Digital Geodetic Archive

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SUMMARY

Since several years, Lantmäteriet (the National Land Survey of Sweden) has worked with the process to convert the analogue information regarding the points in our national geodetic networks to digital format. These networks are under the responsibility of Lantmäteriet. It is important to have a homogenous archive about the geodetic points. It is also important that the data is easily accessible. Measurements and adjustments belonging to the national 3D, horizontal, vertical and gravimetric networks are stored in a systematic way in the archive. The Geodetic Archive at Lantmäteriet does not have any information about local networks that belongs to the municipalities.

Traditionally the different national geodetic networks have had their own archive separate from the others even though many points are physically the same in the various networks. It is even so that the same point may have several different point identifiers depending on what network it belongs to. Converting towards a digital geodetic archive means that we have been forced to merge the different datasets into one common database to make the use of the geodetic archive more efficient.

A digital geodetic archive has been in place for the staff at the geodetic archive for some years but we are now making it accessible for other users through the Internet. We hope that this will help them to find the information by themselves. It will improve the efficiency of the geodetic archive as well as the archive will be available 24 hours per day any day of the year.

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1. INTRODUCTION

Lantmäteriet (The National Land Survey of Sweden) is responsible for the geodetic archive covering information about all points included in the national co-ordinate, levelling and gravimetric networks. The information used to be archived in paper format but has since several years in steps been converted into digital format. The geodetic archive is today completely in digital form except for very old information that is rarely asked for.

Also traditionally, the databases have been kept separately, information on triangulation points has not easily been shared between levelling or gravity points when ever these are the same physical point. This mean when we have updated the information, e.g. that the point was found in good condition, we used to be forced to update the data in several databases or registers manually.

Having the information in digital format has been necessary for many reasons. The information is collected in digital format and should also be stored as so. Updating the archive must be done from one central entrance independent if the point is originally a GPS-point or a levelled point. The digital information in the archive is therefore more homogenous and of better quality than the previous analogue.

The products asked from the geodetic archive are mainly list of co-ordinates or heights, point descriptions or maps showing the location of the points. Making the archive available through the Internet enables the user to find the information by her self and therefore the work of the staff at the geodetic archive can be more efficient.

The Internet version will be published during 2006, at least for internal Lantmäteriet users. A registration of the users will be necessary so that we can follow what different users are downloading. Despite the revolution concerning measuring techniques mainly with the use of different satellite methods, some information in the archive is still classified or at least it is not acceptable to retrieve large amount of data, this is mainly gravity values and height values. Gravity values will e.g. not be possible to download at all through the digital geodetic archive.

2. WHAT KIND OF INFORMATION IS STORED IN THE GEODETIC ARCHIVE

The information in the Geodetic Archive at Lantmäteriet goes all the way back to the 18th century. Some of the older information were though classified and stored at the Military Archive of Sweden but are today accessible also to the public. The geodetic archive contains information about the national co-ordinate, height and gravimetric reference frames. It includes information about the points and their location. Also the measurements and

computations that have been conducted to achieve the national reference frames are stored in the geodetic archive.

The Geodetic Archive includes today e.g.

- 3 800 modern triangulation points of good quality
- 1 000 other triangulation points of less quality
- 5 500 GPS points
- 12 300 older triangulation points
- 50 000 modern height benchmarks
- 70 000 older height benchmarks
- 23 000 gravity points
- 10 000 manuscripts
- 2 000 point maps
- 8 000 points used for aerial photogrammetry

All information regarding the modern triangulation points, GPS points and modern height benchmarks are stored in the digital geodetic archive. Some of the older information is also available in digital format.

Also as part of the geodetic archive is all the transformation formulas derived by Lantmäteriet between different national reference frames and between national reference frames and local co-ordinate systems.

