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Country Report of Sweden

Swedish Spatial Data Infrastructure

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Short summary

Spatial information is crucial and widely used in the modern society. The information is also produced by many different organisations on national, regional and local level. Efficient production, maintenance and use of the information imply co-ordinated actions between the different stakeholders. In Sweden a national spatial strategy has been set up and based on the strategy the spatial data infrastructure is gradually developed and implemented. During the last couple of years, Sweden has focused to ensure that international efforts, as UN GGIM (United Nations Initiative on Global Geospatial Information Management) and INSPIRE, are recognized nationally and being part of the national spatial infrastructure.

The Swedish SDI development has a wide support in society. Representatives from a great number of central agencies, local authorities and private enterprises have taken an active part in the work. The Swedish Government has also given an outspoken support.

Constructive co-operation requires that the forms for co-operation are supported by simple and clear financial, organisational and legal pre-conditions. The benefits from different actions must be made visible.

The INSPIRE Directive implies great demands, but is also a driving force for the national developments.

It is important to have a long-term approach, but at the same time work with step wise actions and show concrete results.

There is a strong link to the development of e-governance. Swedish authorities are today establishing different kinds of e-services to facilitate communication between citizens and enterprises. Spatial data is an important source of information for visualization, analysis and decision making.

The willingness of the actors is crucial. We work hard with information and communication, but also with cost/benefit-analysis in order to show the benefits from different actions.

This paper gives an overview regarding the national spatial data infrastructure (SDI), its organisation as well as a short discussion on how we try to implement international initiatives also nationally. We have included presentations on some of the governmental agencies producing and using spatial information as well as a few use cases.

An increasing need for geographic information

Forest fires, storms and floods are causing major problems in society every year. Hazardous goods are transported on roads and railways every day. This is just a few examples describing that almost everything that affects our lives is linked to some aspect of geography. The more we know about the area, the better. The more information we have, the more appropriately we can act, plan and allocate our resources, deal with damage, calculate risks, implement preventative measures and make sure we are prepared.

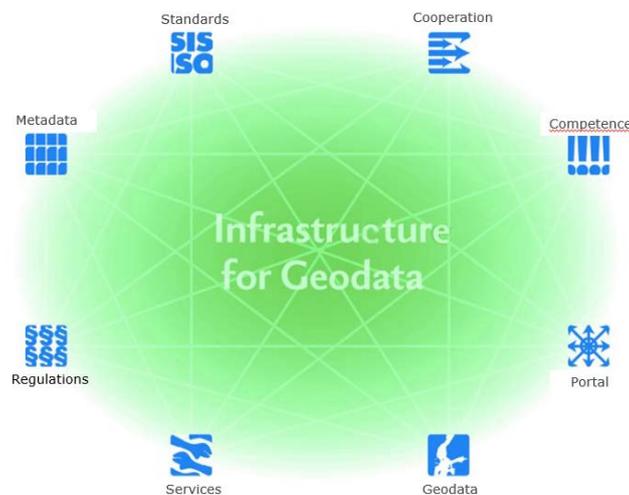
However, we often have a problem with the geospatial information today. The data is stored in different database systems, are based on different specifications or has undefined quality. It can also be difficult to find data of interest or to get the access rights to such data.

Therefore, it is of vital interest to facilitate for the users to search, find and get access to data needed. The users should also only have to go to one single point – the national portal for spatial information www.geodata.se – to find both information about the spatial data available, their quality and the usage rights. The major aims of establishing a well-functioning spatial data infrastructure are to:

- Reduce costs for data collection and maintenance by avoiding duplication of work and establish efficient co-operation between data producers at local, regional and central level
- Improve data quality and consistency – and to implement standardised models to describe data quality
- Facilitate combination of data from different sources by achieving semantic, technical and organisational interoperability
- Improve access to data, for example by offering Web based services available 24 hours 7 days per week
- Support the development of e-governance and of business being established using data from authorities

The Swedish SDI develops

The Swedish SDI concept has been gradually developed since 2006 when the national Geodata Advisory Board was established. Today the Swedish SDI consists of the following cornerstones; good knowledge and competence, a portal that provides the ability to search and evaluate spatial information and services, appropriate regulations governing the provision of information, metadata that describes the information, standards an established cooperation between organizations.



UN GGIM in Sweden

Sweden has been involved and given UN GGIM high priority from the beginning. We have actively participated in the different initiatives, e.g. in the working group regarding the UN Resolution on Global Geodetic Reference Frame. Sweden was also one of the leading countries drafting the work plan for UN GGIM:Europe. The involvement is also demonstrated as the Director General of Lantmäteriet (the mapping, cadastral and land registration authority) was nominated as the first chair of UN GGIM:Europe. The INSPIRE Directive from the European Union creates a common European infrastructure and common rules concerning exchange, sharing, access and use of public spatial data and data services. UN GGIM:Europe acknowledges this and uses INSPIRE as the base.

