NATIONAL REPORT OF LATVIA

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State Land Service of the Republic of Latvia

The State Land Service of Latvia (SLS) consists of Department of Economic and Program management and Internal Audit Department, Administrative Department, Department of Finance and Material Resources, Geodesy Board *http://www.vzd.gov.lv/en/structure/gb.htm*, Cartography Board, Large Scale Mapping Board, Main Board of Information, Real Estate Formation Board, Real Estate Valuation Board and 8 Regional Offices.

Geodesy Board of the SLS deals with geodetic reference networks.

The main tasks of the Geodesy Board are as follows:

- To create and to maintain unified geodetic information space in the state,
- To plan geodetic networks and to be in charge of them in order to supply the state with geodetic information,
- To supply unified methods for geodetic works and to control them,
- To plan and to conduct network development,
- To supply necessary documentation for geodetic work.

GPS network

Reference system for our national GPS network was established in 1992 according to the EUREF.BAL`92 campaign in 1992. There were 4 points - RIGA (0201), ARAJS (0410), INDRA (0407) and KANGARI (0406) included in it. GPS reference network was developed in 1993 and it contains 44 stations in total. Development of the First and the Second Order GPS Network was started later. We should complete national GPS network in 2002. Most of all GPS measurements in the country have been carried out by four Trimble 4000 SSE and three 4700 type receivers of the State Land Service of Latvia.

Station	Latitude N D M S	Longitude E D M S	Ellipsoidal Height (m)
0201 **Riga**	56 56 54.46246	24 03 30.95078	29.338
0410 **Arajs**	56 29 36.58352	21 46 58.81493	208.604
0407 **Indra**	55 52 44.75337	27 36 40.10489	213.326
0406 **Kangari**	57 05 40.53204	27 35 37.18558	163.854

Summer - autumn, 1992. There was organized first experimental works with rented instruments for renovation of geodetic network.

GPS activities in the framework of campaign EUREF.BAL 92. This campaign was performed with assistance of the Nordic Geodetic Commission and geodesists from Norway, Sweden, Finland and Denmark implemented it. Measurements were performed in 24 points and 4 from them were located in Latvia: Riga (201), Kangari (406), Indra (407) and Arājs (410). Adjustment of this network accomplished by Kort og Matrikelstyrelsen (KMS) in Copenhagen. As a result the base points of Latvian geodetic network - Riga, Arajs, Indra and Kangari was included in O class network of the European states (Madsen & Madsen, 1993).

On June 4, 1992 the Cabinet of Ministers of the Republic of Latvia accepted the act NR. 213 “About transition to Latvian geodetic co-ordinate system LKS-92“ (Latvian Co-ordinate System - 92) in the whole Latvia, which is included in used European system ETRF - 89. Geodetic origin of LKS-92 serves the main mark M 1884 of satellite observation station Riga and points Arajs, Indra, Kangari:

- orientation of ellipsoid is given through 4 GPS points (Riga, Arajs, Kangari, Indra), surveyed in the time of EUREF. BAL 92 campaign,
- central meridian 24°,
- scale factor 0,9996,
- Transversal Mercator projection.

Geodetic commission of the Baltic States in 1993 accepted conventional agreement that is in campaign EUREF. BAL 92 determined point co-ordinates, which have to be presumed as a basis for creation of the state geodetic networks.

USA Defense Mapping Agency (DMA) from August 24 to September 3, 1993 performed GPS surveying campaign of Latvian Base Network LATVIA 93, where geodesists from Latvia participated. Measurements were performed with 9 Ashtech receivers and in two sessions per day. Measurements were performed in 44 points, from whose 42 were first class before and 2 – second class old triangulation points. Afterwards network adjustment and calculation of point co-ordinates was performed at the Institute of Geodesy at the Riga Technical University.

GPS measurements in Riga sector were performed by guidance of professor O.West from the Curtin University (Australia). Measurements were performed at 70 sites, from these 18 was new and others was identical to existing triangulation points of higher or lower classes.

Fig. 1: Surveyed GPS sites per year

The SLS of Latvia created points of G1 and G2 (GPS base network), which comprises from 740 points. There was G3 network created, which is not finished yet and comprises more than 2000 points, formed for needs of the land reform (surveying).

SLS participated in campaign of Baltic Sea Level BSL-97 and EUVN 97 project in 1997.