The geodetic archive will most probably not grow much in the future since the change of measuring strategies has been implemented with the use of GNSS. The existing triangulation network based on 3 800 points is now replaced by a much smaller number of permanent GNSS stations and the new height network, that consists of some 50 000 points, will not be replaced in a foreseen period of time with something similar. Permanent stations will be the future regarding development and maintenance of most reference frames. Our height network is maintained using levelling but this will only increase the number of height benchmarks with a low number every year.

3. THE NEED AND ACCESSIBILITY OF GEODETIC INFORMATION

There are several reasons why we need to have the data in digital form and also accessible for the users as well as the staff over the Internet. A geodetic point in Sweden may be a triangulation point, GPS point, height benchmark or gravimetric point but many points are a combination of two or three different types. The digitizing of the data forced us to merge the different information types so e.g. when we update the information for a point in our national triangulation network the same update can automatically be found when retrieving information from the very same physical point but this time as part of our levelling network. The information in the archive is therefore now more homogenous and of better quality.

Another important need for making the information available was to decrease the working load of the staff at the geodetic archive so that they can do other type of work. The products

asked from the geodetic archive are mainly list of co-ordinates or heights, point descriptions or maps showing the location of the points. Making the archive available through the Internet enables the user to find the information by her self and therefore the work of the staff at the geodetic archive can be more efficient. We believe that this could save us a lot of work and therefore also money.

4. ANALOGUE TO DIGITAL

Most of the analogue information that should build the archive was in the form of point descriptions, see figure 3. To scan the material and do a correct OCR was not possible. Tests were made but there where to many inaccuracies, that was to be corrected manually afterwards. Therefore most of the analogue material was entered by hand. For the triangulation points all information i.e. the name, description and type of benchmark of the points was to be entered, together with the scan of the sketch.

Most of the height benchmark information was already in digital format and only the sketches were analogue. The information was to be imported into the database.

The sketch were scanned in both cases and together with the sketch, the point identifier was scanned with OCR to get a correct file name of the sketch.

5. TECHNICAL DESCRIPTION OF THE DIGITAL GEODETIC ARCHIVE

5.1 The database

5.1.1 Basic database solution

The digital geodetic archive consists of a database and a file server. The database is an Oracle 9.2 relational database. Side by side with the database a file server is running to store the sketch picture that belongs to each point.

To get fast and accurate access to the data, one view for each product was implemented. The content of each view is representing the data needed for the specific product.

Altogether there are about 100 tables that hold information of the actual digital geodetic archive, 130 views and 50 functions in the table space.

5.1.2 Content

As mentioned in chapter 2, the aim with the Digital Geodetic Archive is to store information about our geodetic points. The information is divided into main tables and sub tables. The main table types are:

- PKT – Fundamental point information i.e. point identifier and description of the point.
- DATA – Co-ordinates and height information

Of the total amount of tables, 19 tables are main tables.

To illustrate the surroundings around each point a sketch is drawn. This picture is saved as a *.png file. These files are stored in a file structure on a file server and the path to the file is stored in the database. There are about 11500 sketches of triangulation and GPS points and about 48600 sketches of height bench marks stored as *.png files.

5.1.3 Structure

Due to the fact that it is possible for a single physical point to be several different types of points, there are several different point identifiers for the same point. To make it possible to connect the different kinds of information to a single physical point, we choose one point identifier as our main identifier. All other identifiers are then related to the main identifier. A consequence is an information union for many of the points. Some point information is connected to a specific project i.e. co-ordinates or height and other information is point specific i.e. textual description. This is the basics why the database is build around one table containing the main point identifier.

5.2 Digital Geodetic Archive client

For the staff that works with the Digital Geodetic Archive on a daily basis to keep the database up to date a client program is being used. The client makes it possible to keep the database up-to-date with new information and to correct data that are wrong.

At an early stage of the development phase the aim was to serve most of the customers with the client. The client was supposed to be used for the most of interaction with the database. With the client data can be viewed together with a map as background and selections can be based on the present map extent. Due to the development of the WWW interface, the client is nowadays a plain tool to keep the database up-to-date.