To link the international initiatives to a national coordination, a UN GGIM Sweden was established during 2015. The current members consists of Lantmäteriet, Statistics Sweden, Swedish Environmental Protection Agency, Swedish Maritime Administration and The Swedish Environmental Protection Agency but the group will be expanded in the future. The purpose is to ensure that global initiatives are also considered nationally. The UN GGIM Sweden is also a subset of the national Geodata Advisory Board.

INSPIRE and EU Spatial Data Infrastructure

The INSPIRE Directive consists of a legal framework for the spatial data infrastructure and the Directive was implemented in Swedish law in 2011. The following requirements can be found by the INSPIRE Directive;

- Member States must develop metadata for data and services covered by the Directive
- Develop network services in order to make data available over the Internet
- Harmonise data and services in order to make these "interoperable"
- Create an access point that makes it possible to find data and services
- Authorities within the Member States shall share data between themselves and with institutions at EU-level
- Member States shall establish a structure for coordination of the implementation
- Monitor the implementation and use of their infrastructures and to report on the implementation to the Commission

The following underlying principles exists for the spatial data infrastructure;

- It should be easy to discover which spatial data that is available, and to learn more about it
- Spatial data should be shared between all levels of government
- Spatial data needed for good governance should be available on conditions that are not restricting its extensive use
- Spatial data from different sources should be interoperable and possible to share between users and applications

- Data should be collected once and maintained at the level where this can be done most effectively

The national strategy for spatial information

The Swedish Government commissioned Lantmäteriet and the Geodata Advisory Board in 2006 to prepare a strategy for the development of a national SDI. The current strategy, presented in 2012, describes a clear vision for the future including strategic goals to work towards, but also concrete and measurable targets for the short term actions. The vision is “as simple as possible for as many as possible to find and use geodata”. The seven strategic goals are:

- the benefits of the infrastructure for geodata are **known**
- information provision is supported by **appropriate** regulations
- terms and conditions and fees for using geodata are **simple** and uniform
- geodata and services are **described** in a clear and user-friendly manner
- geodata can be **combined**
- services are **accessible** and meet needs
- there is good **knowledge** for using geodata, building up and managing the infrastructure for geodata

For each goal, an action plan has been developed to ensure that the goals are achieved at the latest 2020.

Organisation of the Swedish SDI and data sharing

The Swedish Government has given Lantmäteriet the role as coordinator of the Swedish SDI, including being the national contact point for the INSPIRE Directive as well as UN GGIM. To support Lantmäteriet concerning the INSPIRE Directive, the Government has appointed representatives from both producers, users and researchers to form a high level Geodata Advisory Board.

Within the Government, the Ministry of Environment is responsible for the implementation of the INSPIRE Directive. The Swedish legislation implementing the directive is rather detailed and points out which organisations are responsible for each of the data themes covered by the Directive. About 25 organisations have such responsibilities. Lantmäteriet is responsible for some of the data themes, for the coordination of the implementation of the directive as well as the monitoring and reporting of the progress. Representatives from the 25 agencies meet on a regular basis in order to plan and coordinate their work

An important part of the development and implementation of the Swedish spatial data infrastructure has been to create a model for data sharing between different public organisations to fulfil the INSPIRE Directive. The parties of the data sharing model have signed an agreement which defines rights and responsibilities. The aim is to simplify sharing of data between

organisations being responsible for provision of spatial information, facilitate for all kind of public organisations to make use of existing spatial information.

The data sharing model is implemented by an agreement between the partners. The agreement consists of the following parts:

- A product catalogue containing information about all available data resources
- Conditions for use
- Economic conditions for participation in a data sharing model, which gives access to all spatial information in the product catalogue for official use for one fixed fee per year. This licence fee is based on a number of agreed parameters.

In May 2015 around 240 central agencies, county administrations and local authorities have signed the agreement on data sharing. This means that they have a licence to use relevant geographic information within their organisations and for setting up services on the Internet

From a user perspective, the provision of spatial information should be handled as far as possible harmonised. It must be easy to find the data, to understand the conditions for use and to get access to data.

National web portal for spatial information

A national web portal, which works as a node where you can find a large number of datasets being stored and maintained by the responsible organisation for each data theme has been developed and is accessible at www.geodata.se. Today some 200 WMS-services are directly accessible via the portal and the number is continuously increasing. Any data provider can offer their data via the portal by describing their data in the metadata catalogue and make their services accessible via the portal.

The portal is based on open source software and is developed in close cooperation between colleagues from Denmark, Norway, Finland and the Netherlands.

Standardisation

In Sweden a standardisation programme for geospatial information was set up already in 1990 within the Swedish Standards Institute. Sweden has via this programme been active in the international standardisation work (ISO TC 211).

