

Geodetic activities at Lantmäteriet, the National Land Survey of Sweden

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1. Introduction

At Lantmäteriet (The National Land Survey of Sweden) the activity in the field of reference frames and reference networks is focused on introducing the new ETRS 89 realisation SWEREF 99, the ongoing projects RIX 95, SWEPOS including developments towards network RTK services and the development of a new height system based on the third precise levelling.

2. Lantmäteriet and EUREF Permanent Network (EPN) and European Combined Geodetic Network (ECGN)

Six stations in SWEPOS, the Swedish network of permanent reference stations (see section 6) are included in EUREF Permanent Network (EPN). The stations are Onsala, Mårtsbo, Visby, Vilhelmina, Kiruna and Borås (ONSA, MAR6, VIS0, VIL0, KIR0 and SPT0). Both daily and hourly data are delivered. Skellefteå is proposed as a new EPN-station.. All the Swedish EPN/IGS stations are equipped with dual-frequency GPS/GLONASS receivers. ONSA, SPT0, MR6G (identical to MAR6), VS0G (identical to VIS0) and KR0G (identical to KIR0) are also included in the IGS network.

Sweden offers the following stations for ECGN, the five EPN-stations KIR0, MAR6, VIS0, SPT0 and ONSA as well as the SWEPOS station in Skellefteå (proposed new EPN-station). See further section 8.

Lantmäteriet co-operates with Onsala Space Observatory in the operation of NKG EPN Analysis centre.

3. Maintenance of EUREF stations in Sweden

Several sets of stations in Sweden have been included in different EUREF campaigns; EUREF 89, EUREF-BAL92, EUVN 97 and finally SWEREF 99. The valid set of stations and co-ordinates for the Swedish realisation of ETRS 89 is the subset of 21 stations of the SWEREF 99 campaign endorsed at the EUREF meeting in Tromsø 2000. According to resolution No.1 of this meeting, the old stations should no longer be valid as EUREF stations. The EUREF database must be updated on this point.

The 21 Swedish EUREF stations are all permanent stations included in the SWEPOS-network. The average distance is c. 200 km. The co-ordinates are checked in a system run on daily and weekly basis (Jivall 2002). The stability of the monuments are checked every third year with local measurements.

The 21 EUREF stations are used as the foundation for further densification carried out in the RIX95 project (see section 5).

In the EUVN 97 campaign four non-permanent stations were included (pillar monumentation). These stations have also been determined in the system SWEREF 99. One of those stations (Smögen) turned into a permanent SWEPOS-station 2002.

4. SWEREF 99

SWEREF 99 was adopted by EUREF as an ETRS 89 realisation in Tromsö 2000. SWEREF 99 was introduced as the national reference system for GPS during 2001.

Lantmäteriet has recommended, in a report to our government during the autumn 2001, that SWEREF 99 shall be our official reference system and replace RT 90 for surveying and mapping. For map projections Lantmäteriet recommends the following:

- For national map projection a Transverse Mercator with central meridian, $\lambda_0=15^\circ$, and scale reduction factor, $k_0 = 0.9996$
- For local surveying, a system of zones with $1^\circ 30'$ between central meridians and $k_0 = 1$ is recommended

A formal decision will come during 2003 regarding the map projection and the timetable for the introduction in NLS databases and product lines.

This year (2003) Lanmäteriet has been given the task to start pilot studies in co-operation with local authorities on the introduction of SWEREF 99. Further more national strategies for the introduction of SWEREF 99 should be developed in consultation with other authorities and the Association of Local Authorities.

5. RIX 95

Since 1995, a project involving GPS measurements on triangulation stations and selected local control points (RIX 95) has been in operation. This is supported by a group of national agencies. The principal aims are to establish transformation formulas between local coordinate systems and the national reference systems (SWEREF 99 and RT 90), and to establish

new points easily accessible for local GPS measurements.

The project is planned to go on until 2006; each year about 450 triangulation stations and 450 new points are measured. The present situation for the measurements is shown in figure 1. Transformation formulas are now available for 122 of 290 municipalities.

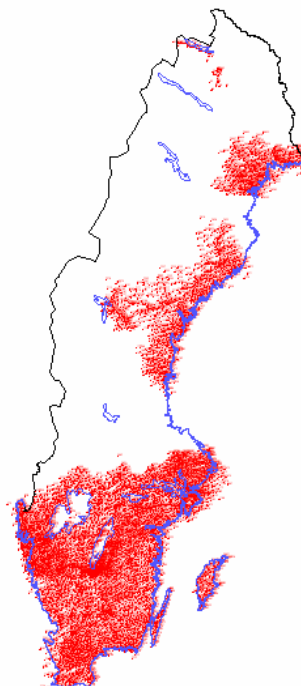


Figure 1: Completed areas in RIX 95.

6. SWEPOS™

Since 1 July 1998 the Swedish network of permanent reference stations, SWEPOS, see figure 3, is operational in IOC mode, i.e. positioning in real time on the meter level and by post-processing on the centimetre level. Positioning in real-time on the centimetre level is possible in regional parts of Sweden.