The client is written in Visual Basic 6.0 and the database connection is an ODBC-connection. For the map based functions, MapInfo is used.

5.3 The WWW interface

To make the Digital Geodetic Archive public, a WWW interface was developed. The first version was a plain HTML solution and the connection to the database was achieved by IDC/HTX. Due to the low performance and the lack of security it was rewritten in ASP. In that time the database where on a Microsoft Windows 2000 server with IIS. Now the WWW interface is running on a Linux server with Apache web server and in the time for the move all scripts were translated into PHP.

The WWW interface is consists of HTML forms produced by PHP and all products are produced by PHP scripts. To connect to the database an OCI extension module in PHP is used. The data exchange is performed with SQL.

For internal users an advanced mode are available, that allows selections to be made based on several different data types, e.g. quality and location of the points. In simple mode, available for external users, selections can mainly be performed based on point identifier.

The products that are implemented into the WWW interface are:

- Point descriptions for triangulation points and GPS points
- Point descriptions for height bench marks
- Lists with triangulation points and GPS points
- Lists with height bench marks

The point descriptions are an information sheet about a point that consists of information to find the point in the terrain. To present the data on one sheet with fixed layout, a PDF-file are generated on the fly, see figure 3 and 4. This is done with a PHP class library called FPDF. Together with the information on the point description, the sketch is placed as a picture file and a map with the nearest surroundings is also included. The map have the size of 12 km^2 map scale 1:50000 (48 km^2 and 1:100000 in the northern part of Sweden) and it is taken from a map server the PHP library CURL.

To create the lists with the co-ordinates and heights as text files, a page are built in HTML. The result can then be saved into a plain text file and can be read by our other software e.g. for transformation into another co-ordinate system.

6. HOW TO ACCESS THE DATA

The data can be accessed via map or via textual information.

6.1 Selection via map

In order to select a point graphically there are an interface that supports selection of points from a map. All points are plotted on the map and are then selectable, see figure 1. A connection to the digital geodetic archive makes it possible to download a point description of the point that is selected.

This tool is actually not a part o the digital geodetic archive. It is a service at Lantmäteriet that can be used to view many different types of data, not only geodetic.

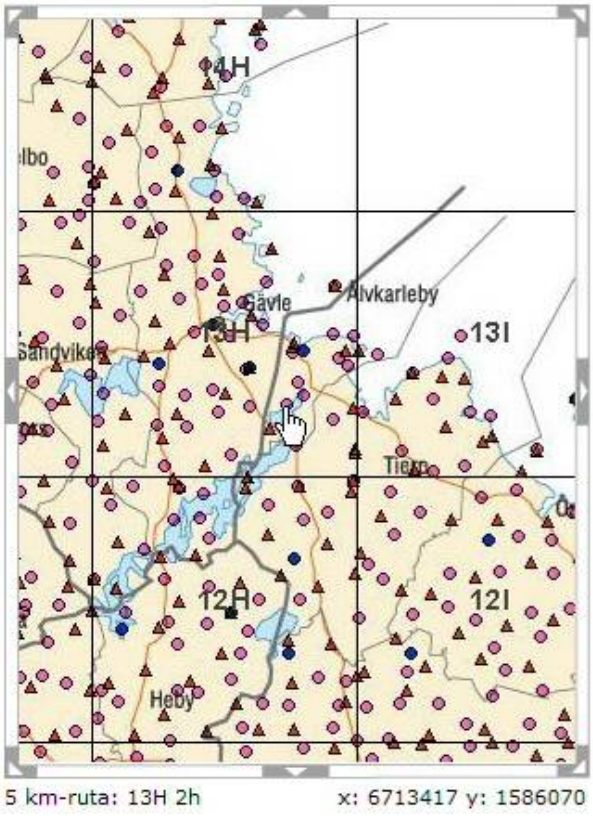

Figure 1: Example of selection via map. When a point is selected, a popup window shows information about the point and a link to the point description.

