THE DANISH WAY

PUBLICATION No.: 9

APRIL 2002

Spatial Information Management in Denmark

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An international publication series
on surveying, cadastre and
land management in Denmark.

Published in
Copenhagen, Denmark, by:

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ISSN 1399-591X

The Danish Association of
Chartered Surveyors

Introduction

At present a network and information society (*e-society*) is rapidly replacing the industrial society. It is both a privilege and a challenge to us all to open such a "century of change". One of the perceptible consequences of the transformation all over the world is that many public sectors and private enterprises undergo great changes to be able to comply with the developmental demands of this transformation. One of the mentioned changes is *e-government*.

Denmark is also in the middle of a transformation to an e-society. A majority of the population already participates actively in a digital network society that influences all aspects of its social life. The Internet is an example of a network technology enabling a considerably different distribution of data/information, however, new network technologies with much greater capacity are on their way. Many citizens are already accustomed in using the Internet for providing information, for self-management and for coming business (*e-commerce*). In a few years mobile hand-held devices will make people independent from time and space.

The ambition across state, county, and municipal government is to use the potentials of an e-society to structure the public sector in a more flexible and efficient way and with higher quality for citizens. The core of a new e-government is among others to create better and more efficient solutions to administrative tasks through the use of information technology. Also business makes use of digital technologies and the possibilities of the network society to improve competitiveness in an increasingly globalised world.

The e-government initiatives are rapidly changing the *spatial data/information*[1] area too, as spatial information affects a major part of human decision-making. Investigations indicate that about 80% of the information needed for e-government can be related to a location on the Earth. This applies to information for public and private tasks like planning, projecting, market analyses, real estate dealing, tourism and much, much

[1] Spatial data/spatial information is often used as synonym of geographic data/geographic information or geo-data/geo-information. Spatial means here the physical space used to describe the geometry and the characteristics of different objects and related attributes. Data is raw facts (numbers, letters etc.). Information is adapted and structured data. Spatial data/information can be divided into text-based registers (databases) and digital maps. The linking between the two data types takes places through keys and georeferences.

more. Especially in the environmental field there is at present an increased demand for information on land use and environmental effects, information that is essential to public authorities to be able to solve statutory tasks.

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 (*participation democracy*). In the future, we will also see that the use of spatial information is spread among far more categories of users than today, including the business world and citizens. 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 will 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.

As mentioned earlier, spatial data/information affects a major part of human decision making, the market for spatial data/information is expected to expand and will consequently be an important driving force in the years to come. Also as mentioned earlier at one and the same time the information must comply with the needs of different authorities, the business world, the research and the citizens, both within their own organisations and across previous professional and administrative barriers. But spatial data/information is not always present, when it is needed, or it is not present in the right form or at a payable price (as can be read in one of the following chapters).

This has in more countries led to initiatives for development of *National Spatial Data Infrastructures (NSDI)* or *National Spatial Information Infrastructures (NSII).* A NSDI/NSII is, together with e-government, e-commerce, participation democracy, geovisualisation, education and training, etc., an important element in ***Spatial Information Management (SIM)***. In the following, greatest importance will be attached to the elements in a Danish[2] NSII.

The NSDI/NSII concept

A NSDI/NSII is not a new area on a global level. The first generation of national infrastructures for spatial data/information has already been presented and evaluated. Common for all the infrastructures is that they have been explicitly national and that there is no general consensus for the meaning of a NSDI/NSII. This means that there is considerable confusion regarding the purpose, scope and contents of an infrastructure. One position is that a NSDI/NSII is just a product, a core data set of spatial information available for the whole nation (a national spatial database). Another position is that a

[2] 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.

NSDI/NSII is a strategy required to manage national spatial data/information (a national spatial data framework).

In Denmark an official infrastructure has not yet been passed, but an effort is made in that respect (see later under the Digital Task Force).
A group of researchers, who has been working several years with topics in relation to a NSDI/NSII, has chosen to define an Infrastructure for Spatial Information as: *The technologies, policies, rules and human resources necessary for a socio-economically effective use of spatial information/data at all levels and across in the public administration, among private enterprises and organisations and in the academic world.*

In some countries there is a legal mandate to develop a NSDI/NSII (top-down approach), in others a NSDI/NSII is an outgrowth from established mechanisms (bottom up approach). Denmark belongs to the latter group.

