

National Report of Sweden to the EUREF 2004 Symposium

- 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 activities in the fields of geodetic reference frames and geodetic reference networks are focused on introducing the ETRS 89 realisation SWEREF 99, introducing the new national height system RH 2000 and the ongoing project RIX 95. Large efforts are also carried out concerning the operation and expansion of the Swedish network of permanent reference stations SWEPOS™, where a regional network RTK service was launched on January 1st 2004. Some of the activities are done within the framework of the Nordic Geodetic Commission (NKG).

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

Seven SWEPOS stations are included in EPN (EUREF Permanent Network).

The stations are Onsala, Mårtsbo, Visby, Borås, Skellefteå, Vilhelmina and Kiruna (ONSA, MAR6, VIS0, SPT0, SKE0, VIL0 and KIR0). Both daily and hourly data are delivered.

Furthermore Onsala, Mårtsbo, Visby, Borås and Kiruna (ONSA, MR6G (identical to MAR6), VS0G (identical to VIS0), SPT0 and KR0G (identical to KIR0)) are also included in the IGS network. Skellefteå (SKE0) is proposed to be a new IGS station. All the Swedish EPN/IGS stations are equipped with dual-frequency GPS/GLONASS receivers.

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

Sweden has, according to a co-ordination done within the framework of NKG, offered all seven Swedish EPN stations except Vilhelmina for ECGN (European Combined Geodetic Network). NKG has also created a Nordic densification called NGOS (Nordic Geodetic Observing System).

3. ETRS 89 realisations in Sweden

SWEREF 99 was adopted by EUREF as the Swedish ETRS 89 realisation at the EUREF 2000 symposium in Tromsø (Jivall & Lidberg, 2000).

The valid set of stations and coordinates for SWEREF 99 is a subset of 21 stations (all permanent stations included in SWEPOS) of the SWEREF 99 campaign endorsed in Tromsø. According to resolution No.1 of this meeting, stations in other older campaigns should no longer be valid as EUREF stations. The EUREF database must be updated on this point. The coordinates for the stations are checked in a system run on daily and weekly basis (Jivall, 2002).

A common Nordic geodetic reference frame is planned within the framework of NKG. It will not replace the national ETRS 89 realisations, but it will give the possibility to verify differences between them. GPS data from 133 permanent reference stations will be analysed during 2004 in ITRF 2000, by five Nordic analysis centres. The data was captured in autumn 2003 (GPS week 1238).

4. Network of permanent reference stations (SWEPOS™)

Since July 1st 1998 the Swedish network of permanent reference stations (SWEPOS), see figure 1, is operational in IOC mode, i.e. for positioning in real-time on the metre level and by post-processing on the centimetre level (Kempe et al., 2004). Positioning in real-time on the centimetre level is possible in regional parts of Sweden. SWEPOS also offers an automated post-processing service,

based on the Bernese software (Kempe & Jivall, 2002), see www.swepos.com.

The purposes of SWEPOS are 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.

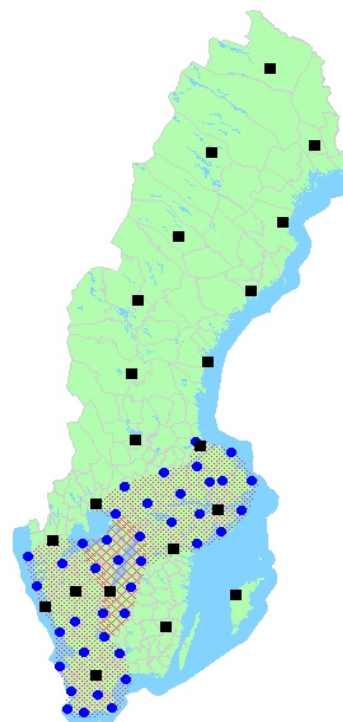


Figure 1: The SWEPOS network in June 2004 (squares are complete stations and dots are simplified ones). The marked area shows the coverage of SWEPOS Network RTK Service.

The same 21 stations that SWEPOS consisted of when it became operational in IOC mode are still in

operation. These stations are complete stations, i.e. they are monumented on bedrock and have redundant equipment for GNSS observations, real-time communications, power supply etc.

