State Land Service of Latvia

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The State Land Service of Latvia (SLS) was formed in 1993. The tasks of the State Land Service was defined by the law " On SLS " at the end of 1992. The District and the City Office of the SLS were made in every region. The main tasks of the Office were connected with implementation of the land reform.

SLS of Latvia consist of Department of Geodesy *http://www.vzd.gov.lv*, Department of Cartography, Department of Large Scale Mapping, Main Department of Information, Department of Forming of Real Estate, Department of Evaluation of Real Estate, Department of strategy and Program Guidance and Internal Department of Audit and 8 Regional branches (Fig.1).

With all geodetic reference networks are dealings Department of Geodesy of SLS.

The main tasks of the Geodesy Board are:

- To create and to maintain unified geodetic information space in the state,
- To plan strategically 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 its,
- To plan and to conduct network development,
- To supply necessary systematic documentation base.

Fig. 1: Main building of the State Land Service in capital Riga

GPS network

Reference system for our national GPS network was established in accordance with the EUREF.BAL`92 campaign in 1992; 4 points - RIGA (0201), ARAJS (0410), INDRA (0407) and KANGARI (0406) were included. GPS reference network was developed in 1993 and contains 44 stations in total. Later development of First and Second Order GPS Network was started. We will complete national GPS network in 2003. Mainly all GPS measurements in the country have been carried out by our four Trimble 4000 SSE and three 4700 type receivers (Fig.4) of the State Land Service of Latvia.

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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	163854

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

Our GPS network is based on EUREF.BAL campaign carried out in 1992, which approved as a densification of the EUREF'89 for the Latvia. This campaign was performed with assistance of the Nordic Geodetic Commission and it was realised by geodesists from Norway, Sweden, Finland and Denmark. Measurements were performed in 24 points and 4 from them were located in Latvia: Riga (201), Kangari (406), Indra (407) and Ar~js (410). Adjustment of this network accomplished by Kort og Matrikelstyrelsen (KMS) in Copenhagen. As a result base points of Latvian geodetic network points Riga, Arajs, Indra and Kangari was included in O class network of European states (MADSEN & MADSEN, 1993).

4 June in, 1992 the Cabinet of Ministers of the Republic of Latvia accepted act NR. 213 "About transition to Latvian geodetic co-ordinate system LKS-92" (Latvian Co-ordinate System - 92) in all 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 must be presumed as a basis for creation of the state geodetic networks.

USA Defense Mapping Agency (DMA) from August 24 till September 3, 1993 performed GPS surveying campaign of Latvian Base Network LATVIA 93, where participated geodesists from Latvia. Measurements were performed with 9 Ashtech receivers and in two sessions per day. Measurements were performed in 44 points, from whose 42 before was first class 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.

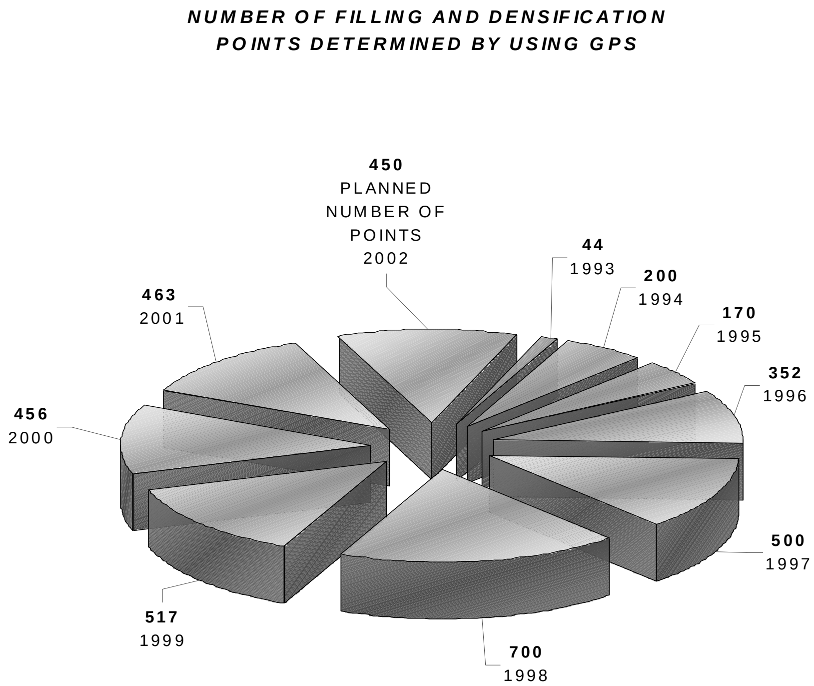

Fig. 2: Surveyed GPS sites per given year

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

SLS of Latvia created points of G1 and G2 (GPS base network), which comprises from 740 points (Fig.3). There was G3 network created, which is not finished yet and comprises more than 3000 points (Fig.2), formed for needs of the land reform (surveying)