6.2 Selection via text

The textual selections are performed via HTML forms that communicate with the database with SQL. The form is filled out and the SQL query is built from the choices in the form. In advanced mode, se figure 2, there are more choices to be made, for example it is possible to define co-ordinates for the search area as a rectangle.

6.3 Example of the products

The main products from the digital geodetic archive are point description sheets and text lists with co-ordinates and heights.

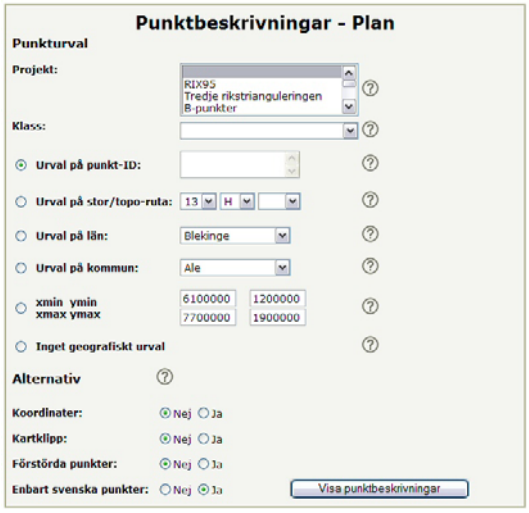

Figure 2: The form of point descriptions in advanced mode.

6.3.1 Point description

The point description is a sheet with information about a point. Due to the different type of information to be displayed, the layout differs for the point descriptions for triangulation and

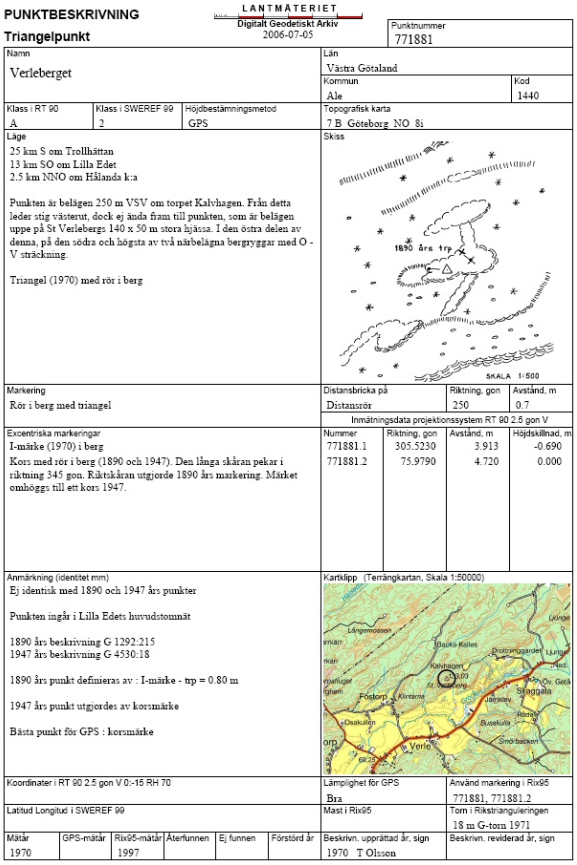

Figure 3: Point description of a triangulation point.

