Spatial Data Infrastructure in Sweden

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Key words:

ABSTRACT

Sweden was one of the first countries to address Data Infrastructure matters and have during several decades developed one of the world's most complete Spatial Data Infrastructure. This presentation will give a short history of the development of the Swedish infrastructure and a description of the present system, and its use and future development.

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The Swedish National Spatial Data Infrastructure

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1. INTRODUCTION

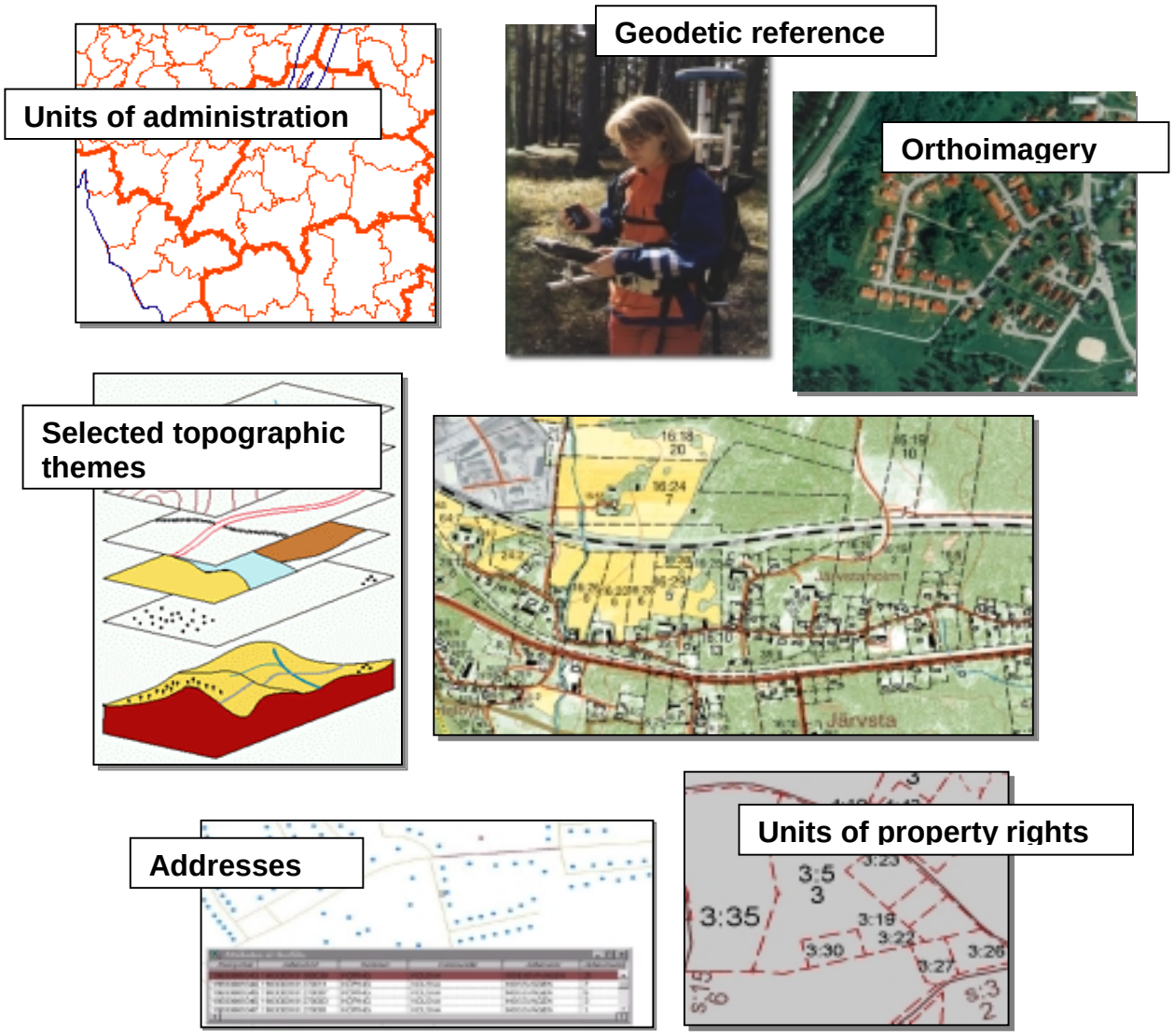
A nation's Spatial Data Infrastructure (SDI) is nowadays commonly considered as an important economic resource and an essential base for sustainable development of the society. The information in the SDI is a very essential part of a nation's Public Sector Information (PSI), which - in the knowledge-based economy - can have a strong positive impact on citizens' quality of life and the development of businesses and administration.
Many governments, the European Commission and other public bodies have more recently introduced ambitious policies, guidelines and programmes within PSI and SDI. The main objectives for those are to implement an information infrastructure that can provide public sector information for common use in the whole society.

