

INFRASTRUCTURE FOR SPATIAL INFORMATION – DANISH INITIATIVES

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Abstract:

Network technology is changing society. We are faced with a new agenda for the Danish welfare society. Economic and political rules are modified. The relations between people, enterprises and authorities will also change. It will influence the geodata/spatial information business.

Today the production of spatial data/information (map data as well as georelated register data) in Denmark is a business running into millions. However, it is very common for different organisations (public as well as private) to duplicate data, as data produced for one purpose or for use in one system cannot necessarily (or only with difficulty) be used in another system, etc.

To accelerate a better use of current and reliable spatial information on all levels and to ensure a continued economic growth, social quality and stability as well as social progress, some initiatives have already been implemented in this field - others have to be. The initiatives are meant to support the national infrastructure for spatial information. The goal must be a road towards information communities instead of isolated solutions in the single organisations. However, a national infrastructure can become a reality only through co-operation between local and state authorities, the private sector, the universities and the sector-research institutions. The initiatives are in agreement with one of the focus points of the recently established Map and Geodata Council appointed by the Minister of Housing and Urban Affairs.

The paper will present initiatives already carried out, initiatives under execution and planned initiatives.

Introduction

The Internet and other network technologies are rapidly changing the geodata sector. Today it is possible to increase the access to digital maps and digitally related registers. The market for spatial data/information¹ in Denmark is therefore expected to expand and will consequently be an important driving force in the years to come.

Over the past two decades analog maps and analog georeferenced registers have been converted to a digital form and new data have been created to fill the gaps. That is why Denmark seems to be in a favourable position concerning spatial information. At the same time the use of GIS (Geographic Information Systems) in both the public, semi-public and private sector is growing among other things thanks to the previously mentioned Internet technology.

¹ Spatial data/information is often used as synonym of geographic data/information or geodata/geoinformation. Spatial means here the physical space used to describe the geometry and the characteristics of different objects and related attributes.

However, in certain areas different organisations² (public as well as private) produce the same data and offer the same product. Moreover data produced for one purpose or for use in one system cannot necessarily or only with difficulty be used in another system, etc.

As far as we can see these problems are not always of a technical nature, but are often of an organisational nature. Some institutions have not been used to or do not have the culture in working together. Data sets collected at a local level are not always accessible on a national level, and vice versa, often because of economic disagreements. Even public authorities may see themselves as competitors though there is a growing understanding and commitment to coordinate. The will to share data at a fair price between public authorities is often disputed. The same dilemma is often seen between semi-public and private producers and users. If finally data are accessible and the owner is willing to share them, new problems may arise that make a common use of the data sets problematic. The data sets may be incomplete and incompatible, data may be insufficiently documented (no metadata) and in the worst case totally obsolete.

The situation has improved considerably the last years thanks to scattered initiatives, but to accelerate a better use of current and reliable spatial information on all levels more initiatives have to be taken. The initiatives described in this paper are meant to support a National Spatial Data Infrastructure (NSDI) in Denmark. Keywords are connectivity, interoperability, coordination of semantics etc.

The infrastructure concept

A NSDI is not a new area on a global level. The first generation of national infrastructures for spatial information has already been presented and evaluated. Leading nations have been Australia, USA, Canada, Britain, Portugal and the Netherlands, but also Nordic countries as Finland, Sweden and Norway have decided on a NSDI. Common for all the countries is that the infrastructure has been explicitly national and that there is no general consensus for the meaning of a NSDI. The last mentioned means that there is considerable confusion regarding the purpose, scope and contents of a NSDI. One position is that a NSDI is a product, a core data set of spatial information available for the whole nation (a national spatial database). Another position is that a NSDI is a process, a strategy required to manage national spatial data/information (a national spatial data framework).

In Denmark we have defined an infrastructure for spatial information as the technologies, politics and rules necessary for a socio-economically effective use of spatial information at all levels and across in the public administration, among private enterprises and organisations and in the academic world.

In some of the countries there is a legal mandate to develop a NSDI, in others a NSDI is an outgrowth from established mechanisms. Denmark³ belongs to the last group.

Why a national infrastructure?

We are already, as mentioned previously, on the threshold of a future where computers and electronic data processing are a generally used information and communication means in the interaction between citizens, private enterprises and public authorities

Investigations indicate that about 80% of the requested information can be related to a place on the ground (in the space). This applies to information for public and private tasks like planning, projecting, market analyses,

² In Denmark, The National Survey and Cadastre is by law obliged to produce topographic maps (medium and small scale maps), but users of large scale maps (municipalities, utility companies etc.) have to produce these maps themselves or let private mapping companies do it for them.