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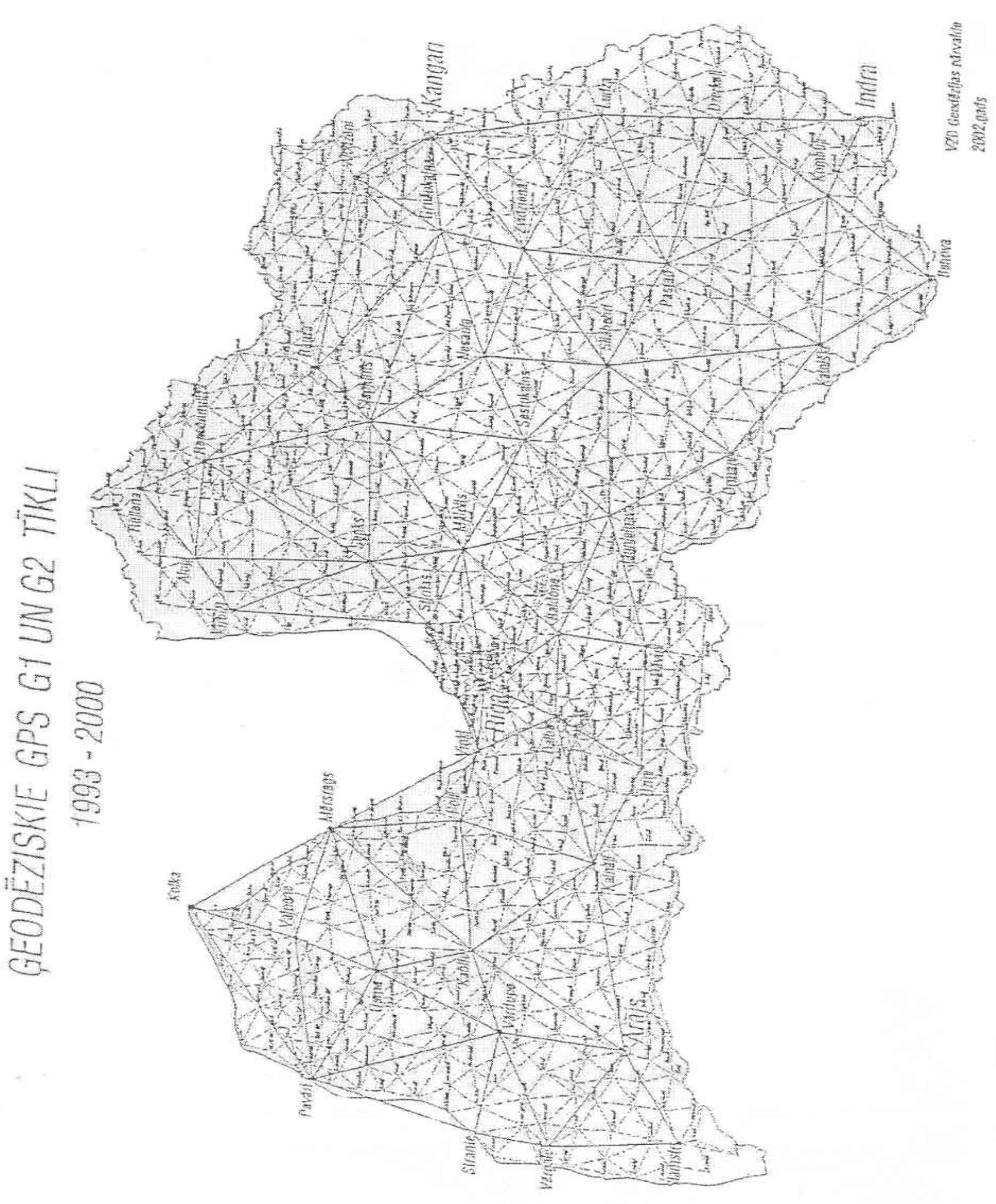

Fig.3: GPS reference network

SLS participated in campaigns of Baltic Sea Level BSL-93; BSL-97 and EUVN 97 projects 1997.

Later there were 40 GPS points surveyed in Kurzeme in the framework of Denmark – Baltic sector programme also aimed for fitting of geoid. They can be regarded as GPS points of G1 or G2 classes as a part of reference network of Latvia.