A number of simplified stations, but no complete ones, have been added during the last six years. Today (in June 2004) SWEPOS also includes 40 simplified stations, which mainly are located on top of buildings and with less redundant equipment than the complete ones. The simplified SWEPOS stations are mainly used for network RTK and for on-going research projects for the use of GPS in meteorological applications.

During the past years, Lantmäteriet together with GPS users in Sweden has run some regional establishment projects with network RTK (Jonsson et al., 2003). Based on the experiences from these projects, a regional network RTK service was launched on January 1st 2004. This service (SWEPOS Network RTK Service) covers the most populated areas of Sweden, see figure 1, and there is today (June 2004) approximately 220 subscriptions. A new establishment project has been launched during 2004 in the south-east part of Sweden and there are also preparations for establishment projects in the rest of the country, except for the mountainous north-west part, see figure 2. As distribution channel for network RTK, GSM is used, but tests with distribution via mobile Internet have also been performed (Peterzon, 2004). In order to verify the performance of network RTK, a lot of test measurements have been performed, where some test measurements also included different

network RTK software (Engfeldt et al., 2003).

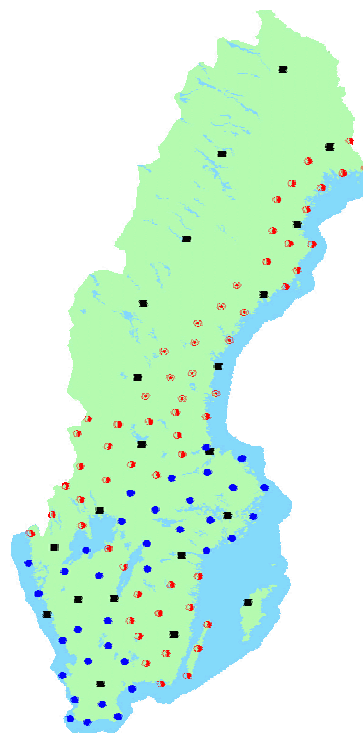


Figure 2: The existing SWEPOS network in June 2004 (squares and filled dots) and the plan for new stations for network RTK (half-filled dots, where four of them already exists).

The establishment of a Nordic Positioning Service based on network DGPS is in progress within the framework of NKG. Actions that have been carried out are the establishment of a computer network between the national control centres, the development of a Nordic web-portal for post-processing data and test measurements with network DGPS.

5. RIX 95

Since 1995, a project involving GPS measurements on triangulation stations and selected local control points called RIX 95 has been in operation. The work is financed by a group of national agencies. The principal aims are to connect local co-

ordinate systems to the national reference frames (SWEREF 99 and RT 90) and to establish new points easily accessible for local GPS measurements.

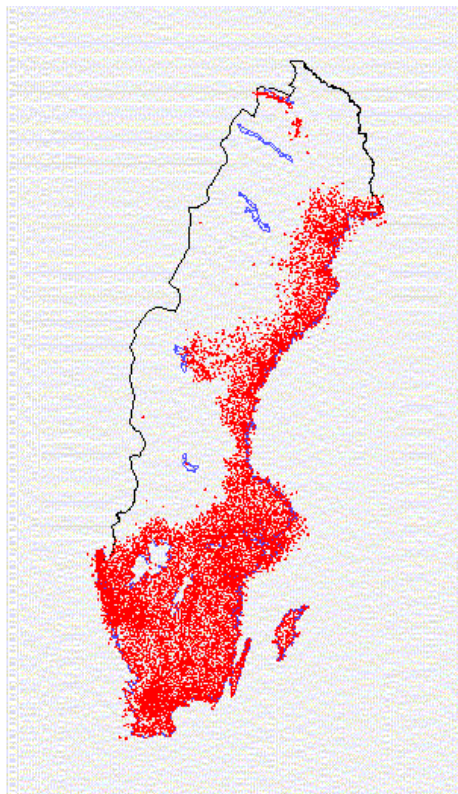


Figure 3: Completed areas in RIX 95 (June 2004).