³ With an area of 43,080 sq. km Denmark is the smallest of the Scandinavian countries. The great majority - about 85% - of the country's 5.3 million inhabitants lives in towns or urban areas and approximately one-third of the total population lives in the metropolitan region of Copenhagen.

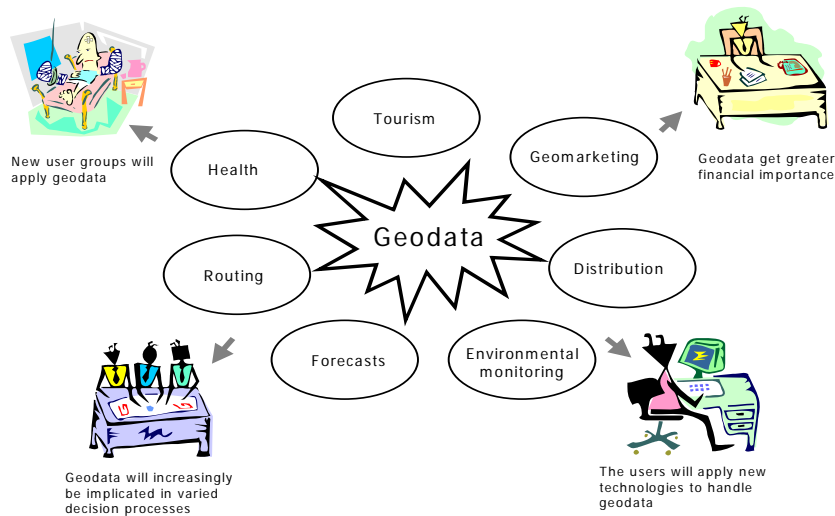
There are three levels of governmental administration in Denmark: central government, county authorities and municipal authorities. Municipalities and counties are both headed by politically elected councils and function partly on the basis of local political decisions, partly in accordance with legislation passed by the Folketing (Parliament). Local authorities are responsible for more than half of the public spending.

real estate dealing, tourism and much, much more. Especially in the environmental field there is at present an increased demand for information on land use and environmental effects, information which is essential to public authorities to be able to solve statutory tasks. On that account many public authorities have invested in GIS.

At the same time the citizens are increasingly demanding better service from the public sector by way of more information and greater transparency in all the mentioned administration tasks. In the future, we will also see that the use of spatial information is spread to far more categories of users than today, including the business world. It is also foreseeable that these new users will have quite different expectations on the spatial data/information of which they will be buyers or users. In the future spatial information may be a product on equal terms with other consumer products in society. The development will imply that very soon there will be demand for relevant, topical and reliable spatial information in electronic form available 24 hours a day and in standards which are usable to all.

With the increasing technological development taking place these years, including the development of the GIT (Geographic Information Technology), GPS (Global Positioning Systems), media technologies and different forms of networks, among these the Internet and the FWA (Fixed Wireless Access) technology, we will get entirely new possibilities of collecting, using and exchanging data. We should also be able to utilise these data much better than today and in quite different ways than we are familiar with or can imagine today.

New business fields apply geodata!



By using IT-based technologies we will also move from a passive to an interactive culture. This means that we all become active users of spatial information - and maybe also producers of new spatial information based on available data sets.

At one and the same time the mentioned information must comply with the needs of different authorities, the business world, the research and the citizens, both within own organisations and across previous professional and administrative barriers - something which is only possible with difficulties today.

We must recognise that also in the future spatial data will be collected and maintained by different organisations and not in a monolithic database. This means that new demands have to be made on

organisation of data, among them accessibility, formats and quality as well as documentation (metadata) of our many digital map and register databases. As a further consequence we must also revise our view of various aspects and barriers in connection with collection, division, sharing, purchase and sale, distribution and use of spatial information.

The initiatives relative to national governmental initiatives

In the report "The Digital Denmark - adaptation to the network society" published in November 1999 by the Ministry of Research the new IT strategy of the government is initiated. In connection to this a policy has to be formulated on how citizens and enterprises can use and profit the society's investments in maps and registers, etc. in new ways. One of the subgoals in "Goal 3" is to direct the efforts towards a better and cheaper service in the public administration. This service is to be obtained through "an effective digital administration based on electronically stored data". Some of the advantages mentioned are partly the possibilities of unlimited reuse of electronically stored data, partly the possibilities of quick and cheap access and distribution of data by electronic means, for example the Internet.