2. SPATIAL DATA INFRASTRUCTURE - ONE DEFINITION

Several attempts to define national, international and global SDI have been carried through more recently by different actors. Though these attempts have resulted in slightly different definitions there are some common basic components within the models. These common components are presented below as a background for the description of the Swedish SDI.
The basic components in the SDI are:

- Information, different data sets with specific focus on **reference data sets** that form the foundation on which other spatial data sets are built, meta data is another important part of the information
- Legislative and institutional framework
- Human resources, technical systems and processes
- Strategies and action plans for interoperability, dissemination and use of the information.

Concerning the fist component the ETeMII project has accomplished an ambitious study on how to improve access to geographic information in Europe (ETeMII White Paper Report 6.2.2). The description of the information component in this study is of great common interest and the proposed definition for European reference data sets is therefore summa-rised here. Five components integrated in the sixth (the common geodetic reference system) create a complete set of reference data as shown in Figure 1 below.



In more detail these information components are:

1. **Geodetic reference system (i.e, a co-ordinate system).**
2. **Units of Administration.** Identifiers and boundaries of units that are used as basis for administration by governments at the local, national or European levels.
3. **Units of property rights (i.e, cadastral parcels).** Identifiers and extent of any cadastral parcels. It may include buildings considered as properties.
4. **Addresses (i.e, the point of delivery for goods and services).** Includes aggregation of addresses into units such as postcodes.

Selected topographic themes. Three elements are specifically identified

– Elevation models,

- Transportation networks
- Hydrography.

5. **Orthoimagery.** Imagery that allows the identification of landscape features is considered to be a component of reference data.
6.

The second basic SDI-component, the legal and institutional framework consist of policy decisions, laws and decrees and administrative decisions about the organisations that manage the SDI. This framework is of course specific for each nation and can for that reason be a lot different in different countries. In spite of that there are many similarities even among these basic components. A very important basic condition is a highly developed co-operation among responsible public bodies and between those, the market and the users.

The organisation and use of human and technical resources is of course also adapted to the specific institutional situation. A commonly used approach is a process-oriented workflow with the following components: building up the databases, management including updating and development, and dissemination. A very important maintenance approach is to update the information from the source of the information. This call considerable amount of arrangements and co-operation but is still the most efficient way to handle updating. The technical evolution in the IT-sector is an important driving force in the development. The use of standards in different areas is also a significant element.

The framework for interoperability, dissemination and use is also adapted to the specific national situation. Important common issues to address are co-operation on the reference data, use of standards, public-private co-operation. Since the accessibility and use of the information are the most important objectives there is a clear focus on dissemination. Financing and pricing are probably the most frequently discussed matters within SDI and also one of the most important. To have the information available on Internet is of course a natural part of the dissemination. Less obvious still important is direct accesses to the information fom handling systems and other applications in business and administration. This is often achieved within a public-private co-operation where the public body is responsible for the base information and the private partner develops the application.

3. A GENERAL VIEW OF THE DEVELOPMENT OF THE SWEDISH NATIONAL SPATIAL DATA INFRASTRUCTURE

The Swedish SDI is developed out of the Land Data Bank System, the Land Use Map and the Topographic Map, all based on the National Geodetic Network.

A short history of the development is presented below.