We have also developed a framework and generic standardisation model, which has been used to produce standards for a number data themes, such as transport networks, hydrologic networks, utility networks, addresses and buildings. Lantmäteriet provides chairman for the standardisation project (Stanli) within the Swedish Standards Institute.

Good place-name practice in Sweden: Lantmäteriet as place-name authority

Lantmäteriet is the Swedish place-names authority and is responsible for the standardization of place-names, the co-ordination of national place-names activities and providing advice and recommendations. The formal base for these activities is an Act (2009:946) that contains regulatory instructions to Lantmäteriet. In 5§, 7p, it is stated that Lantmäteriet shall monitor and ensure that questions relating to place-names are handled in a rational and professional manner and, where this responsibility has not been assumed by government authority, check and approve place-names. Lantmäteriet shall also formulate general guidelines for handling place-name questions in connection with cadastral activities and real property registration. For this purpose we publish a national series on geographical names and the care and preservation of place-names.

It is stated that Lantmäteriet shall be responsible for the basic and normative decisions regarding place-names. In Sweden it is standard practice to submit place-names to the Institute for Language and Folklore for checking linguistics and etymologies and to the National Heritage Board for checking from a cultural and historical point of view, before they are finally approved.

Since July 2000 there is a code of good practice paragraph (§ 4) on place-names included in chapter 1 of the Historic Environment Act. In the Act emphasis is placed on linguistic correctness but even stronger on the importance of preserving place-names as a part of the nation's cultural heritage.

The paragraph is especially directed towards decision-makers in central and local government organizations who have responsibility for allocating names. It prescribes that names that have been approved by Lantmäteriet, for example in the real estate register or on official maps, shall also be used in their approved form for other purposes. This means that the names and name forms that occur on Swedish national maps shall be normative.

There are about 1 million place-names in the Swedish national map series and they are also registered in a national place-name database. To meet the demand for easier access to place-name information Lantmäteriet has an Internet service "Map search and place-names" (www.lantmateriet.se), which gives authorities, organizations and the general public access to officially approved place-names data - as a national place-names dictionary. The place-names database also contains place-names in the minority languages (saami, finnish and meänkieli) with their officially approved orthography.

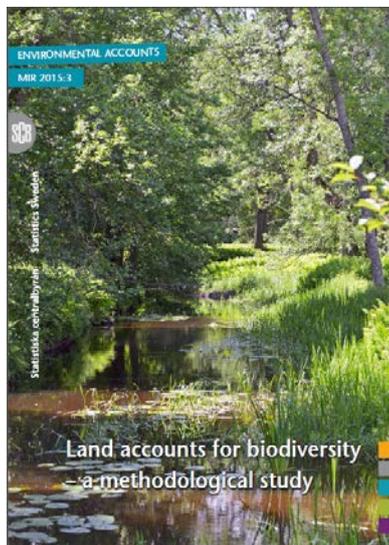
The Place-Names Advisory Board is a dedicated consultative and support body and is closely integrated with Lantmäteriet. The Board is made up of representatives for parties that are engaged in the work of caring for, preserving and creating place-names. The task of the Board includes supporting Lantmäteriet in its task of promoting an appropriate and careful management of place-name issues. The Place-Names Advisory Board has developed a guide to name standardization; the guide is assisting with the

interpretation and dissemination of information about the concept of good place-name practice, at creating an increased understanding of the principles of care and preservation of place-names, and at generally increasing the impact of the paragraph. The work of the Place-Names Advisory Board contributes to a significant degree to giving this co-operation concrete form. Although the board does not have formal decision-making rights, it does have an independent advisory and interface function. In this role the board seeks to provide guidance to authorities and other name-giving organizations to assist them in taking decisions.

Through the inclusion of the code of good place-name practice paragraph in the Historic Environment Act, a one hundred-year-old tradition of working for the care and preservation of place-names and their role as an important part of the cultural heritage has been consolidated. As the national place-name authority with the task of making basic and normative decisions concerning place-names, Lantmäteriet has a special responsibility for ensuring that this tradition is maintained and that it influences all work with place-names in Sweden.

Examples of Swedish use cases on the combination of spatial information from different governmental agencies

Land accounts for biodiversity



Report: www.scb.se

Statistics Sweden has in cooperation with the Swedish University of Agricultural Sciences (SLU) conducted a project to develop a new statistical module within the environmental accounts in Sweden. The purpose was to combine data about land that is valuable for biodiversity in line with EU Art and habitat Directive, article 17 with data related to the economy.

One target in the Art and habitat Directive is that the value of biodiversity shall be integrated in development plans, economic decisions and national accounts. The Swedish environmental quality objectives also pick the target up. By latest 2018 the importance of biodiversity and ecosystem services shall be publicly known in Sweden and be integrated in economic decisions, political discussions and other decisions in society.