In the follow-up on "The Digital Denmark", named "Adaptation to the network society, IT and tele-political statement for the Folketing", published by the Ministry of Research in January 2000, the following is one of the things mentioned under initiatives, which are to be initiated in 2000: "The digital administration, including the public information server, which must allow easy access to all the information that the public sector has registered about Denmark and the Danish citizens". In the same report, however, a number of matters is mentioned which makes these challenges difficult to achieve. One of them is that a divided public sector impedes a co-ordinated adaptation process.

At the end of 1999 the Minister of Housing and Urban Affairs established an advisory body: The Map and Geodata Council. One of the focuses for the new council will be a geodata policy. Hanne Brande-Lavridsen, Aalborg University, is a member of this Council.

The initiatives in the EU and international perspective

As mentioned previously, a number of countries have already realised the importance of directing attention to infrastructures for spatial information, and they are also supporting the further research and development within this field. The background is an growing realisation that research and technology play an increasing role at the implementation of new policies both nationally, within the European co-operation and globally. There is a need that the research produces new knowledge, which can be used in connection with the development of new policies within environmental protection and land and resource use, etc., which again shall guarantee all of us economic stability, social security and quality of life.

Under the Info2000 programme and the GI2000 initiative & 5th framework programme the EU has also planned a European Infrastructure for Geographic Information (EGII) for exchange of data across the borders. The initiatives are still in an initial stage, but it has been realised that a lot of different market mechanisms (political as well as economic), technological matters (formats, standards) and legal conditions have to be clarified first. A total harmonisation of spatial information within the EU and Europe is therefore still far away.

At a global level, efforts are directed towards the establishment of common standards (CEN (Comité Européen Normalisation), ISO (International Standardisation Organisation), OGC (Open GIS Consortium), etc.) for establishment of global data infrastructures (the GDIS initiative).

The international standardising work in the geodata field is well established and in a very active development. A Danish infrastructure for spatial information will have to be connected, to the possible extent, with the mentioned standardising work, and this will therefore be an important element in the NSDI initiatives.

What has been done so far?

The initiatives so far in Denmark are characterised by being concentrated on isolated fields and are therefore more or less uncoordinated.

Digital maps

Today Denmark is covered by digital large scale maps (*technical maps*) in scales from 1:1000 (towns and built-up areas) to 1:10.000 (rural areas). As the maps are produced on demand by different users and in different qualities (TK1, TK2 and TK3 standards) the maps do not form a homogenous nationwide product. During the last few years the *Specifications for Technical Maps* (originally produced on initiatives from the municipalities) have been revised radically to adapt them to an object-oriented model conception. Consequently, the demands on the geometric connection, accuracy and completeness of the map features have been substantial.

The *Danish cadastral maps* are a legal ownership map series that defines property boundaries, administrative boundaries etc. The map series has since 1997 been in digital form and is based on *Specifications on Digital Cadastral Maps*. The technical maps, as well as the cadastral maps are designed on the basis of the Danish Reference System 34.

The *Web-cadastr* is an information system on the Internet that contains updated cadastral information. Using the system requires subscription.

In December 2000 the National Survey and Cadastre finished a nationwide map database (*TOP10DK*) in scale 1:10.000 (based on the *TOP10DK Specifications*). The TOP10DK is expected to become very important in connection with an integrated use of spatial data. The map database is built up to be used among other things in GIS connections and the map will eventually have different linking facilities for example to the property-related data collections. TOP10DK includes a *Digital Terrain Model*.

Digital colour orthophotos based on aerial photos have in recent years found increasing use by Danish users of geoinformation as base maps for presentation of different thematic data sets. The orthophotos (with resolutions down to 40 cm (in town areas down to 8 cm) are produced and sold by several private photogrammetric companies.

Also available are several map series on the Internet. First of all we have several *road and street maps* and road-search machines produced by private companies, but also many counties and municipalities have published *thematic web-maps* and *regulation plans*.

We can conclude that within Denmark there are reasonably well functioning digital map series and specifications for the production of these maps (including common object types) with possibility for description of quality and quality checks.

Public digital registers (databases)

The registers can be distinguished between legal property registers (the Cadastral Register and the Land Registry Information), administrative property registers (the Building and Housing Register, the Communal Property Data System and the Planning register) and other registers (the Central Population Register, the Sales and Valuation Register and some industrial registers).

The *Cadastral Register* (digital from 1986) is a central registration of all property in the country in relation to the law providing for the parcelling out of estates, the law governing agricultural matters and the Forestry Act. It also forms the basis of the *Land Registry Information* (digital from 2000) and of the Communal Property data system (ESR).