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

Riga station belongs to the EUREF Network of Permanent GPS Stations (Fig.5 and Fig.6), 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. 4: Trimble 4700 in operation

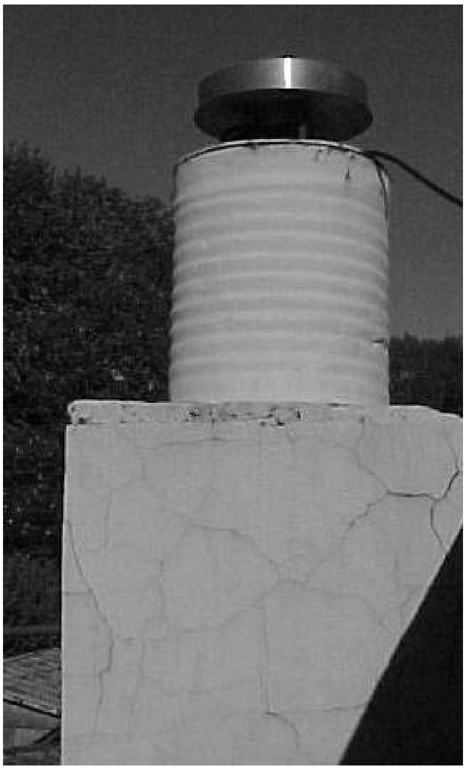

Fig. 5: Monument of Riga permanent GPS point

Fig. 6: Permanent GPS station Irbene (also LV-04 within EUVN 97)

The vertical network of Latvia

In 1969, preparation work for the new adjustment of the total levelling network of USSR were started. The vertical datum was defined by reference benchmark monumented in the railroad station Orienbaum of city Lomonosov. A fragment of the Fundemental levelling network of USSR in the territories of Baltic States is show in Fig .7.

The future levelling plans have been prepared considering the current possibilities. The existing levelling network has been readjusted within the United European Levelling Network (UELN – 95) project (SACHER et.al., 1999).