The project covered the habitats western taiga, grasslands, wetlands and key biotopes (forestry). To get information eight registers and databases have been used and interlinked. Through the ownership a “key” is created that is used to connect to databases about economic structures of various industries. The data sources used were various inventories of habitats: wetland inventory, key biotopes for forestry, grasslands from the Swedish Agriculture Agency, etc. The Business statistics register is important to provide information of companies. Finally the Property map and the Property and tax register were used to complete the geospatial analysis.

The study will need to be extended to the water area and more land areas in the future. The aim is to develop a method that can work also for other statistical agencies, to enable harmonized comparisons. It is important to know who owns the land in order to know what decisions need to be taken to protect the biodiversity. The monetary valuation of ecosystems still needs to be developed.

By developing methods to link the economic actors in mandate of the land that is important for biodiversity it will be possible to take actions and better plan for how to preserve valuable ecosystems.

Access to green infrastructure



15. A Good Built Environment



Cities, towns and other built-up areas must provide a good, healthy living environment and contribute to a good regional and global environment. Natural and cultural assets must be protected and developed. Buildings and amenities must be located and designed in accordance with sound environmental principles and in such a way as to promote sustainable management of land, water and other resources.

This objective is intended to be achieved

within one generation.



Green infrastructure within localities

During the last decade urban green space has been a topical subject in Sweden. Increased public access to green space in urban areas is stated among the national, environmental objectives and policies for densification of cities versus preservation of green areas are currently under debate in many Swedish municipalities.

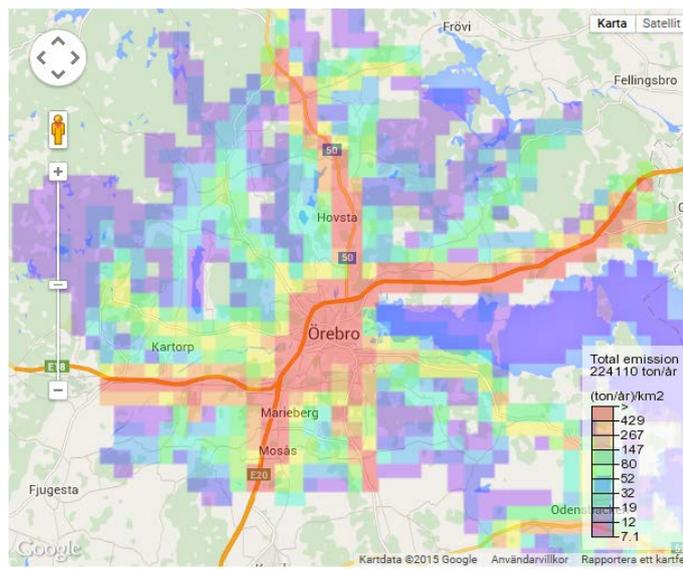
Statistics Sweden releases statistics on urban green space every fifth year. In 2005, the statistics for the first time was based on interpretation of satellite imagery combined with register data on population and real estates. The method used was cheap and efficient, yet it failed to meet the increasing need for statistics enabling analyses on ecological and social functions of the green spaces in urban environments. This would require not only a detailed

mapping approach but also characterization of qualities and properties of the green spaces in terms of accessibility, ownership and vegetation.

During 2013, Statistics Sweden carried out a development project together with a remote sensing consultant aiming to improve the methods for urban green space statistics. The procedure encompasses methods for sub-pixel classification and post-processing of land cover data to categorize the green areas by ownership and vegetation qualities.

Greenery is a key element of a sustainable urban environment. Green areas are important from an ecological as well as cultural and public health perspective. As urbanization puts demands for a more dense urban fabric data on green spaces and peoples access to it becomes increasingly important. In addition, the inversion of green space mapping shows urban soil sealing. Information on the imperviousness of the urban environment is increasingly important from a climate change adaption perspective.

Emissions distributed on grids



Total emissions from transport, Örebro city (2012)

Statistics Sweden has a long term commitment in the Swedish Environmental Emissions Data (SMED) in collaboration with IVL Swedish Environmental Research Institute, SLU Swedish University of Agricultural Sciences and SMHI Swedish Meteorological and Hydrological Institute. SMED is heavily involved in all work related to Sweden's international reporting obligations on emissions to air and water, waste and hazardous substances. A central objective of the SMED collaboration is to develop and operate national emission databases and offer related services to clients such as national, regional and local governmental authorities, air and water quality management districts, as well as industry.