Sweden was one of the first countries to address Spatial Data Infrastructure matters and has during several decades developed one of the world´s most complete Spatial Data Infrastructures. The first ideas in this field – to give basic public information a spatial dimension and use computers for analysis – was presented by Professor Torsten Hägerstrand in 1955. The ideas represented the earliest form of GIS booth in the meaning Geographic in

Statistics and Geographic Information System. The ideas influenced the design of the Swedish Land Data Bank System – the worlds first computerised Land Information System. Central co-ordinates-based on the national geodetic reference system – for parcels and buildings were implemented in the system and gave a spatial dimension to all information that could be connected to the parcels or buildings for instance owners, citizens, property value and different services.

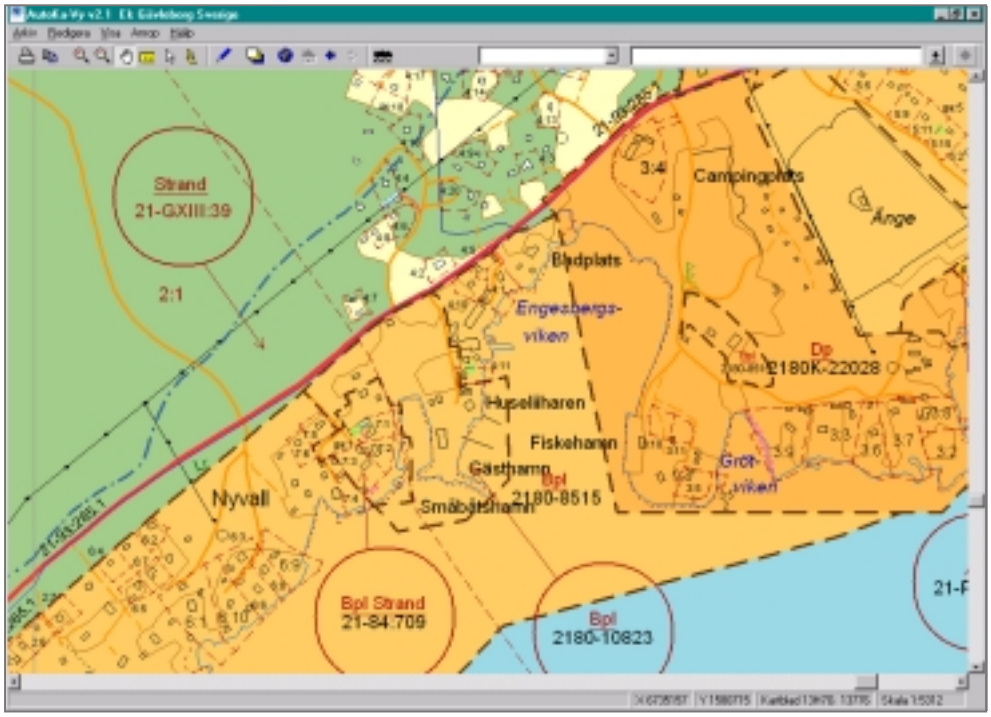
The Land Data Bank System - a combined Cadaster and Land Register - was first established in one county in1976. The implementation in the whole country was finished in 1995.This very fundamental reorganisation was carried out by an organisation specifically created for this task – The Central Board for Real Estate Data. The National Land Survey – responsible for cadasteral services – and the National Courts Administration – responsible for land registration – participated in the reorganisation and the system is now managed and maintained by the new National Land Survey, (Lantmäteriet).

In the nineteen-seventies and eighties National Land Survey produced a new Land Use Map and a new Topographic Map. By the time the production was more computerised but the result was still to a large extent printed maps. User demand for digital spatial data grew dramatically when PCs and Geographic Information Systems entered the market in the late nineteen-eighties and early nineties. The National Land Survey responded to this and launched a programme for digitising the basic information content in the Land Use Map and the Topographic Map. The programme was completed for the whole country in 1997. Other governmental producers of spatial data and the municipalities carried out similar programmes.