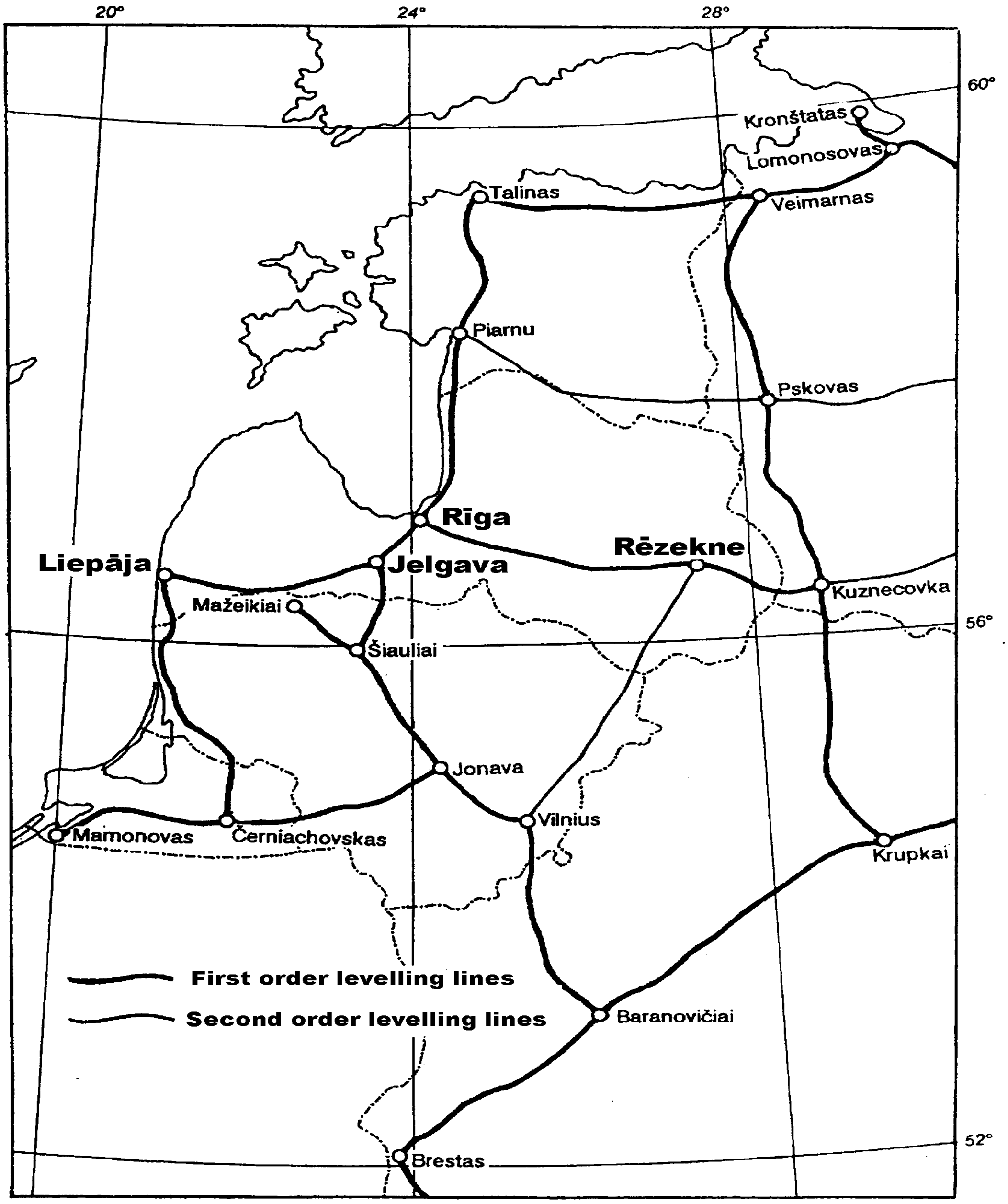

Fig 7. The first and the second order levelling lines, leveled in 1954-1968

We performed 301 km of the first order repeated levelling in 2000; 397 km in 2001 and it is planned to perform 350 km levelling in 2002 (Fig.8).

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

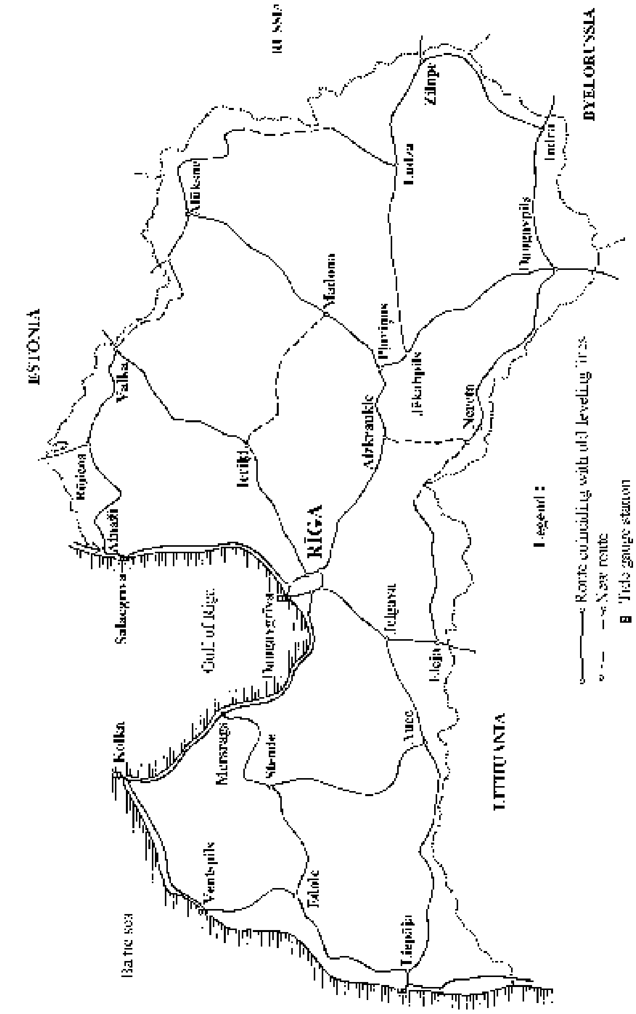

Fig. 8: Latvian precise levelling network

Gravity survey and geoid in Latvia

About Gravity data

In 1998 the reference gravity network started to create (contains 24 stations). 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, which 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.9).

About 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 (KAMINSKIS & ABOLS, 1999).

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 some cases in 1980-ies. It is difficult to put all available geodetic data together into consistent system due to influence of time.

Fig. 9: Gravimeter CG – 3 in operation

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 the ongoing repeated first order levelling (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 up to 1 cm accuracy,
- Parallely to the levelling works the gravity surveying also is conducted aimed at improving terrestrial gravity coverage (reaching accuracy better than 60 mGal),
- Mutual consolidation of gravimetric, levelling and GPS networks, which is one of the chief 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 cm accuracy,
- Latvia's geoid model for 1998 is formally approved for uniform use in the country by State Land Service,
- In future we will establish virtual national framework as infrastructure supply system based on permanently operated multi – functional DGPS service.

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