One task is to allocate emissions from various sources to grids 1x1 kilometer. This way it is possible to show the allocation of greenhouse gases and air pollution which is used for regional follow-up of environmental quality

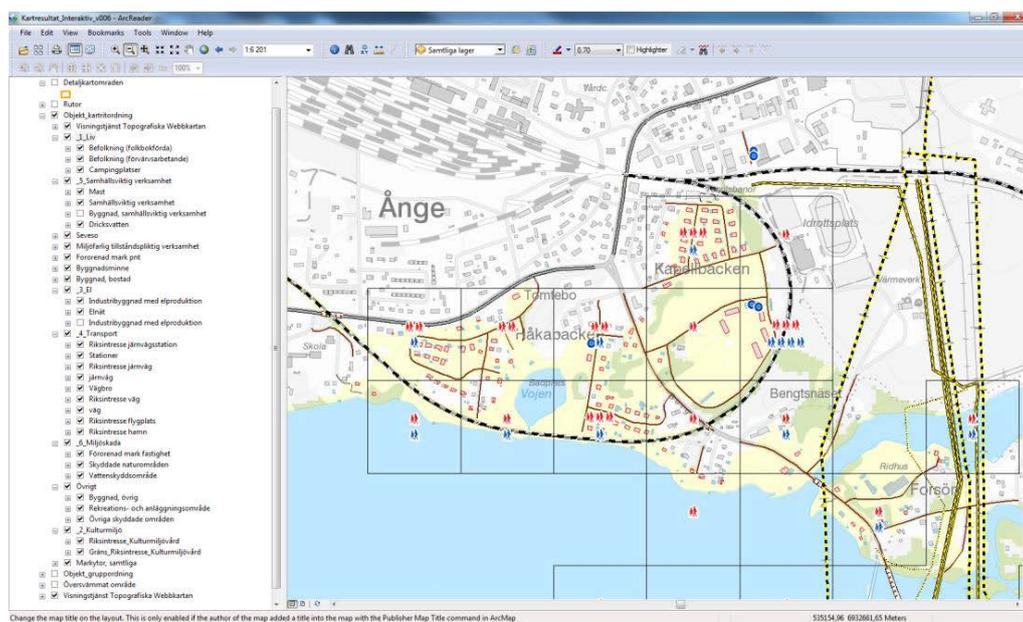
objectives and climate issues. Air pollution is also reported every five years according the Convention on Long-Range Trans Boundary Air Pollution.

Gridded emissions are used for air quality simulations from the urban level to more aggregated levels, as it is possible to separate regional, urban and local contributions. Simulations are useful on national level for long term evaluations. They are also used in SIMAIR, a web based model tool for calculation of Air Quality in Swedish population centers provided by the Swedish Meteorological and Hydrological Institute.

Geospatial data that are used are land use data and road network together with address coordinates for various point sources that produce emissions.

By connecting emissions to grids it is possible to get valuable information on local, urban or regional level for regional follow-ups as well as national simulations and evaluations of the environmental quality objectives.

Flooding as a consequence of dam failure



Example of GIS-application using all relevant layers for calculation of consequences of dam failure

Statistics Sweden (SCB) has on behalf of Elforsk developed and tested a GIS based method that in an effective way can be used to identify and map objects that can be flooded as a consequence of a dam failure.

The method builds on putting together available digital information for objects in an entire river valley that in the case of a flood could be damaged with societal consequences and disturbances as a consequence. A GIS model has been developed for information processing, analysis and presentation of results. The method comprises the following steps; putting information together, preparing a model for a river valley, applying an inundation layer representing a flood scenario, and mapping and presentation of objects.

The mapping and the presentation of the objects within the inundation layer is implemented in an automated process in the model. The results can be presented in tables (Excel), maps and as a data set (shape files with squares 250*250 m and information about items that are within the squares). The selected subdivision of objects differentiates between people, essential services to the society (electricity supply, transport infrastructure and other essential services), environment and health, cultural environments and others.

Results from application of the method for specific dams can be used as a base for the dam owner's work with consequence investigation and classification according to the new legislation for dam safety, but it can also support the development of coordinated emergency preparedness planning for dam failures.

APPENDIX

Presentation on governmental agencies producing and using spatial information

Lantmäteriet

Lantmäteriet is one of the major producer of spatial information in Sweden. The mission of the agency is to give support for creating an efficient and sustainable use of Sweden's real property, land and water. The organization has three main activities: the cadastral services division, the land and geographic information division and the land registration division.

The mission concerning land and geographic information is to secure efficient collection, storage and administration of geographic and real property information. It also includes the analysis and establishment of demands and needs of such information in society. The collection is carried out by Lantmäteriet and often in co-operation with other public authorities including the municipalities.

An important task is to make the information available and used by a broad spectrum of users thereby contributing to efficiency, improvement and renewal in the public as well as in the private sector. In this regard, Lantmäteriet perceives major social development potential and has been working for a couple of years on finding the financial resources to open up geographical data and addresses for free use. Starting in 2015 and continuing in 2016, small scale geographical data as well as a sub-metre positioning service will be available for free.

