEDS IN THE FIELD OF SPATIAL INFORMATION

The *Polish Spatial Information System* is dedicated to public administration at each level of both governmental and self-governmental administration: locally, regionally and nationwide. So the principal goal of the *System* is to satisfy public sector needs in the field of geographic information and to develop people's (governmental and local decision-makers) awareness of geographic information and its associated technologies. The *System*, when established, should promote greater harmonization and interoperability among the public sector and between public and private institutions. The user community should reach an agreement on what fundamental datasets are required in the national interest, to what standards they should be collected and maintained, which agencies should have guardianship of the data, and what the national priorities are for the collection of that data.

As determining user requirements is a crucial issue in the development of any information system (Bernhardsen, 1999; GIS Devp. Guide, 2000) a structure base analysis identifying potential users and their needs has been conducted. The main actors on the Polish geoinformation scene are data owners, data providers, data integrators and distributors, data brokers, educators and clients (SDI Cookbook, 2000). The data owners and the data providers, defined as participants, are institutions that are engaged professionally and financially in the process of creating and exploiting the *System.* The participants include: government administration, local decision-makers, public utility service, land register offices, statistical offices, and some agencies (for example: environmental, agricultural, highway) and other public and private institutions. It is worth mentioning that the participants' requirements should be fulfilled at an early stage according to the functionality and facility of the *System*.

Administration needs spatial information for making many decisions. It has also been forced to systematically collect spatial data in the form of registers or files, for its regular operations. The collected data differs in their accuracy, quality and coordinate systems. Polish administration needs in the field of spatial data are as follows (Bielecka & Ney, 1999; Bielecka, 2001a):

- land register offices need detailed information about the location of parcels and property;
- public utilities are extremely dependant on the accurate spatial location of the technical infrastructure they have to maintain;
- planners (at all levels) require a lot of environmental and economic statistical data to undertake rational decisions;
- forest management departments use detailed spatial information to achieve the highest production;
- monitoring agencies are mostly interested in applying spatial data in modelling the environment and in detecting change;

- agriculture departments need a lot of information to estimate agricultural production conditions especially with regards to the tax and subsidy systems;

- water agencies use detailed data about hydro-technical infrastructure, land cover, soils and their infiltration ability, precipitations to manage water resources and for predicting floods and to mitigate of their consequences;

- statistical offices require up-to data and consistent topographic and cadastral data for providing regional and local statistics.

It was found that the requirements of almost all users (participants) are spatial in nature. Some of the users require information to solve very complex planning or management questions, while the others need only simple information about the location of objects. All of them prefer a cartographic form of presentation rather than other forms (text, tabular, graphs). In all of the cases above considerable effort is required to integrate datasets from separate jurisdictions to produce a consistent database. This is because the datasets have been produced without a a common standard, for the specific purpose of each jurisdiction. The datasets are usually difficult to integrate with other similar datasets due to semantic conflicts and a lack of common ontology (Bielecka, 2000).

The result of assessing users' needs is the conceptual project of a geo-database, with a thematic scope, a source of data, along with knowledge of its accuracy and detail. Although many of the datasets such as cadastral data, topographic data, environmental data are already in place, there are important differences between systems with respect to their accessibility, accuracy and local restrictions. This creates particular problems for GIS applications in all 365 local administrative units or 16 voivodships in Poland.

4 THEMATIC SCOPE OF THE DATABASE

The data required for the *Polish Spatial Data Infrastructure* varies according to the level of government administration. At local and regional levels it includes the following information groups (Bielecka, 2001b):

- Administration boundaries and boundaries of other land divisions (census population, forest, protected areas, and a lot more);

- Land and building register, addresses;

- Geodetic reference data;

- Land use and land development;

- Environmental information (among others: relief, hydrography, soil, protected areas, mineral resources);

- Technical infrastructure (transport infrastructure, public utilities);

- Socio-economical infrastructure (education, health and social welfare, security, culture and art);

- Statistical data (demographic and economic).

The detail or scale of spatial information should be suitable for local and regional purposes. It was noticed that the regional administrative level (apart from some selected detailed data) is mainly interested in information coming from an aggregation or the generalization of elementary data, collected at the local level.

