National Report of Poland to EUREF 2003

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Summary

Since 2001 the main geodetic activities at the national level in Poland concentrated on

- maintenance of the EUREF stations in Poland,
- completing field works related to re-levelling the 1st order vertical control,
- activity toward a cm geoid model in Poland,
- continuing operational work of permanent IGS/EUREF stations,
- conducting GPS data processing on regular basis at Local Analysis Centre at WUT,
- activity toward setting up the GPS active control.

The work done is summarized in this report.

1. Maintenance of the EUREF Stations in Poland

The first EUREF-POL campaign in Poland was conducted in July 1992 (Zielinski et al., 1993). The network consists of 11 stations with average distance of 160 km between them (Fig. 1). Station coordinates were determined in ETRS89, epoch 1989.0.

Fig. 1. EUREF-POL network

The results of the campaign were submitted to the EUREF Technical Working Group and according to the resolution No. 1 of the EUREF Symposium in Warsaw, 8-11 June 1994, they were accepted as a class B standard and endorsed as improvement and extension to EUREF-89 (Report of the EUREF Technical Working Group, 1994). At the XXth Meeting of the EUREF Technical Working Group the need for periodical reoccupation in a class B survey was pointed out and the re-observation at EUREF sites within a period of at least 10 years was recommended (Report of the EUREF Technical Working Group, 1999).

The EUREF-POL network was considered as national zero-order control. New primary POLREF network was further established as the densification of the EUREF-POL network. The POLREF network that consists of 356 stations (average distance of 30-35 km between stations) was surveyed in three campaigns (two in 1994 and one in 1995) (Baran and Zielinski, 1995). Coordinates of POLREF stations were determined in ETRS89. The results of POLREF campaign were reported to EUREF in 1996 (Baran and Zielinski, 1996). By the decree of the Prime Minister of the Republic of Poland, of August 8, 2000, the ETRS89 system became the official reference frame for geodesy, surveying and mapping in Poland. Since then, the system has been widely applied to all kind of surveying activities. The national geodetic control consisting of more then 6500 stations of the primary network and above 70000 points of the secondary network has been recomputed to this new system. The first important users of the ETRS89 solution were the civilian airports in Poland, which had to be coordinated in the WGS-84 framework.

Following the recommendation of the TWG of EUREF the Head Office for Geodesy and Cartography in Poland confined to the Department of Planetary Geodesy of the Space Research Centre of the Polish Academy of Sciences, in 2001, to re-survey the EUREF-POL network. The second EUREF-POL campaign was conducted within five days, namely 26-30 September 2001. The same set of stations as in the first EUREF-POL campaign was re-surveyed. One EUVN network station named Sanok was also included in the campaign. The observations collected during the campaign were processed at the Department of Planetary Geodesy of the Space Research Centre, Polish Academy of Sciences, using Bernese v.4.2 software.

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The comparison of results of the old and new campaigns shows the stability of the network within the limits of accuracy of 1992 epoch. Estimated average differences in coordinates are ±3 mm (north), ±5 mm (east) and ±10 mm (up). Monumentation of the EUREF-POL stations proved to be robust and reliable. A number of comparisons have been done between the current solution and the solutions for POLREF network and the EUVN network. They are reported in (Jaworski et al., 2002; 2003). The EUREF-POL 2001 campaign demonstrated that the national geodetic system for Poland based on the EUREF-POL 92 solution is good enough for all practical purposes and needs no substantial modifications.

2. Re-levelling the 1st order vertical control

The re-levelling of the 1st order vertical control in Poland of total length of lines of 17 015 km has started in 1999 and was completed in 2002. Linking the network to the vertical control of neighbouring countries is in progress. The description of the present campaign that is the 4th vertical control measurement campaign in Poland, was reported to EUREF Subcommission in 2001 (Pażus, 2001). The results of preliminary analysis of closing errors in 135 loops of the network were presented to EUREF in 2002 (Krynski et al., 2002). First results of network adjustment are expected in July 2003.