The *Building and Housing Register* (BBR) is a nationwide register of all buildings and residences. The register, which was finished in 1977, is updated daily in the municipalities in connection with building casework etc. The register was established to form the linkage between, on the one hand, the Cadastre, the Land Registry, the Municipal Property Register, the Real Property Taxation Register, the State Sales and Assessment Register etc. and, on the other hand, all other registers using the CPR-number or address code as identification (see later).

The *Communal Property Data System* (ESR) is a nationwide municipal register over real estates. The register contains all information about the estate important for its valuation. The individual municipalities do the input of data.

The *Planning Register* is a nationwide register for municipal plans, local plans, town plan regulations as well as urban renewal plans and land value areas.

As a fundamental component for activities in the public sector (such as planning, budgeting, provision of social services etc.) and for private enterprises a *Central Population Register* system (CPR register) was established in 1968. The identification herein is the person number - the CPR- number. The register numbers all persons residing in Denmark and includes the address of each individual person.

The tax authorities use the *Sales and Valuation Register* (SVUR) for calculation and collection of taxes.

The *Enterprise Register* (CVR) is a central administrative register of all private and public legal entities (enterprises). The register also includes larger construction sites.

All Danish farmers are registered in the *General Agricultural Register* (GLR) / the *Central Domestic Animal Register* (CHR) by either a SE-number or the user's CPR-number. The register contains information about the enterprise. The GLR/CHR register is described in a data model.

The *Land Information System* (AIS), finished in 2000, is the first attempt to integrate geoinformation within the nature- and environment field in Denmark. The system (thematic maps and their data sets) contains information about the countryside such as habitat types, land use, hydrology, natural resources etc.

The registers have originally been designed for specific purposes and have been used and kept at the institutions that have developed the databases. However, with the introduction of GIS, the data has become available for many new users that may use the data for other purposes the data was originally designed for. In contrast to the digital maps we must conclude that at present there are only specifications for the BBR, CPR and CVR registers and no well functioning specifications for the other registers.

Keys and geo-references

A condition for combination of data from different data collections is that common keys exist in the registers. To ensure this an independent key register - the *Cross-Reference Register* - has been established. The register has no data contents like a number of descriptive data; however, it exclusively contains common keys as well as the relations between these keys.

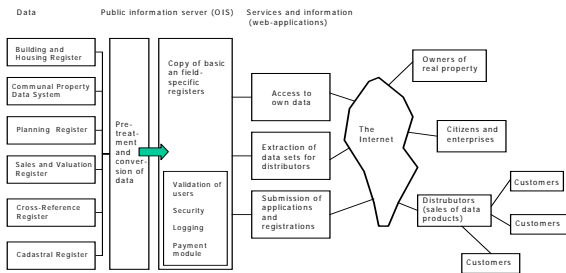
It is widely accepted that the address issue is of great importance when talking about spatial information. The address can link data from registers containing personal, property and enterprise data sets. In Denmark several address themes have seen the light of day. *DAV* (the Danish Address and Road register) is produced by a private company Kampsax and "*Adresseprojektet*" is produced in cooperation between public authorities. "*Adresseprojektet*" is based on exact co-ordinates to the addresses.

Data models

The conversion of the property-related data collections to digital form and an increasing interest in an integrated utilisation of these data have resulted in the need for establishment of a data model for the property data field. Based on this and on an assessment of the business areas - land registration, cadastral changes, property assessment, etc. - linked to the central property-related data collections, a logical data model for the property data field has been developed under the auspices of the National Survey & Cadastre (*Logical data model for property data*). The data model has been developed on the basis of knowledge of administrative traditions and the legislation linked to the respective business areas. Also other data models e.g. *The County Data Model* have recently been presented. All public authorities have been encouraged to draw up logical data models for those administrative functions for which they are responsible

Public services

Kommentar [k1]: Det er ikke helt rigtigt. BBR er velbeskrevet i både lovgivning og regler, bla. BBR-instruksen. Det samme gælder CPR og CVR, medens GLR/CHR er grundigt beskrevet endda tilmed i en datamodel. Derimod er ESR, Planregister og Krydsreferenceregister meget ringe dokumenteret.



The Public Information Server (OIS) concept

Under the auspices of the Ministry of Housing and Urban Affairs a piece of work has been started to develop and implement a public information server (OIS). The concept around OIS is to give potential users - citizens, enterprises and public authorities - the possibility of getting data from the public data collections via the Internet (only register data), including property data. It is expected that the information server will be in operation from the spring 2001. It has not yet been decided whether the service is going to be free of charge or a fee will apply to the users.