The purpose of SWEPOS is to:

- provide single- and dual-frequency data for relative GPS measurements.
- provide DGPS corrections and RTK data for broadcasting to real-time users.

- act as the continuously monitored foundation of the Swedish geodetic reference frame (SWEREF 99).
- provide data for geophysical research.
- monitor the integrity of the GPS system.

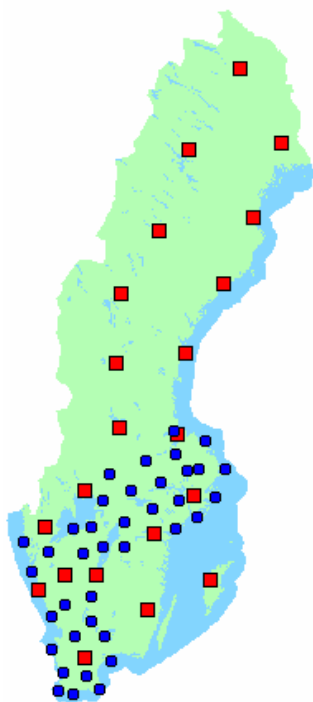


Figure 3: The SWEPOS network September 2002.

Twenty-one of the SWEPOS stations are complete stations i.e. they are monumented on bedrock and have redundant equipment for GNSS-observations, communications, power supply etc. In addition there are thirty-six simplified stations i.e. stations mainly located on the top of buildings and with less redundant equipment than the complete stations. The simplified SWEPOS stations are used for regional Network-RTK services and for the on-going research projects for the use of GPS in meteorological applications.

All the SWEPOS stations have real time connections to the control centre at Lantmäteriet in Gävle via leased TCP/IP connections.

Three prototype regional positioning services based on Network RTK started up last year (Stockholm area, Southern Sweden and West Sweden). These services are carried out as projects with partners from governmental agencies, local authorities and consultancy companies. The aim of these services is to evaluate and improve the Network-RTK techniques and production work. The intention is to provide regional services on regular basis from January 1st, 2004. Preparations or establishment projects are going-on in the south-eastern and middle-western parts of Sweden.

In a Nordic co-operation, steps towards a Nordic Positioning Service have been taken.

SWEPOS DGPS correction data is distributed by the following companies: Cartesia, and Fugro-Omnistar.

In October 2000 an automated post processing service, based on the Bernese software, was introduced at the SWEPOS web page (www.swepos.com).

7. Development of a new height system

The third precise levelling of Sweden is progressing according to plan which means that the new national height network should be calculated in the winter 2003/4.

The final network will consist of about 50 000 bench marks representing roughly 50 000 km double run precise levelling measured using motorised levelling technique.

Preparation for the computation of a new height system has started. This work is currently divided into two different projects aiming at preparing data for the final calculation as well as investigating how the new height network should be implemented.

The work with this preparation includes building up more knowledge on the more theoretical aspects of a new height system.

Within the working group on height determination under the Nordic Geodetic Commission (NKG) work is focused on calculating a Nordic Height block including the height networks from Denmark, Finland, Norway and Sweden. Our purpose is to set up an EVRS2000 realisation in the Nordic countries based on NAP, zero tidal system, epoch 2000.0.

8. Gravity Network

Absolute gravity measurements in Sweden has been done at five locations (Onsala, Göteborg, Mårtsbo, Furuögrund (also known as Skellefteå) and Esrange (also known as Kiruna)). Onsala, Mårtsbo, Furuögrund and Esrange are co-located with GPS. Onsala is also co-located with VLBI. None of these stations are located nearer a mareograph than approximately 15 km.

An absolute gravity plan for the Nordic area has been developed during 2003 within the framework of NKG. The plan suggest four new absolute gravity points in Sweden and these are Borås, Kramfors, Östersund and Arjeplog. Borås will be co-located with SPT0, Östersund and Arjeplog with the SWEPOS-stations OSTE.0 and ARJE.0.

Onsala, Mårtsbo, Furuögrund, Esrange, Borås, Kramfors, Östersund and Arjeplog will all be measured during 2003.

Relative gravity measurements on the 63° land uplift line will be measured during 2003 in collaboration with Denmark and Finland. The line has been measured several times, latest in 1999 with the aim to control the gravity change due to post-glacial rebound.

Last year the measurements of our First Order Gravity Network were completed.

9. Related Activities

In August 20-23 2002 a GPS-campaign was carried to connect the Swedish and Finnish levelling networks over Åland Sea. A total of 10 levelling benchmarks (four in Sweden between Stockholm and Gävle) were included besides the permanent networks in Sweden and Finland. Three full 24 h sessions were observed at each station and Dorne Margolin T-type antennas were used on all stations. The project is a co-operation within the Nordic Geodetic Commission (NKG) between Lantmäteriet and the Finnish Geodetic Institute (FGI). A preliminary GPS solution was presented at the NKG General Meeting in October 2002.

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