The Danish development in the map and geodata field

Over the past two decades analogue maps and geo-referenced registers have been converted to a digital form, and new data have been created to fill the gaps. Therefore Denmark seems to be in a favourable position concerning spatial information. At the same time the use of GIS (Geographic Information Systems) in the public and semi-public sectors and in private business is growing among other things thanks to the previously mentioned technologies and the initiatives, which will be described in the following.

However, especially within the mapping sector it is often seen that different organisations[3] (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 for other products or in another system (lack of common data models, interoperability), etc.

As far as can be seen, these problems are not always of a technical but often of an organisational nature. Some institutions have not been used to or do not have the culture of co-operation. 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 co-ordinate. 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.

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 outlined barriers to an efficient utilisation of spatial data/information are unfortunately not only seen in Denmark.

[3] In Denmark, The National Survey & Cadastre is by law obliged to produce topographic maps (medium and small scale maps) and cadastral 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.

Therefore the goal of a Danish infrastructure is to reduce duplication and costs of spatial data/information, to improve quality, to encourage co-operation on common standards and data models and last, but not least, to make spatial data/information more accessible to as well public authorities as private enterprises and citizens.

Figure 1. *The figure shows the most important contributions to a Danish Infrastructure for Spatial Information (DAISI). The different subjects will be discussed later.*

The situation has improved considerably these last years thanks to e.g. governmental initiatives (se figure 1 and the next chapter), but to accelerate a better use of current and reliable spatial information at all levels more initiatives have to be taken.
The initiatives described in this publication are meant to support a ***Danish Infrastructure for Spatial Information (DAISI)*** (see figure 1).

Governmental IT initiatives

During the last ten years the state has prepared various action plans and reports that lay down goals for the further development in Denmark within the IT field. The objective of them all has more or less been the wish to enhance the efficiency of the public administration and management (see figure 1, top).

- The subject spatial information/data is treated in detail for the first time in the action plan *"The information society for all - the Danish model"* from 1996. In

this plan the first thoughts about a new distribution system for at first public property registers are described, but later also for digital base maps.

- In the report "*Digital Denmark - adaptation to the network society*" published in November 1999 and the follow-up on "Digital Denmark….", named "*Adaptation to the network society, IT and tele-political statement for the Folketing*", published in January 2000 the new IT strategy of the government is initiated. In connection with this a policy has to be formulated on how citizens and public and private enterprises can use and profit by the society's investments in maps and registers, etc. in new ways. In the latter report, however, a number of matters are mentioned which make these challenges difficult to meet: one is that a divided public sector impedes a co-ordinated adaptation process; others are economic and legal barriers.
- In May 2001 came the publication "*Digital Management*", followed shortly after by the report "*Course for the digital county*". In the first report the objective of a digital management is described again. More points are mentioned as necessary, before the objective can be attained, including again the importance of adapting laws and regulations so that an increased use of data is allowed. The latter has partly taken place, partly through the new Personal Data Act from 2000, partly through the new Building and Housing (BBR) Act from 2001. In the second report the subject spatial data/information is proclaimed as a field with a great potential, but again the barriers (ownership, access, pricing, conditions of use, etc.) are pointed out, which limit an efficient utilisation.

At the end of 1999 the Minister of Housing and Urban Affairs established an advisory body: *The Map and Geodata Council*. The members of the council came both from the public and the private sector as well as the academic world and represented both users and producers of spatial information/data. Unfortunately, the council was abolished at the end of 2001 in connection with the retrenchment policy of a new government. Some of the core areas of the council are, however, to a smaller extent carried on by *The Digital Task Force*[4], which was established in the summer 2001, provisionally only with representatives from the public sector.

In the autumn 2001 the Task Force carried out an analysis of the geodata field. The conclusion of the analysis was, not surprisingly, double: on one hand Denmark is in a strong position and has good conditions of using geodata offensively in digital management. The reason is that a number of basic registers are in place and that large investments have been made in the digitising of map products. On the other hand, it is stated "that the existing co-operation structures in the field are too informal to achieve the most expedient utilisation and production of spatial data across authorities and that it has not been possible, to an adequate extent, to give priority to the different wishes and needs in the field".