As mentioned earlier, Lantmäteriet is responsible for the co-ordination of the national infrastructure for spatial information. The Swedish spatial data infrastructure is a part of corresponding information systems within EU. The national spatial data infrastructure, NSDI, will make it easier to access information, and thereby maximize the benefit for society from the spatial information that exist in Sweden.

- Lantmäteriet aims to create the preconditions for increased use of spatial information.
- Lantmäteriet will also make it possible to exchange and combine spatial information from different sources, which is a precondition for efficient collaboration, both between users in the public sector and in the interaction between companies and the general public.
- By making greater use of spatial information Lantmäteriet creates better preconditions for sustainable development and greater competitiveness in the business community, public administration and society in general.

Lantmäteriet map reality and provide the society with maps, images and other fundamental geographic information. Carried out is aerial photography and airborne laser scanning as well as land surveys.

Lantmäteriet cooperates with central and local authorities in order to collect fundamental data and reliable geographic information. You may associate Lantmäteriet with printed paper maps, but nowadays maps are primarily packaged in various digital formats. Lantmäteriet is also responsible for the national geodetic infrastructure, including a national CORS and connected network-RTK service.

The spatial data services are "machine to machine" services that allows to look up, view and retrieve maps, images and property information into appropriate systems.

Statistics Sweden

Statistics Sweden is a governmental agency responsible for producing and communicating statistics for decision making, debate and research. Statistics Sweden is mainly assigned these tasks by the government and different agencies, but customers in the private sector and in the research community are also important target groups. Besides producing and communicating statistical data, the agency is tasked with supporting and coordinating the Swedish system for official statistics as well as participation in international statistical cooperation.

Statistics Sweden has a longstanding tradition of geographical applications in the production of official statistics. The first steps towards usage of georeferenced information as a regular component of the statistics portfolio were taken already in the 1980s. In late 1980s, real property coordinates together with data from the population register were used to produce the first machine generated population grid of Sweden. Today, GIS and geospatial information are integral parts of the production chain in many statistical products, especially in the field of land use statistics. The use of geospatial information within Statistics Sweden can be broadly divided into two different categories depending on the purpose of the usage and the properties of the end-use product.

- Production of geospatial statistics, such as gridded statistics or other small area statistics, where the geospatial statistics itself is released as the end-use product or at least forms an essential part of the result. This category also includes delimitation of localities etc. In general, geospatial statistics is not part of the official statistics in Sweden. Products created within this category are available for use either within the Geodata Cooperation or for purchase.
- Production of official statistics where geospatial information and/or geospatial processing is involved at some stage of the production chain but not essentially part of the disseminated result. Stages of production may concern design of surveys, sampling, data collection, processing, analysis and dissemination. The majority of the data produced within this category are available as open data.

In a broad sense, most statistical products retrieved from administrative records have a geospatial component as many of them rest upon an underlying framework of georeferenced records. However, in terms of

production setting, such as data sources used, tools, methods for data processing and analysis, the most “geography intense” field of statistics is land use statistics. Accordingly, the impact of the Geodata Cooperation has been most significant in the production of land use statistics.

Since 2011 Statistics Sweden has been member of the Swedish Geodata Cooperation, both as a provider of data and as a user. Statistics Sweden’s contribution to the Geodata Cooperation is gridded population data and delimitation of localities and other statistical units. For Statistics Sweden as a user the Geodata Cooperation has encompassed a paradigmatic shift of the production of land use statistics, and other geospatial statistics, due to the widely extended access to geodata.

Statistics Sweden is responsible for a large number of official products concerning use of land and water, comprising statistics on land use, land cover, land ownership, protected nature, urban green areas, coastal settlement and development, urban development etc. In all of them, external geodata and geospatial processing plays a key role.

During recent years, Statistics Sweden has taken active part in several international initiatives aiming at better integration of geography and statistics. During the preparatory work of the INSPIRE Directive, Statistics Sweden took part in working groups responsible for specifications of Annex II & III regarding population distribution and statistical units. Currently Statistics Sweden is committed to the work of UN GGIM Europe and since February 2015 it is also coordinating a European project called GEOSTAT 2 aiming at a better foundation for creation of spatial statistics in a pan-European perspective.

Statistics Sweden also provides interactive maps and visualizations. The Statistical Atlas at Statistics Sweden’s webpage is a thematic atlas for interactive visualization of regional statistics. The Atlas shows several different views that are all interrelated. Among other things, these views include thematic maps, tables, bubble charts and bar graphs. It is possible to animate time series to see development over time. Interactivity allows you to freely select the statistical variables that are available in the Statistical Atlas and analyse them in different views. The Statistical Atlas also includes short analyses of the statistics in the form of descriptive texts known here as stories.