One of the most crucial types of data stored at the local level (in LIS) is information about real estate. The development of the real estate market in Poland has resulted in a substantial increase in demand for reliable information on land ownership and the legal boundaries of the real estate. This information derives from two important registers. The first one, "Mortgage register", is a public register kept under the supervision of the Ministry of Justice. The second one, "Land and Building Register" is kept by second order administration units (powiat) under the supervision of the Head Office of Geodesy and Cartography and the Ministry of Infrastructure. Although these registers are autonomous in the sense of legislation, organization and financing, the transfer of information between them and *SIS* is of utmost importance. The cadastral data is the most useful

data that is collected in the National Land Information System. This data has the best usability as it is always stored in a similar way and the scope of information is always the same, the responsibility, the quality and all the information needed are well known. The LIS databases can be easily incorporated into other systems and integrated with them.

The information at the national level comprises, first of all, of reference data and metadata. Reference data, as well as metadata should be standardized and harmonized. It is proposed to establish a national standard for metadata based on the ISO Metadata Standard. It is fundamental for making data more usable. Reference data is the skeleton of the GIS application, it provides a spatial context and structure for geo-databases, and a mechanism with which to integrate and link diverse data (SDI Cookbook, 2000; ETEMI, 2000). The reference data components are as follows: geodetic reference system for both horizontal and vertical measurements, the register of administration units, ortho-images, the gazetteer, selected topographic themes. The list of the components reflects the most commonly needed and shared reference data in Poland. The other information mainly refers to the data in relation to Europe.

5 HOW THE *POLISH SPATIAL INFORMATION SYSTEM* WILL MAKE GEODATA MORE USABLE FOR THE USER COMMUNITY - OPPORTUNITIES FOR SHARING DATA

To achieve the main goals of the *Polish SIS* the following functions are indispensable: data collection, storage and maintenance, data updating, data integration, geo-processing, data retrieval and dissemination. The proposed functional infrastructure is adapted to the multiple levels of the organizational framework and enables the performance of distinctive tasks relevant to the character of a region. It means that mandates for *SIS Centres* vary, and they depend on priorities in land management, existing spatial resources and the number of data providers.

The structure of *Polish SIS* is modular and hierarchically oriented (Jankowski & Bielecka & Wysocka, 1999). The *SIS Centre* works as a module adapted to the administration structure of Poland. The hierarchy of the system applies, first of all, data models for the reference data and metadata, data communication, data transfer in an ordered manner. Integrated spatial data has to be stored in a geo-data warehouse. A geo-data warehouse is a central repository database into which the data from operational databases is copied, and it constitutes the main nodes of the spatial data infrastructure (SDI Cookbook, 2000). General assumptions for warehouse execution are the same, independently of the system's level. However particular solutions should differ according to functional requirements (obligations). Within a geo-data warehouse data is held in formats, which makes it available for analytical processing.

Cooperation between the *SIS Centre* and surrounding systems is maintained by interfaces called adapters. Adapters are specialized computer programs that allow automatic data transfer from source systems to the *SIS* warehouse. They are only used for the execution of regular, repeatable mandates; meanwhile singular, extraordinary orders are conducted by operators using DBMS functions. The other essential element of *SIS Centre* architecture is metadata. Metadata helps data providers collect pertinent data in a uniform format, which can then be inserted into a geo-data warehouse and queried automatically. The main feature of metadata is that it is structured in a hierarchical way (Poe & Klauer & Brobst, 2000). The first level comprises general information, the next – more detailed. Metadata will achieve the *openness* postulated in for the *Polish SIS.*

To deliver spatial information to a large number of potential users the Internet has been recommended and interface applications should be prepared with regard to data security and ownership. The role of this application is immense because an efficient retrieval of data depends not only on properly structured data in the database to provide fast data retrieval time but also on appropriate human computer interaction, including a well designed interface and query language for the information system.

It is obvious that data should flow both horizontally and vertically among nodes of the SDI. Horizontal exchange of data means data flow from source databases to a geo-data warehouse and between other geo-data warehouses located at the same level of administration. Queries and replays are sent vertically as well. Considering the goals of government activities one can easily see that the interest of authorities shifts from unique entities at the local level of administration to thematic and statistical data at the regional and national levels (Bielecka, 2000b). Data flow is bound with data processing for executing user requirements and takes place between a geo-data warehouse and a client. The scheme of data flow is shown in Figure 1. A client sends a request by the Internet (or Intranet) to a geo-data warehouse server (1). A server communicates with metadata (2) to identify and find pertinent data. The selected data is sent to an application server (3) where geo-processing is performed. The

results, in the form of a report, a map, a table and others are sent to the client using a dedicated interface (4) or web network. The information on analyses conducted is stored in log file.