There were 40 GPS points surveyed later in Kurzeme in the framework of Denmark – Baltic sector program also aimed for fitting of geoid. They can be regarded as GPS points of G1 or G2 classes and a part of the base network of Latvia.

Fig. 2: GPS reference network

There are two operating permanent GPS-stations in Latvia - Riga and Irbene.

Riga station belongs to the EUREF Network of Permanent GPS Stations, besides it is co-located with Satellite Laser Ranging System, absolute gravity station and ground water registration spot. Since May 1998 the second permanent GPS-station in Latvia Irbene has been operational and it was included in EUVN97 project (ZHAGARS & KAMINSKIS, 1998).

Fig. 3: Trimble 4700 in operation

Fig. 4: Monument of Riga permanent GPS point

Fig. 5: Permanent GPS station Riga, number 12302M002

The vertical network of Latvia

The future levelling plans have been prepared considering the current possibilities. The existing leveling network has been readjusted within the United European Levelling Network (UELN –95) project (Sacher et.al., 1999). We performed 301 km of the first order repeated levelling in 2000 and it is planned to perform 350 km levelling in 2001.

We have digitised the first and the second order levelling network catalogues and in order to close levelling loops inside the country, the future levelling plans are made.

Fig. 6: Latvian precise levelling network

Gravity survey and geoid in Latvia

Gravity data

The reference gravity network began to create (contains 24 stations) under supervision of the SLS in 1998. It is necessary to complete gravity reference network and to continue detailed gravity measurements to verify and to improve Latvia gravity database. Points are selected along the roads with the distances between points less than 5 km. Trigonometric points or levelling benchmarks are used in the detailed survey. Gravity surveys are based on three absolute gravity points measured by J. Mäkinen (October 1995), (Mäkinen et.al., 1995)

In the future the improvement of national gravity reference network can be obtained from absolute gravity observations. Geodynamic changes of network geometry influence surface gravity values, what makes it important to continue with ongoing improvements and research in reference networks.

Since 1998 new gravity measurements were begun in order to create and complete gravity reference network and to verify and to improve Latvia's gravity database. For that purpose the new gravimeter Scintrex CG-3 is used.

Fig. 7: Gravimeter CG – 3 in operation

Geoid

To follow up the growing need for accurate and common vertical reference network in 1996 at the National Survey and Cadastre of Denmark (KMS) we have computed Latvian Gravimetric Geoid (LGG96) what is a part of Nordic Geoid (NKG96). We have tested our geoid on 32 Zero Order GPS points and received standard deviation for LGG96 8 cm after fitting of the geoid. Gravimetric geoid contains information for approximately 12 000 gravity sites on our territory. Unfortunately, 95% of the mentioned sites are digitized from the gravity anomaly maps in scale 1: 200 000, what is insufficient to reach geoid accuracy up to 1 - 2 cm.

Levelling data used for geoid test at the reference GPS sites are rather old, because the last levelling of those sites were carried out in 1960-ies or in same cases in 1980-ies. It is difficult to put all available geodetic data together into consistent system due to influence of time.

For the fitting of the geoid we must use GPS Zero Order, First Order and Second Order sites together with First and Second Order levelling data, which makes the base for a 4-parameter empirical datum fit of geoid to GPS/levelling stations. Received reliable geoid could be used for modern and efficient survey techniques and will not spoil up our national height system.

In 1996 the Sector Programme between Denmark and Latvia titled "Vertical Network Analysis and Modernisation in Latvia" was started. The Programme includes GPS, levelling, gravimetry and local geoid solution – LV98.

Conclusions

- After one more first order levelling (planned total length of lines ~ 2800 km) is completed and these high precision levelling lines are connected to GPS reference network it will be possible to create Latvia's geoid with 1 cm accuracy,
- Together with to the levelling works the gravity surveying also is conducted focused at improving terrestrial gravity coverage (reaching accuracy better than 100 μGal),
- Mutual consolidation of gravimetric, levelling and GPS networks, which is one of the main goals of the *Geodesy Board of the State Land Service*, allows to create uniform reference surface for the entire country - geoid as digital height reference surface with 1 cm accuracy,
- Latvia's geoid model for 1998 is formally approved for uniform use in the country by the State Land Service according to the regulation No 29 dated on February 20, 1999,
- We will establish virtual national framework as infrastructure supply system based on permanently operated multi – functional DGPS service in future.