The Swedish Maritime Administration

In Sweden, the Hydrographic Office is responsible for hydrographic services and is organized under the Swedish Maritime Administration (SMA). The Hydrographic Office is responsible for hydrographic surveying in Swedish waters and publication of official nautical chart products in electronic and paper format and maritime safety information such as Notice to Mariners. Most of SMA’s activities are financed through dues on ships and cargoes. As a coastal state Sweden has ratified the United Nations Convention on the Law of the Sea (UNCLOS) and the Conventions for the Safety of Life at Sea (SOLAS). Related to hydrography these two UN conventions require that the coastal state’s waters must be charted so relevant nautical charts and

publications can be published to secure navigation in and passage through the coastal state's waters. The Swedish government has mandated these tasks through its instruction to the SMA. Through these instructions the SMA is also representing Sweden in the International Hydrographic Organization (IHO).

Shipping is a global market dependent on international standardised nautical products. Therefore a hydrographic office is totally dependent on international interaction. The intergovernmental co-operation in hydrography is done through the IHO, by the member states hydrographic offices and the bureau (IHB) in Monaco. Regional aspects are organised through regional hydrographic commissions such as the Baltic Sea Hydrographic Commission (BSHC). All countries surrounding the Baltic Sea are member states in the BSHC which is very active in international work and analyses. Among actions within the BSHC includes coordination of vertical reference levels for nautical products and water level information, coordination of international paper and electronic charts in the Baltic Sea and co-operation on a bathymetry portal. The Baltic Sea Bathymetry Database <http://data.bshc.pro/> has been developed by the hydrographic offices of the countries surrounding the Baltic Sea under the leadership of the SMA. A 500 m grid of depth data is available for viewing and downloading at the portal. The Baltic Sea Bathymetry Database developed by the Hydrographic Offices from countries surrounding the Baltic Sea under the lead of the Swedish Maritime Administration.

Co-operation with other Swedish Authorities as well as the private shipping sector is essential for the SMA. There is an established successful cooperation with Lantmäteriet where one important example is the compilation of a common coastline for use in both parties' official products. Successful co-operation is also established with the Swedish Agency for Marine and Water Management, the Geological Survey of Sweden as well as the Swedish Meteorological and Hydrological Institute and others involved in marine environmental and spatial planning issues.

Bathymetry is primarily used for nautical products to secure safe shipping, however many other sectors of society are dependent on bathymetry. Examples are mapping of the marine environment, marine spatial planning and efficient preventive measures for protection from the effects of expected future climate change in the coastal zone.

Swedish waters cover an area of 165,000 km², mostly comparatively shallow, with 2,700 km of coastline. Archipelagos are widespread and are a challenge to seafarers and especially challenging to surveyors. As a result of a successful project co-financed by the European Commission TEN-T programme the Swedish and Finnish Hydrographic Offices managed to speed up the surveying of its waters up to the applicable IHO standard. In 2015 as much as 50 % of the Swedish waters have been surveyed up to the standard thanks to the co-financing from the European Commission.

The vector based Electronic Navigational Chart (ENC) are used in the Electronic Chart and Display Information System (ECDIS) which is the approved system on-board on commercial ships. On the electronic chart

display the ship's position is shown as well as other ships positions using GNSS and AIS (Automatic Identification System). The UN agency the International Maritime Organization (IMO) has decided upon carriage requirements of ECDIS being implemented and the regulation require ships engaged on international voyages to be fitted with ECDIS according to a timetable meaning that most ships will have an ECDIS on-board 2018. Swedish official ENC's are produced by the SMA in usage bands similar to the scale areas described for paper charts above. The use of electronic charts is steadily increasing as an alternative to or a complement to paper charts. In order to use ENC instead of paper charts the system must fulfil the requirements specified in the IMO Performance Standards for ECDIS. Swedish waters are completely covered by ENC's which is also the case in all neighbouring countries. Official Swedish ENC's are distributed via a global distribution centre, PRIMAR, which is a part of the Norwegian Hydrographic Service with head office in Stavanger, Norway. PRIMAR serves as a centre for ENC-distribution to the shipping sector and the end users receive continuously updated ENC's. In the case of Sweden the SMA distributes 1,500 updated ENC's in a typical year. Examples are changes in harbours and fairways, new under water cables and pipelines or changed depth information as a result of the hydrographic surveying. Updates are available for the end user by both an online service and a weekly produced CD.