The stakeholders in the field agree that there is a need to strengthen and rethink the co-operation within the framework of a service community, which should replace the existing co-operation forums in the field. The Task Force therefore recommends that a bind-

[4] The Digital Task Force, which is financed by the Danish government, is brought into the world for a three-year period to be catalyst of the development of digital management (e-government) in Denmark.

ing service community is established which can replace existing co-operation forums and secure the drive in the spatial data/information field.

Building blocks for a Danish Infrastructure for Spatial Information

As mentioned earlier, the initiatives so far in Denmark are characterised by being concentrated on isolated fields and are therefore more or less uncoordinated.

Digital maps (see figure 1, left side)

Digital mapping in Denmark started seriously in the 1970s in connection with the introduction of natural gas. Today digital maps are produced for use in the state, county and municipality for different purposes and with different degrees of detail. Besides the public authorities utility owners, supply enterprises and enterprises within transportation and distribution are important users of digital maps. Apart from public map producers a number of private map companies exists.

- Digital large-scale maps (*technical maps*) covers Denmark in scales from 1:1000 (towns and built-up areas) to 1:10.000 (rural areas). As the maps are produced on demand from different users (municipalities, utility companies, etc.) and in different qualities (TK1, TK2 and TK3 standards), the maps do not form a homogenous nationwide product even if they follow the *Specifications for Technical Maps.*

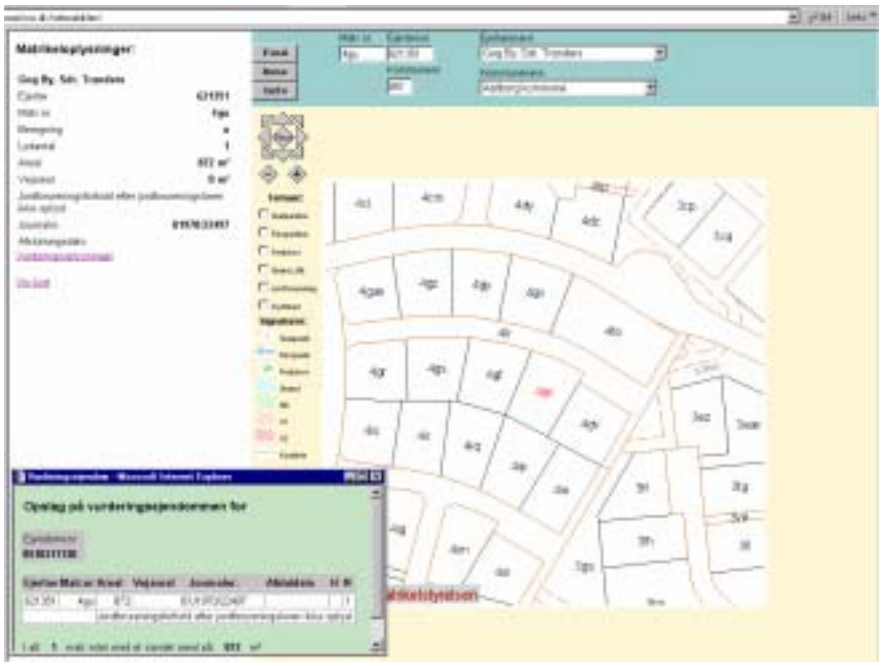


Figure 2. *The Web-Cadastre (www.kms.dk). A map is presented on the right side of the screen with the cadastral number (4gu GUG) asked for in the middle. The textual information at the top on the left side of the screen informs among other things about the geometric area of the property. By clicking, additional information on valuation can be obtained. Access requires subscription.*

- The Danish *cadastral maps* (matrikelkort) are a legal ownership map series that defines property boundaries, administrative boundaries, etc. Since 1997 the map series has 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 34/45. Smaller scale maps as for example the topographic maps are produced using the UTM coordinate system.
- In December 2000 the National Survey & Cadastre finished a nationwide vector-based map database (*TOP10DK*) in scale 1:10,000 (based on the *TOP10DK Specifications*). The TOP10DK (see figure 3) 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 Elevation Model (DEM). Other *topographic products* in smaller scales (raster-based) are also available (see figure 7).
- The *Web-Cadastre* (see figure 2) is an information system at the Internet that contains updated cadastral information. Using the system requires subscription.