In the middle of the nineteen-nineties substantial digital data were available but still were constitute not structured and integrated to a Spatial Data Infrastructure. The necessary co-ordination of organisation, information and systems now began and in a few years a real national spatial data infrastructure was established. A key activity in this process was the merging of the Central Board for Real Estate Data and National Land Survey into the National Land Survey, Lantmäteriet in 1996. Main objectives for this merging were to co-ordinate and integrate the information in the Land Use Map and Topographic Map with the information in the Land Data Bank System. This integration began in 1996 when Lantmäteriet started the production of a new National Cadastral Index Map.

The Cadastral Index Map contains graphic information on properties, parcels, plans and regulations and easements. It is produced out of data from the Land Use Map and from Large Scale Maps in the municipalities. It is the base for all geographic data sets that present property information. The properties and other objects will be handled with unique identifiers integrated with the information in the Real Property Register. It is stored and managed in a system run by Lantmäteriet and as all information in the Real Property Register updated by the source of information daily. It will be completed for the whole country before the end of year 2003 and it is available via Internet and other channels.

An example of the Cadastral Index Map is shown in Figure 2 below.



A new law on the Real Property Register was introduced in Sweden in year 2000. The law replaced the old legislative framework for the Land Data Bank System from the nineteen-seventies and is a base for a partly new structure for Real Property Information. Important news is that the Cadastral Index Map is a part of the Real Property Register. The information in the Real Property Register is divided into five different parts with the information listed below:

Real Property Part	**Land Register Part**
property unit joint property unit co-ordinates plans, regulations and rights precincts joint facility cadastral index map	title leasehold mortgage rights notifications
Building Part	**Address Part**
building unit address co-ordinate	address unit property unit
Property Tax Assessment Part	
total assessed value assessed value for land assessed value for buildings basis for valuation owner	

The new structure of the Real Property Register and the establishment of the new Cadastral Index Map have given Sweden a most modern system and the Real Property part of the Swedish SDI now fulfils all demands from the society and the market.

Lantmäteriet has also worked with other important parts of the reference data since the new organisation was introduced. The activities concerning addresses and transportation network is presented below.

The location address and the postal address for property units and buildings are stored and handled in the Address Part of the system for the Real Property Register at Lantmäteriet. The address situation in Sweden is not in all aspects good. Especially in rural areas there is a lack of location addresses. Lantmäteriet, the municipalities, the Swedish Post Company and the Swedish National Tax Authority have together launched a programme in order to improve the situation and establish a system that can fulfil the demands on a SDI within this part. The municipalities are responsible for creation and updating of location addresses. Within the programme they set new location addresses in the form of street addresses, village addresses or other kind of addresses in the rural areas. The addresses are delivered to Lantmäteriet. In co-operation with the Swedish Post Company postcodes and postal places are added to every location address. The complete addresses are stored in the Address System and disseminated for use in the whole society. An important part of the dissemination is the deliveries to the National Taxation Authority were the addresses are used in the system for national registration of citizens. In this way addresses spread to every citizen and to activities connected to them. This joint programme has now improved the Swedish address system and it now meets the demands one can have on the address part of the SDI.

The transportation networks; streets, roads and railways, have always been a part of the information in the Topographic Map and the Land Use Map. The information has to a great extent been stored in databases mainly used for map production without a proper structure with nodes and links, identities and topology that is required in a SDI. The Swedish National Road Administration has managed a Road Database with information mainly used for management and maintenance of the main roads and with poor geographic presentation. This database covered only the roads managed by the government authority, about 100,000 km out of a total of more than 500,000 km in the country. In 1996 the Swedish National Road Administration was assigned by the government to establish a national road database in co-operation with Lantmäteriet, the municipalities and the forestry industry. The Swedish National Road Database (SNRD) is now established in a specific system and the basic network with identities, nods, links and topology are also to be implemented in the system with basic geographic information at Lantmäteriet. Network and attributes will be updated currently by the municipalities and others. The information in the SNRD is based on a Swedish standard and will be the basis for all information concerning the Swedish road network. Since it is also established in the system for basic geographic information it is a part of the reference data in the SDI and fulfils the demands on the transportation network part of the SDI.