The nautical chart of today is a comprehensive and complex document showing a detailed shoreline, detailed information on depths, characteristic landmarks, fixed and floating navigational aids etc. In addition a navigator is provided with necessary navigational, traffic and port information, compass charts with deviations, chart limits etc. A navigator needs as much information as possible but at the same time not too much information since it would overload the chart with misleading information of lesser use for navigation. This is valid for paper charts as well as electronic charts. The ability to show the vessels position, given from GNSS, on top of the electronic chart requires an improved accuracy of the chart information than was the case when charts were only available as a paper product. Quality improvement of the content in the chart products is one of the major challenges and where SMA puts in a lot of effort. Improvement of accuracy is concentrated on the most crucial themes for mariners. As described previously hydrographic surveys are performed in all areas used by commercial shipping and will result in updated and accurate depth information in the charts. The coastline is continuously improved through the co-operative project with Lantmäteriet where the old coastline in charts is replaced with new photogrammetric surveyed coastline. The joint coastline project is a part of a larger challenging project, which makes a major quality improvement, and its goal is to change the vertical reference level in all chart products. A common vertical reference level for the whole Baltic Sea has been agreed upon in the BSHC. Due to post glacial land uplift since the end of the last ice age, there is a need to refer the depth information to a more up to date vertical reference level. The current situation could be confusing; with a depth figure in the chart saying 8 m which in reality is only 7.5 m.

Improvement in positioning of nautical objects such as lighthouses and buoys also contributes to greater accuracy of the nautical chart products.

The Swedish Environmental Protection Agency (SWEPA)

SWEPA is the public agency with an overview of the state of the environment and progress in environmental policy. SWEPA also have the task of coordinating, monitoring and evaluating measures involving many agencies, to meet national environmental objectives. The Agency works on behalf of the Swedish Government. The remit comprises:

- compiling knowledge and documentation to develop SWEPA's and others' environmental measures,
- helping to develop environmental policy by providing the Government with a sound basis for decisions and by giving an impetus to EU and international measures,
- participating in environmental policy implementation by ensuring compliance with the Swedish Environmental Code and achievement of the national environmental objectives.

SWEPA is the central government agency for the environmental sector. This sector responsibility comprises the responsibility to coordinate the environmental data provisioning. Environmental data is collected, aggregated, analysed and used for monitoring and assessment of the environmental objectives. It is also used for national and international reporting and is presented to the public; in order to meet national and international requirements on public access to information and public participation.

In order to assist decision makers, by presenting a well prepared basis for decision, the monitoring and assessment of the environmental objectives make use of data on drivers (D), pressures (P), state (S), impact (I) and response (R). The DPSIR data is produced by different authorities and form the basis for a complex system analysis.

Drivers are the social, demographic and economic developments in societies and the corresponding changes in life styles, overall levels of consumption and production patterns.

Drivers function through human activities which may intentionally or unintentionally exert *Pressures* on the environment.

The pressures exerted by society may lead to unintentional or intentional changes in the *State* of the ecosystem.

Changes in the quality and functioning of the ecosystem have an *Impact* on the welfare or well-being of humans through the provision of ecosystem services.

Humans make decisions in *Response* to the impacts on ecosystem services or their perceived value.

Responses are actions taken by groups or individuals in society and government to prevent, compensate, ameliorate or adapt to changes in the state of the environment by seeking to

- Control drivers or pressures through regulation, prevention, or mitigation
- Directly maintain or restore the state of the environment
- Deliberately "do nothing"

There are two dimensions that are of special interest when analysing environmental data – the time dimension and the spatial dimension. Many of the environmental courses of events are extended in time. It is therefore most relevant to have datasets stretching over long time periods. The other dimension of interest is the spatial dimension. It is of most importance to be able to pinpoint and present where a certain phenomenon occurs.

The production and use of geographical data is hence essential for SWEPA. Access to geographical data from other authorities is necessary in the daily work.

Examples of geographical data that is produced, used and provided by SWEPA are:

- *Protected sites*
- *Land Cover classification*
- *Swedish Land Cover database*
- *Habitat classification (Natura 2000)*
- *Environmental monitoring information*
- *Results from analyses and inventories*

Geographical data owned by SWEPA is distributed as Open Data with a Creative Common License (CC0). Metadata and services are described and published according to regulations in the INSPIRE directive and there are also customized services following “de facto” standards.

SWEPA also produces official environmental statistics, on:

- *waste*
- *state of the environment*
- *emissions to water and air, and on*
- *the implementation of the Swedish Environmental Code*

International reporting obligations are requirements to provide information agreed between countries and international bodies such as the European Environmental Agency (EEA) or international conventions. Reporting obligations provide the basis for most environmental information flows. These flows often implies that locally collected environmental data gets aggregated, analysed, used and presented to the public, on a national and international level.

ROD is the EEA's reporting obligations database. It includes all environmental reporting obligations that EEA member countries have

towards DG environment, European marine conventions, Eurostat, OECD, UN, UNECE, as well as the EEA itself.

At the moment Sweden have in total 384 international environmental reporting obligations.

The public access to environmental data is regulated via international treaties, via EU legislation and via Swedish national legislation.