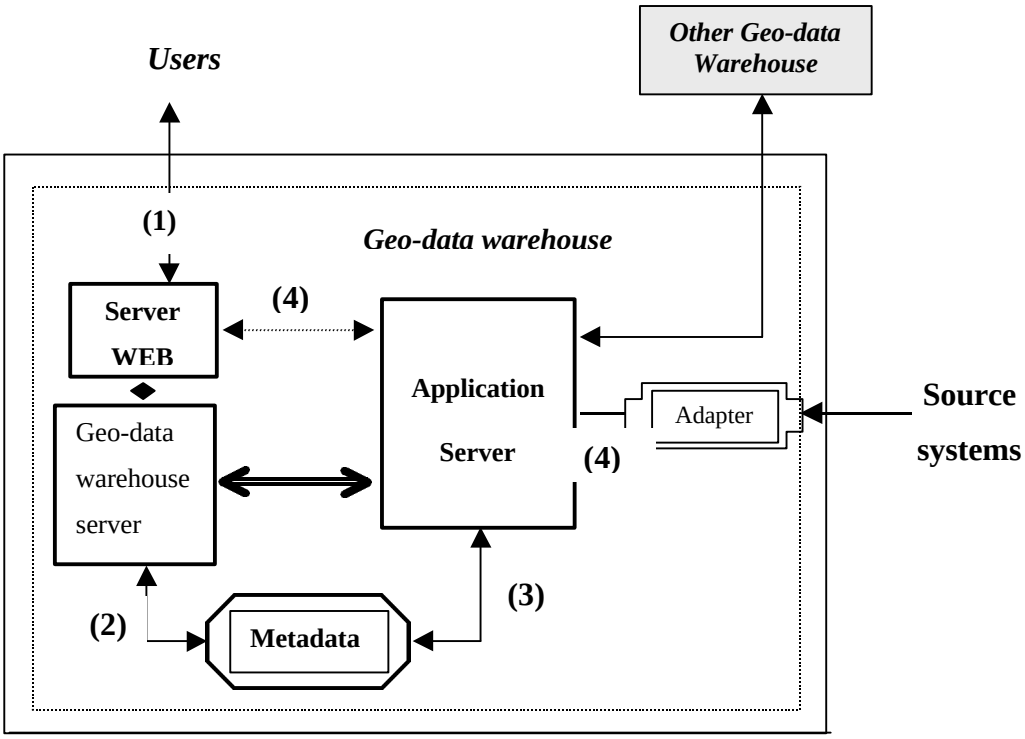

Figure 1. The scheme of data flow among nodes of the SDI, clients and surrounding systems.

It is strongly recommended that data exchange (via the Internet) should be carried out on the basis of agreement or commitment. Effective data exchange will be followed by standardized data models and applications, and requires the construction of an integrated database scheme. No fully automated approach for schemata integration is known today (Frank, 2000). But it is sufficient to identify the data and describe the common semantic and structure.

6 BARRIERS TO DATA SHARING

Even though spatial data is becoming more available for use, there are still many barriers to access to this data. Some are due to technical factors and the lack of information related to a data use policy. Many of these barriers can be overcome as a result of improved technology and policies.

At the local level of administration the scope of activities that the municipalities have wanted GIS to support as well as earlier computerization practices of local government have resulted in widely different system approaches. The completeness of GIS applications varies from the Land Register to complex city-management systems. The level of computerization ranges from stand-alone computers through co-operative computers to *client-server* architecture. In some systems OpenGIS technology is being implemented. The above-mentioned diversity creates technical problems when attempting to unify data sets.

Too little attention is still being paid to implementing the institutional framework and adequate legal instruments, which will enable the cohesion of the *Polish SIS* to be preserved without creating barriers to

cooperation with the surrounding systems. The lack of clear rules for sharing data, principles for copyright and privacy protection, as well as pricing policy, means that data is used without preserving personal privacy. Spatial data also contains personal information and other restricted information. Current legislation does not allow the delivery of this data to the user. Rules and practices for re-using the data diverge between units of administration and are very often not clear. The public sector bodies themselves establish ad-hoc policies when faced with a request to re-use information.