If other initiatives shall be emphasised, one must be the info database Geodata-info.dk available on the Internet. The info database is a catalogue (metadatabase), describing the digital maps and other collections of geo-related data in Denmark. The metadatabase gives a short overview of each data set, and where to get further information about the data set.

What to do next?

The above described confirms that Denmark already have many well functioning datasets. However, there are still problems. The data sets are developed and maintained in many different organisations and are often expensive to access for users outside them. The definition of the same objects and concepts in the data sets may differ from organisation to organisation, which makes collocation etc. very difficult.

Good inspiration in developing a NSDI can be derived from the results obtained by the countries previously mentioned; however, none of the recommendations can directly be transferred to Danish conditions. The traditions in the legislation and geodata use are much too different for that.

The objective of a national infrastructure is to create the basis for co-ordinated solutions across organisational boundaries (local/regional/national authorities - private/public organisations - public authorities/the citizens, etc.). On many occasions public as well as private enterprises within the geodata sector have pointed out organisational and structural problems as drags on an effective utilisation of our spatial data/information. At the same time the new network-based economy involves possibilities of market expansion. However, the necessary knowledge about essential infrastructural conditions for such expansions is not always available today. The research initiatives mentioned below shall make essential contributions to provide this knowledge. Furthermore, it is foreseeable that demands of an infrastructural nature will be made on Denmark from international quarters (firstly the EU) as regards barrier-breaking data sets, and therefore we have to be at the forefront of the international development, both technologically and commercially.

Basic public databases containing spatial core data, which are stable, standardised and can be used effectively, should be part of the infrastructure of the Danish society. The databases should be the basis for rationality, efficiency and growth in the country as well as for social security and quality of life as mentioned previously.

The Map and Geodata Council has recently contacted the Minister of Housing and Urban affairs asking for an expansion of the earlier mentioned Public Information Server (OIS). It is requested that information of general interest that already are paid for by public institutions (maps, registers and keys) should be readily

accessible - free of charge or for a delivery fee - at first for the public sector later for private enterprises.

Research

From many quarters, including the Ministry of Housing and Urban Affairs, the need of increased interdisciplinary research in the field is pointed out. Also statements in response to the research plans of the National Survey & Cadastre point in that direction. Four research projects⁴ have been identified so far:

1. *The Geographic Information Market*: In the research initiative different market models for digital spatial data will be described and analysed. The research will also involve the actors in the market, which today is characterised by interaction between a few professional actors, many of whom are both producers and users.

2. *Spatial Data Modelling and Cataloguing*: The research initiative is expected to develop methods to restructure spatial data from maps and registers into object-oriented catalogues and spatial data models. The object catalogue should be limited to the objects of general interest, and duplication should be eliminated. The strategy would then be to concentrate production and coordination efforts to these objects and eventually improve quality and reduce the cost of production and maintenance.

3. *Distributed Geographic Information Prototype*: The research initiative is intended to produce an experimental web service based on the object catalogue and the spatial data model developed in the previous research project mentioned above. The intention is to analyse selected use cases, test the usefulness of the object catalogue and spatial data model for individually adapted services and to evaluate the commercial viability of distributed geoinformation.

4. *Visualisation of Spatial Information in Electronic Media*: The purpose of this initiative is to enhance visualisation of geographic information and optimise the understanding of geographic information, but also to point out new possibilities of use of geographic information in society.

Final remarks

A condition for the building of a national infrastructure for spatial data in Denmark is that a formalised co-operation is increasingly established between the parties - both in the private and public sector - who are engaged in the production and use of geodata, a co-operation, which for example is to secure:

- that an expedient responsibility and competence distribution is established between the implicated actors at the organisational level
- that the building of spatial data collections takes place on the basis of known/common data models
- that a constant uncovering takes place of the technological possibilities and the use of geodata in this relation.

Within a number of central fields, activities, as mentioned in the paper, have been started to support the development in the direction of a NSDI. The national research and other initiatives, together with the implication of international experiences within this field, will make it possible that within a few years Denmark will have a strong national management tool in the form of a DK-NSDI. But international experiences also show that political attention and support is necessary for a successful NSDI.

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⁴ Based on a joint research programme by Poul Daugbjerg, National Survey and Cadastre, Mogens Kühn Pedersen, Copenhagen Business School and Hanne Brande-Lavridsen & Bent Hulegaard Jensen, Aalborg University.

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