Fig. 6: Permanent GPS station Riga, number 12302M002

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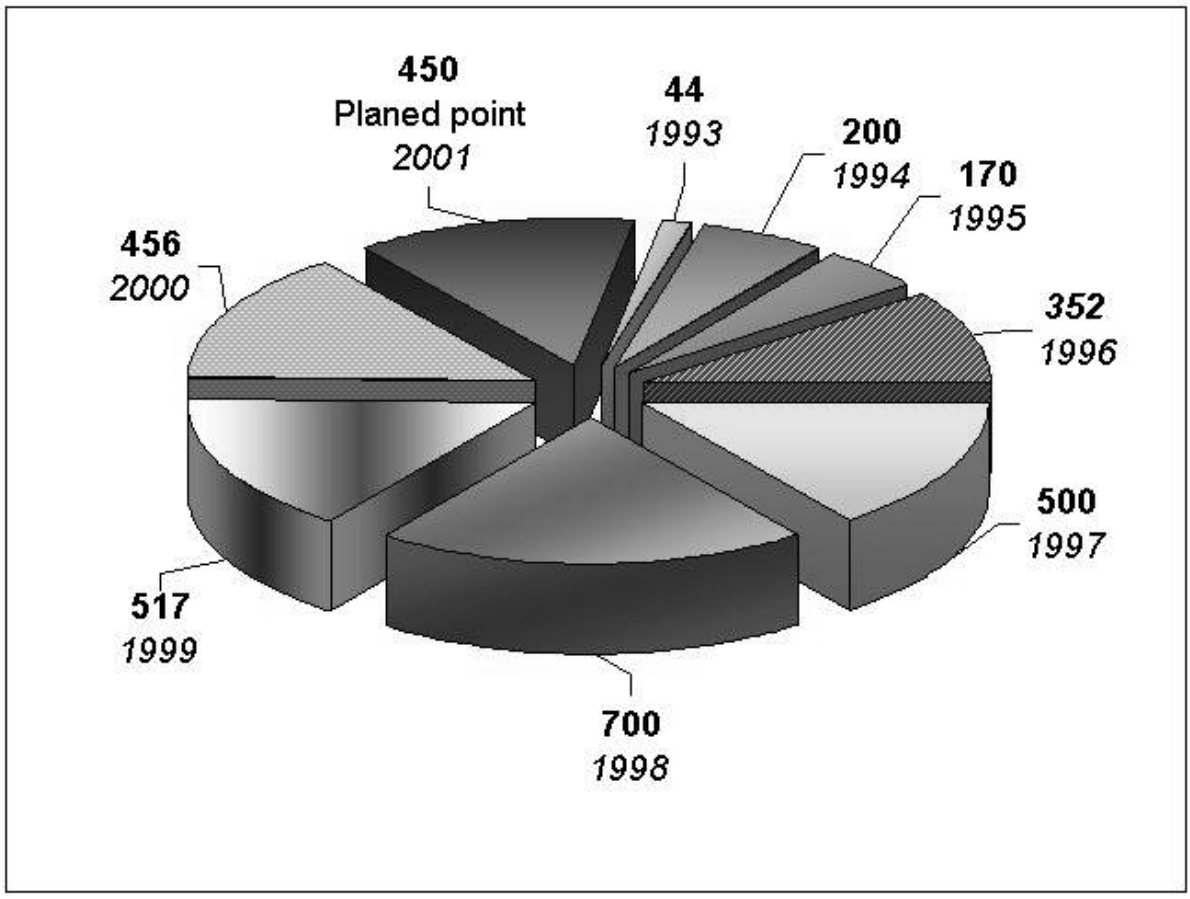
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