***Figure 3**. Examples of digital map databases. Left the topographic database TOP10DK produced by the National Survey & Cadastre. Right a colour orthophoto database produced by the private company Kampsax.*

- In recent years *digital colour orthophotos* (see figure 3) based on aerial photos have found increasing use by Danish users of geoinformation as base maps for presentation of different thematic data sets. The orthophotos (with solutions down to 40 cm (in urban areas down to 8 cm) are produced and sold by several private photogrammetric companies. DEM's used in the production are also available.
- As examples of digital *thematic maps* the following can be mentioned: *geological maps*, earth classification maps, field block maps, *road networks* and maps of administrative classifications.
- 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 of description of quality and quality checks. But we must also conclude that so far no co-ordination has taken place between the different stakeholders in the map market. Actions are, however, on their way.

Digital map data in Denmark are expensive. It has been discussed intensely whether publicly produced map data should be ransomed or reduced in price, but so far no decision has been taken in the field.

Public digital registers (databases) (see figure 1, right side)

Since the late 60s Denmark has established a wide range of digital public registers, many of them with contents of spatial information. The responsibility for the spatial information registers is distributed among different public authorities at the state level as well as at the county and municipal level. The registers can be linked by common identifiers, which are maintained in the *Cross-Reference Register* (see later).

The registers can be distinguished between legal property registers (the Cadastral Register and the Land Registry), 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, the Land Information System etc.).

- 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* (Tingbogen) (digital from 2000) and of the Communal Property Data System (see later).
- 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 *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.

Figure 4*. Information about 4gu – GUG (see figure 2) in the Building and Housing Register (text only in Danish).*
Besides general information about address, ownership and area the register also gives information about technical installations like water supply, sewer, heating and the like.
The example is taken from The Public Information Server (www.ois.dk) where information from the Cadastral Register, the Communal Property Data System, the Planning Register and the Sales and Valuation register also can be obtained.
Address coordinates can be obtained from the Cross Reference Register.

- 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. Planning data are registered and used by both municipalities and counties as well as by state authorities. In the legislation there are in some cases clear regulations for the planning data to be collected.
- 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 in it is the person number - the CPR number. The register numbers all persons residing in Denmark and includes the address of each individual person. The CPR *Road Register* contains a complete list of all Danish roads with house number intervals and divisions into administrative districts.
- The tax authorities use the *Sales and Valuation Register* (SVUR) for calculation and collection of taxes.
- The *Central Enterprise Register* (CVR) is a central administrative register of all private and public legal entities (enterprises). The register also includes large construction sites.
- All Danish farmers are registered in the *General Agricultural Register* (GLR) / the *Central Domestic Animal Register* (CHR) by either a SE (enterprise) number or the user's CPR number. The register contains information about the farm. The GLR/CHR register is described in a data model. Digital maps in the form of ”field block maps” are linked to the GLR/CHR register.
- The *Land Information System* (AIS), finished in 2000, is the first attempt to collect and integrate geoinformation from different regional and national authorities within the nature and environment field in Denmark. The system contains information about the countryside such as habitat types, land use, hydrology, natural resources, polluted areas, etc. A central element in AIS is the nationwide *land information map* (AIS-map) describing the land use in urban and rural areas.
- As examples of other registers can be mentioned the Central Forest Register, the Building Preservation Register, the History of Civilisation Register, State and Local Registers of Statistics, the National Health Register and the Information System of the Road Sector (VIS).

It is characteristic of the mentioned registers that they have been created, as they have been required. Among other things one reason is that data responsibility and data ownership are divided between national, county and municipal authorities. At the same time it is characteristic of the registers that they are not planned for providing data for other purposes than those which were laid down at the establishment of the register. In that sense the registers only offer limited possibility of flexible data use and therefore only slightly support a development towards digital management. In contrast to the digital maps we must conclude that at present there are only well functioning specifications for the BBR, CPR, CLR/CHR and CVR registers.