4. CURRENT SITUATION AND SOME CONCLUSIONS

Though there are still some programmes to be completed, the Swedish National Spatial Data Infrastructure is now well established and the SDI is a good base for the development of the Swedish society. The management, maintenance and future development of the SDI is a task that can be well compared with the establishment. New possibilities and increasing user demands are new challenges to deal with for those responsible for the SDI.

For the basic components in the SDI the situation is summarised below:

4.1 Information

Compared with the complete set of reference data proposed by the ETeMII project the Swedish SDI holds a strong position**.**

The Geodetic Reference System is well established and used. Permanent GPS beacons providing differential GPS services is also in use. The System is adjusted to the common European and Global Reference System.

The Units of Administration are well established in the Real Property Register and in the system with basic geographic information. It is possible to generate most kinds of administrative units out of the system and one example is the Swedish part of the Seamless Administrative Boundaries of Europe (SABE).

Units of Property Rights are perhaps the strongest part in the Swedish SDI with the Real Property Register and its Cadastral Index Map.

Addresses are with the joint programme described above handled in a way that all requirements within the SDI will be satisfied.

Selected topographic themes

- **elevation models** are established for the whole country
- **transportation networks** are well established with the Swedish National Road Database
- **hydrography** is established in the system for basic geographic information, this information is still in a quit simple structure but a programme to make it more adjusted to the infrastructure will start in 2002
- **Orthoimagery** is well established and there are orthophotos covering the whole country

4.2 Legislative and Institutional Framework

The legislative framework is adequate with the new law on Real Property Register and the responsible organisations are well established and efficient. The situation in Sweden with strong municipalities, responsible for large-scale mapping, calls for a developed voluntary co-operation between responsible national governmental bodies the municipalities in order to achieve an efficient NSDI. Such a co-operation has been developed in recent years as well as the co-operation between governmental bodies.

4.3 Resources and Processes

A process-oriented workflow is implemented at Lantmäteriet. The approach to update the information at the source of the information is implemented for all reference data and also for other important data sets.

4.4 Interoperability, Dissemination and Use

The co-operation between responsible bodies and the commitment to use common standards have lead to a satisfactory interoperability. The dissemination of base information, for instance via Internet, and the development of applications by service providers have lead to a widespread use of the information (more about that below). The pricing policy for base information has an out-spoken low-price profile even if the information is not free to use without fees.

The current situation for the Swedish NSDI can be illustrated as in the Figure 3 below. The bodies responsible for the activities that create the information also update it in the SDI. Within the SDI the responsible bodies co-operate. There is an efficient dissemination to service providers and users.