Even though a large number of geo-datasets exist their locations must first be identified in order to be made widely available in a consistent manner. So far there is a gap between the information itself and the available information about the information. Its usability is rather poor due to a lack of common access to digital forms of this data. The data has been collected and handled in different co-ordinate systems; is of unknown quality, is seldom up-dated, and is poorly documented. To all intents and purposes a metadata system for geographic data does not exist. Many data providers have either written or digital data descriptions, which are seldom made available to users. Data is difficult to access and rather expensive. The market for geo-information has been developing quickly and some of data suppliers have not been able to keep up.

A significant barrier to data sharing and to making it more usable is the lack of accepted standards for data recording, storiage and transfer. This creates a large number of problems when data exchange and transfer is of utmost importance.

Another limitation is the shortage of GIS professionals. There are still too few experts among clerks working at an administration level. Although, there are a lot of GIS courses, regular and occasional, under-graduate, graduate or post-graduate the awareness of improving the skills and abilities is insufficient.

7 FOLLOW UP ACTIVITIES

A lot of things have changed recently in the sphere of government and inter-institutional co-operation. Some agreements and commitments have been made among governmental, self-governmental administrative units, and private companies concerning the joint funding of a GIS system and in storing data. At the regional level GIS systems are built with topographic data as the reference data. Although the GIS environment is different, regional databases are harmonized at the conceptual level. At the national level most GI Systems are devoted to environmental monitoring and protection. They are continuously modernized, but most of them are still stand-alone systems.

In the GIS domain many activities have been taken over by the Head Office of Geodesy and Cartography – the Polish mapping agency. Only last year several immense projects were launched. These include: the topographic database (at the scale 1:10 000) project, DTM, a geographic database (at the scale of 1:250 000) and a metadata database.

Work on geographic information standards are being carried out by the Commission for Normalization Problems No 297 for Geographic Information, which is appointed by the Polish Normalization Committee. The Commission is responsible for the adoptation of European standards and the elaboration of Polish ones. The importance of standards in setting up a spatial information infrastructure in an orderly manner is indispensable. The following measures should be standardized:

- reference data and other thematic data sets of utmost importance;
- geodetic reference system;
- a metadata system and the way it works;
- data models and data quality;
- technical access to data.

So far only the geodetic reference system has been standardized, as well as the standard for exchanging data collected in the land register (SWDE).

8 FINAL REMARKS

The goal of this paper was to give an overview of the problems and solutions implemented to improve spatial data usability in Poland. The fact that Poland is still not ready for a full on-line spatial data infrastructure can be ascribed, in large part to the lack of financial resources and a clear policy framework. Inadequate funds are mainly responsible for the slow progress in digitizing cadastral and topographical data and the insufficient state of telecommunication. Long-term of funding must be obtained to develop, implement and maintain the Polish SIS on a continuing basis. Pervasive funding both from internal and external sources must be secured to ensure that a SDI is created.

The investigation into the potential for re-using of geo-data has shown that most users who need geographic data do not know that it has already been collected by others. The search for data that is already available is an important first step in accomplishing re-use. Hence the better documented an information source is, the easier it is for others to re-use it.

The difficulties faced by Poland in implementing a geographic information strategy and infrastructure are nearly the same as described by Cralia and Masset (2001). First of all there are limited financial resources, varying policies with respect to data access and pricing, poor motivation and little awareness across the different levels of the public administration system as well as a lack of management support and technical skills.

GIS provides a framework for integration, thus creating a GIS community that requires: standardized data sets; a network of data providers; a dissemination policy framework; an organizational framework for management; and technology for easy development. All the aspects mentioned above were considered and acknowledged in the concept of *Polish SIS.* Finally a spatial data infrastructure will help achieve a better future for the nation through better economic, social and environmental decision-making. Adopting the *Polish SIS* perspective not only helps users avoid wasting resources on data collection, storage and integration, but also to gain an impressive advantage as well.

The concept of *Polish Spatial Information System* was studied by the team of experts from research institutions, universities, government and private companies. IGiK was the leader of the working team. The concept has been widely discussed and the final version of *Polish SIS* has been elaborated.

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