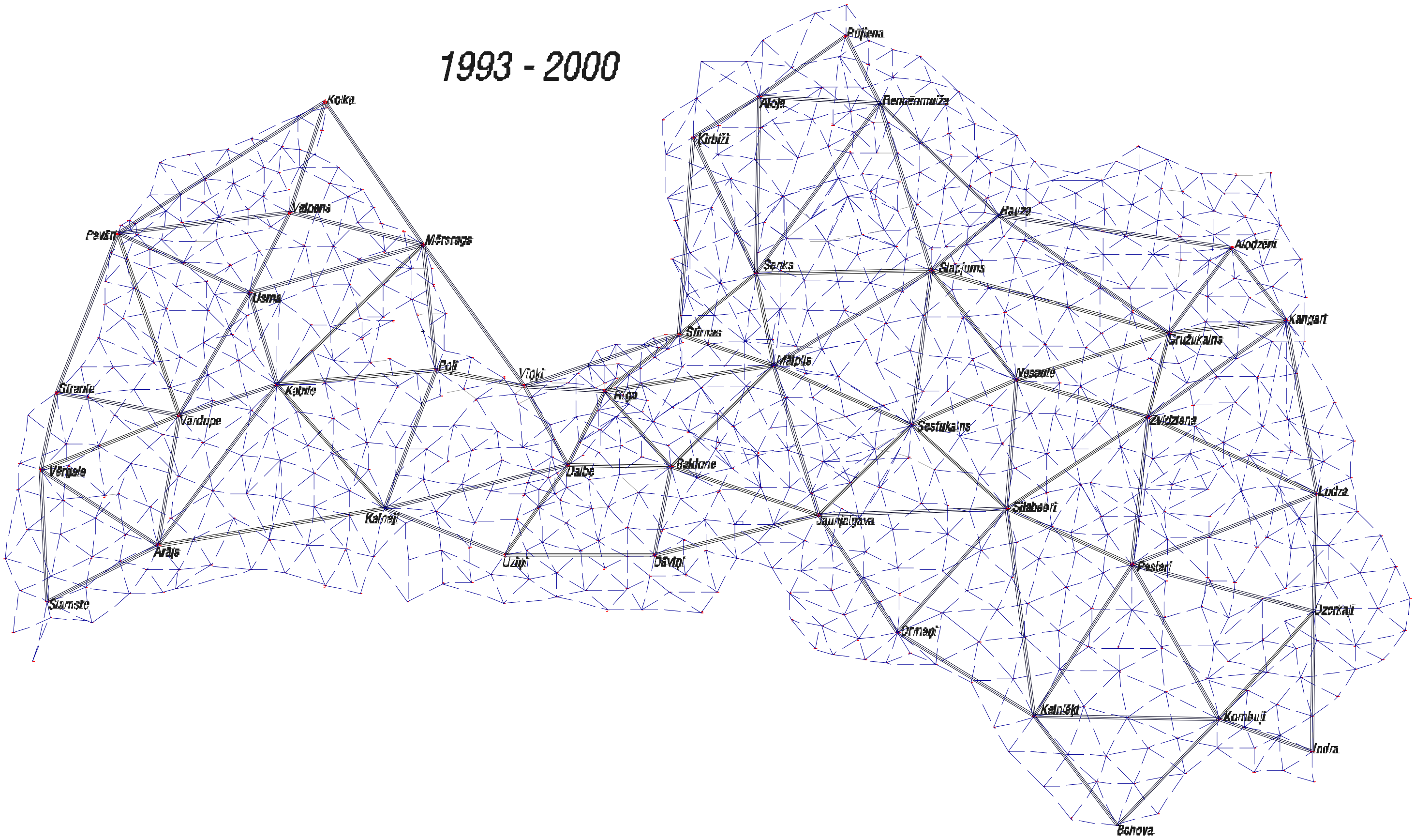

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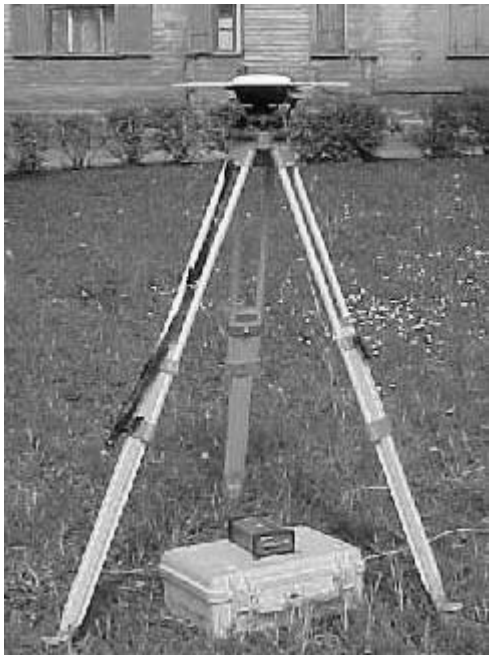

LATVIAN PRECISE LEVELLING NETWORK