The project is planned to be completed in 2006. Each year about 450 triangulation stations and 450 new points (mainly existing local control

points) are measured. The present situation for the measurements is shown in figure 3. Transformation parameters are now (June 2004) available for 145 of the 290 Swedish municipalities.

6. Introduction of the ETRS 89 realisation SWEREF 99

SWEREF 99, the national realisation of ETRS 89, is used as the national geodetic reference frame for GPS since 2001.

Lantmäteriet has decided that SWEREF 99 shall also be our official reference frame and replace RT 90 for surveying and mapping.

A formal decision regarding map projections for national mapping purposes as well as for local surveying was taken in 2003 (Lantmäteriet, 2003). All the projections are of Transverse Mercator type and the chosen values for the defining parameters are shown in table 1.

System	Projection parameters			
	central meridian, λ_0	scale reduction factor, k_0	false northing (m)	false easting (m)
SWEREF 99 TM	15° E	0,9996	0	500 000
SWEREF 99 12 00	12° 00' E	1	0	150 000
SWEREF 99 13 30	13° 30' E	1	0	150 000
SWEREF 99 15 00	15° 00' E	1	0	150 000
SWEREF 99 16 30	16° 30' E	1	0	150 000
SWEREF 99 18 00	18° 00' E	1	0	150 000
SWEREF 99 14 15	14° 15' E	1	0	150 000
SWEREF 99 15 45	15° 45' E	1	0	150 000
SWEREF 99 17 15	17° 15' E	1	0	150 000
SWEREF 99 18 45	18° 45' E	1	0	150 000
SWEREF 99 20 15	20° 15' E	1	0	150 000
SWEREF 99 21 45	21° 45' E	1	0	150 000
SWEREF 99 23 15	23° 15' E	1	0	150 000

Table 1: Defining projection parameters for SWEREF 99 map projections.

The timetable for the introduction in databases and in product lines at Lantmäteriet will be decided later.

The work with the introduction of SWEREF 99 among other authorities in Sweden such as local authorities are in progress. Approximately 30 of the 290 Swedish municipalities have started to replace their old system with SWEREF 99.

7. Introduction of the new national height system RH 2000

The third national precise levelling of Sweden has been completed. The network consists of about 50 000 bench marks, representing roughly 50 000 km double run precise levelling measured by motorised levelling technique.

The final computation of the new national height network will be performed during 2004, according to the preparations done during the past years. The name of the new national height system will be RH 2000. The final computation will most probably use a land uplift model based on the three Swedish national precise levellings. The definition of RH 2000 will be done according to EVRS 2000.

The zero-point(-s) will be calculated in a common adjustment of a Nordic height block, based on data from mainly the Nordic states and the states around the Baltic Sea. This adjustment will use Lambeck's land uplift model. The work is done within the framework of NKG and will also give information about the closing error around the Baltic Sea (Mäkinen et al., 2003).

The work with the introduction of RH 2000 among other authorities in Sweden such as local authorities are in progress. Approximately 10 of the 290 Swedish municipalities have started to replace their old height system with RH 2000.

8. Gravity activities

Absolute gravity measurements in Sweden have been done at nine locations (Onsala, Göteborg, Borås, Mårtsbo, Kramfors, Östersund, Arjeplog, Furuögrund (also known as Skellefteå) and Esrange (also known as Kiruna)). All points are co-located with permanent reference stations for GPS in the SWEPOS network except Göteborg and Kramfors. Onsala is also co-located with VLBI.

According to the absolute gravity plan for the Nordic area first developed during 2003 within the framework of NKG, absolute gravity measurements will be performed at two new points during 2004. These points are Visby and Smögen, which both are co-located with GPS. The existing points Onsala, Mårtsbo, Kramfors, Östersund, Arjeplog, Furuögrund and Esrange will also be measured during 2004. All points that are not connected to the zero-order national gravity network will further be connected with relative measurements during 2004.

Relative gravity measurements on the 56° and 63° land uplift lines have been performed during 2003 in collaboration with Denmark and Finland. The lines are measured in regular intervals, with the aim to study the gravity change due to post-glacial rebound.

9. References

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