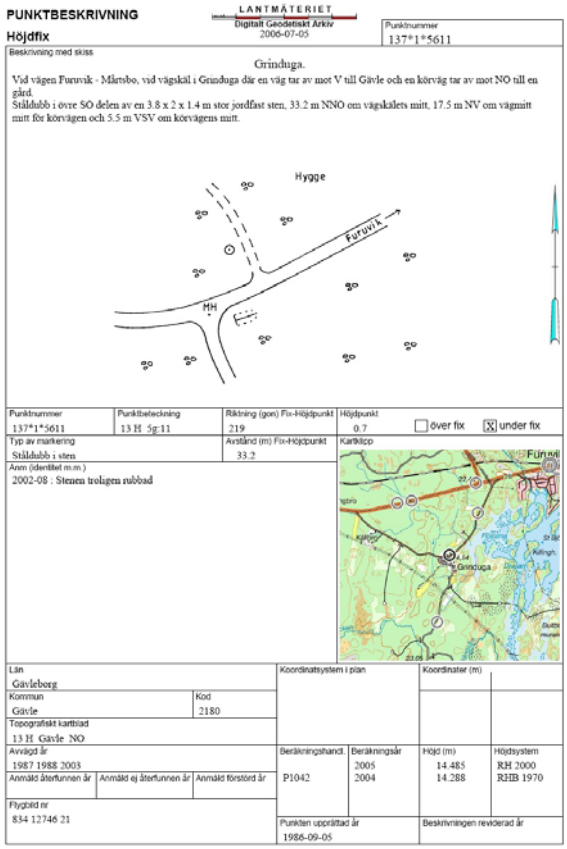

Figure 4: Point description of a height bench mark.

GPS points, figure 3, and height bench marks, figure 4.

The point descriptions are presented as PDF-documents and are convenient to save and send digitally to other users. In cases when more than one point constitutes the selection, the PDF-document consists of as many pages as points.

6.3.2 Lists

To get an overview of all the points in an area, it is convenient to get a list of all points. The lists are supposed to be read by other programs, i.e. the format is important, e.g. the header of the file should have a specific appearance.

The lists with co-ordinates for the triangulation points and GPS points will include the point identifier, co-ordinates, status, a classification and the project that the point is a part of. The

lists can also include attributes like type of benchmark, heights, height measurement method and name of the point; see below for an example of a complete co-ordinate list.

The content of the height lists are point identifier and the height of the point in the chosen vertical height system, in addition to that it can also include type of benchmark.

```
KFIL                  2006-07-05 13:56:44
DGA-urval     5 punkter
Kommun: Gävle   Kommunkod: 2180
Projekt: RIX95, 3RT
Klass:
Definitiva (aktualitet = 1) eller preliminära (aktualitet = 0) xy-
koordinater.
Projekt i ATTRIBUT = det projekt som koordinaterna beräknats i.
/
SYSTEM RT 90 2.5 gon V 0:-15 RH 1970
/
ATTRIBUT    >Markeringstyp >Aktualitet >Klass >Projekt >HMetod >Namn >
/
PUNKTER
127730   6685491.386 1569627.010 97.844  >RST>1>A>3RT  >GPS>Hadeåsen >
1277490  6688580.440 1572105.820 59.215  >DSS>1>B>RIX95>GPS>Sevallbo >
1278390  6691935.092 1565168.306 57.941  >DSS>1>B>RIX95>GPS>Ålbo     >
1279190  6698234.028 1557653.746 63.339  >DSS>1>B>RIX95>GPS>Vinnersjö>
/
STOP
```

BIOGRAPHICAL NOTES

Anders Alfredsson
Mr Alfredsson graduated in 2002 from the Royal Institute of Technology as a land surveyor with emphasis on Geodesy and Photogrammetry. He is working at Lantmäteriet since 2002 at the Geodetic Research Division.
Mr Alfredsson is a member of the Swedish Map and Measuring Technique Society.

Mikael Lilje
Mr Lilje graduated in 1993 from the Royal Institute of Technology as a land surveyor with emphasis on Geodesy and Photogrammetry. He is working at Lantmäteriet since 1994 with various topics, mainly at the Geodetic Research Division. Currently he is the head of a group working with reference frame and co-ordinate system questions.
Mr Lilje is chair of the Swedish Map and Measuring Technique Society and chair of the FIG Commission 5 Working Group on ”Reference Frame in Practice”. Mr Lilje was also secretary for FIG Commission 5 during the period 1998 – 2002.

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