Today most register data are paid for, however, efforts are made to find a solution of payment, which shall be cost-neutral at least for the public sector.

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* (KRR) - 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. Beyond functioning as a property map the digital cadastral map can also be used as key of access to the property-related registers.

Fundamental to the registers was the standardization of addresses in connection with the establishment of the *Central Population Register*. Later it has been 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 been developed.

- *DAV* (the Danish Address and Road Register) is produced by a private mapping company and is based on interpolated address co-ordinates.
- Contrary to this the *"Address-project"* is produced in co-operation between municipal authorities and the National Survey & Cadastre (KMS). Practically all municipalities have today registered one set of co-ordinates for every single of the about 2,1 million front door addresses of the country.
- Until "the Address Project" is completely nationwide, the National Survey & Cadastre offers a preliminary address theme *"FLAT"* based on the digital cadastral map.

Having almost completed a national coverage with geo-referenced and standardized addresses, development efforts are now being directed to the establishment of *geo-referenced building IDs*. An automated process will produce a simplified data set based on a combination of the cadastral map, the topographic map and the Buildings and Housing Register, and with a small additional effort the municipalities will then be able to enhance the geo-references to a fully detailed data set.

Data models, etc. (see figure 1, bottom)

Until today data have been in focus, but an important condition of utilising spatial data across public institutions and sectors (and the whole geo-data business) is that the different data can "interact", as otherwise full benefit cannot be derived from the possibilities offered by technology.

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 a logical data model for the property data field developed under the auspices of the National Survey & Cadastre (*Logical data model for property data). A County Data Model*, have also recently been presented.

PlanDK is a data model for digital planning data. The data model describes how digital planning data and GIS-systems can be used in physical planning.

FOT (Common Object Types) is an attempt to point out and describe common object types in technical and topographic mapping. FOT is a co-operation between the National Survey & Cadastre, county and municipal authorities, utility owners, private firms and the Ministry of Environment and Energy.
Other data model jobs within common object types are on their way. One is on common object types in the Land Information System (AIS) and the County Data Model.

All public authorities have been encouraged to draw up logical data models for those administrative functions for which they are responsible.

Public services

In accordance with to the government's general IT policy the former Ministry of Housing and Urban Affairs launched a web-based *Public Information Server* (Offentlige InformationsServer - OIS) (see figure 1, right and figure 5) in August 2001. In its first version the server only delivers attribute data from some of the public property registers mentioned above (se figure 4).

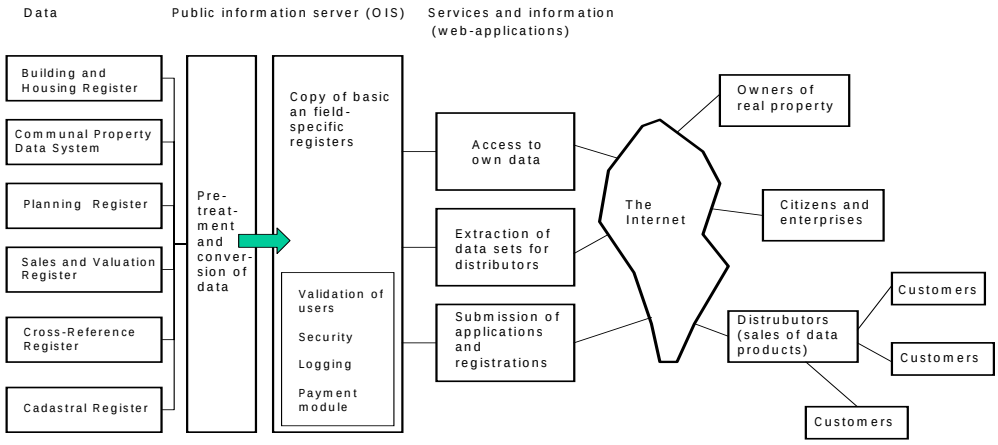


***Figure 5**. The Public Information Server (OIS) concept.*

Shortly after (November 2001) the National Survey & Cadastre launched another web-based service, *The Map Service* (Kortforsyningen) (see figure 1, left and figure 6) that gives access to the topographic database TOP10DK and the cadastral maps (vector-based), a number of small-scale topographic maps (raster-based) and the FLAT-addresses. The service is based on the OGC Web Map Service standard.