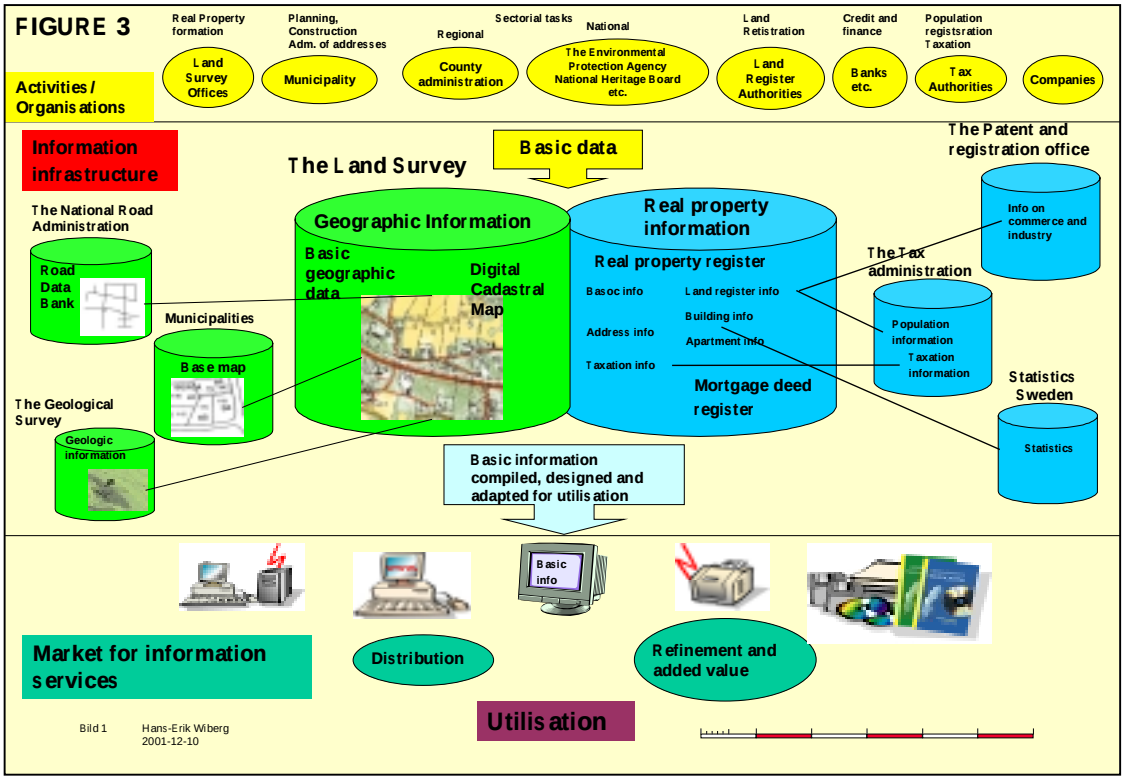


FIGURE 3

5. SOME FACTS AND NUMBERS

In order to illustrate the costs for and benefits of a NSDI some figures from the Swedish experience are presented.

A well-known fact is that the funds needed to build up the databases are the main investment in the SDI. That is also the experience in Sweden. The cost for the build-up of the Swedish Land Data Bank System is calculated to about USD $ 80 million and for the build-up of the Cadastral Index Map about USD $ 30 million. The programme for build-up of the databases from the Land Use Map and the Topographic Map is calculated to about USD $ 50 million. The annual cost for managing the SDI at Lantmäteriet is about USD $ 30 million.

These figures could be compared with some macro economic figures for Sweden. The total market value for all real property units is estimated at about USD $ 600,000 million. The total amount of mortgage based on real property was in December 2001 USD $ 213,000 million. The total value of the shares at the Stockholm Stock Exchange Market was in January 2002 USD $ 296,000 million. The annual tax for real property, paid to the government was for year 2000 USD $ 2,300 million and the annual transaction tax for title transfer and mortgages was US $ 470 million.

6. THE USE OF THE INFORMATION IN THE WHOLE SOCIETY - THE BEST BENCHMARK

The most essential objective for the SDI is to deliver information that can fulfil the demands from users in the whole society. The best way to evaluate the SDI is therefor to look at the users and their use of the information. Lantmäteriet carries out an annual survey about this and the result is used as a base for programmes for improving the activities. There are other methods to measure user satisfaction and a common recommendation is just to listen to the service providers and the users and try to adjust the activities to fulfil their demands.

To measure market shares is a common used method. Within the SDI, where the producers often have some kind of monopoly, this method is not very suitable. An interesting method could instead be to measure how many actors in a business that is using the information in the SDI. In Sweden, for example, practically every bank office and real estate broker have access to the SDI in a way that the information is used in every real property transfer and mortgage matter.

7. THE FUTURE

The Swedish SDI is now well established but there are still a lot of new and changed user demands to fulfil and a lot of opportunities to exploit. The basic concept will be the same for some years but the focus will be on management, maintenance, updating and development in stead of building up the databases. The development will for some years be directed towards object handling methods both for the information and the systems.

The use of standards, especially these who are now prepared by ISO/TC 211, will have a great positive impact. The GIS-market will also continue to develope. The business is still a young application field.

In Europe there is a strong force towards harmonising of data set on a European level in order to support policies and activities in environmental, agricultural, transport and other areas. Such a European SDI will be based on the spatial infrastructures that are established in the nations. Examples on this are the environmental initiative E-ESDI and the proposal within transport, E-RDS. The some kind of initiative can also be seen on the global level.