The objective of both services is to give potential users – private enterprises and public authorities - the possibility of getting data from the public data collections via the Internet and to provide a market place for spatial data, specifically by offering resellers or value-adding distributors direct access to the server. After registration and password, citizens have free access to all data in the Public Information Server about own property.

One of the barriers to a better utilisation of spatial data information often mentioned is lack of documentation and metadata (see figure 8).

Figure 6. *The web-based map service "Kortforsyningen" (www.kms.dk). Left an example from the raster database. Right an example from the vector database.*

If other initiatives shall be emphasised, one must be *Geodata-info.dk* the Danish meta-database available on the Internet. The meta-database is a catalogue describing the digital maps and other collections of geo-related data (among others the earlier mentioned public registers) in Denmark.

The meta-database gives a short overview of each data set, the data set owners or producers and where to get further information about the data set. In its first version the database has been implemented according to the CEN standard and will eventually be developed further to comply with the ISO TC211 standard.

Figure 7. *Examples from the Danish meta-database (www.geodata-info.dk) Left the welcome page. Right the meta-data for the Cadastral Key Points.*

New challenges

The initiatives described confirm that Denmark has already many well functioning building blocks for an Infrastructure for Spatial Information and recently, it was suggested that binding service communities should be established in the spatial data/information field.

It is foreseeable that demands of an infrastructural nature will be made to Denmark from international quarters (firstly the EU) as regards border-breaking data sets, and therefore we also have to be at the forefront of the international development, both technologically and commercially.

There is no doubt that in future there will be a growing demand for spatial information to advance a sustainable development. Basic public databases containing spatial core data, which are stable, standardised and can be used effectively, should therefore 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.

In the near future spatial data and spatial information will no longer be isolated. Spatial information will together with other types of data sets be integrated in large information and knowledge systems. This means that we have to shift focus from just creating spatial databases, facilitating access to spatial information, etc. to the development of integrated decision support tools enabling the use of all kinds of data. Data management as *geo-visualisation*, data-modelling and analysing activities will then come in focus. This is the real challenge of e-government.

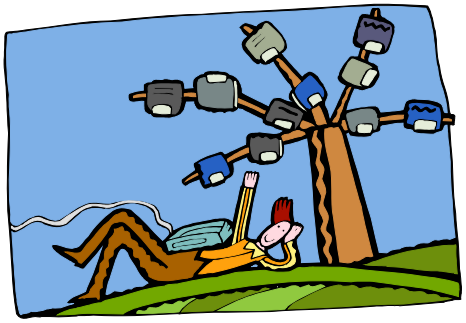
Already the increasing use of spatial information/spatial data has caused a strong need of people who can manage both technical and organisational aspects of manipulating data and turning data into understandable information (knowledge). The e-government and e-commerce within Spatial Information Management will again require people with new qualifications on all professional levels. Here new technologies offer new possibilities for *training and education* in the form of distance learning. In Denmark we have e.g. established a MTM (master in technology management) education in Geoinformatics based on a computer-based conference system and a web-based Learning Lab Geomatics is on the writing desk.

The Internet as an information network for spatial data/spatial information is already in use in Denmark. New challenges will be mobile services provided through hand-held devices offering “on the fly” information and Location Based Services. With this we could say that we are leaving the network society and entering the mobile society. Wise people say on that regard that with the new technology we also leave the information society in favour of the knowledge society.

Final remarks

Spatial Information Management (SIM) should not be an isolated achievement. Taking into consideration the importance of the public sector in the full economy, it is vital that

SIM contributes positively to the development of a network/mobile and/or information/knowledge society from which citizens as well as businesses and public authorities will benefit. SIM is, however, a dynamic concept that will change concurrently with technological conquests and political and organisational initiatives in the society. The e-society will thus currently make new demands on its e-citizens and on e-commerce and e-government.



E-government ?

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