3. Modellig a cm geoid for Poland

The project on the cm geoid in Poland came into operational stage at the beginning of 2003. Its first step is a qualitative and quantitative analysis of all available data, i.e. gravity data (terrestrial, sea-borne and air-borne), deflections of the vertical, GPS/levelling, altimetry, tide gauge data, topographic data (DTM), crust density. Some supplementary control surveys will be conducted. The independent geoid models, i.e. gravimetric, astro-geodetic, GPS/levelling, using the uniformed data will be computed and their internal accuracy will be estimated. Finally a geoid model based on a combination of gravimetric, astro-geodetic and GPS/levelling data will be derived (Krynski, 2001). The project is in progress. Its completion is expected at the end of 2005.

4. Operational work of permanent IGS /EUREF stations

Permanent GPS stations of IGS and EUREF networks operate in Poland since 1993. The number of GPS stations in Poland was growing within last years. Recently 8 permanent GPS stations, i.e. Borowa Gora (BOGO, BOGI), Borowiec (BOR1), Jozefoslaw (JOZE, JOZ2), Lamkowko (LAMA), Cracow (KRAW) and Wroclaw (WROC) (Fig. 2) are in operation in Poland within the IGS/EUREF program. A brief characteristic of those stations is given in Table 1. Products of the permanent GPS stations in Poland, together with such stations in Europe, were the basis of the networks that are applied for both research and practical use in geodesy, surveying, precise navigation, environmental projects, etc. Data from those stations is transferred via Internet to the Local Data Bank for Central Europe at Graz, Austria, and to the Regional Data Bank at Frankfurt/Main, Germany. The EPN stations at Borowa Gora, Borowiec, Jozefoslaw and Wroclaw participate in IGS/IGLOS program. Jozefoslaw and Krakow stations take part in the EUREF IP pilot project (Table 2) (http://www.epncb.oma.be/projects/euref_IP/euref_IP.html).

Fig. 2. IGS/EUREF network of permanent stations in Poland

5. Data processing at Local Analysis Centre at WUT

Works on data processing strategy in the networks of permanent GPS stations are conducted since 1995 at Warsaw University of Technology in close cooperation with the CODE Centre of the Institute of Astronomy, University of Bern. The strategy is used since 1996 to process the EPN data at Local Analysis Centres (LAC) of EUREF. Recently 15 LAC operates in Europe. Data from 36 permanent GPS stations of EPN (Fig. 3) are processed at the Warsaw University of Technology EUREF Local Analysis Centre (WUT EUREF LAC) on the daily basis (Bogusz et al., 2002).

WUT EUREF LAC is also one of the main analysis centres within Central Europe Regional Geodynamics Project (CERGOP) that is coordinated by section C "Geodesy" of the Central European Initiative (CEI) (Becker et al., 2001). WUT EUREF LAC processed the data collected at CERGOP network (Fig. 4) within consecutive observational campaigns in 1994, 1995, 1996, 1997, 1999 and 2001 and participated in analysis of the results. Data from CERGOP and CERGOP2 campaigns were reprocessed in 2002 according to recent EPN standards. The results obtained were combined with those of all CERGOP Data Processing Centres (Becker, at al., 2002).

Table 1. Characteristics of Polish EPN stations

4 char Station ID	Domes Number	**Location**/ Institution	**Receiver**/ Antenna	Started operating	**Meteo**/ Rec. device	Data transfer blocks	Additional observations
BOGO	12207M002	**Borowa Gora** Inst. of Geodesy and Cartography	**Ashtech ZXII3** ASH700936C_M SNOW	08JUN1996	**Yes** LAB-EL Poland	24 h 1h	Ground water level Astrometry Gravity GPS
BOGI	12207M003	**Borowa Gora** Inst. of Geodesy and Cartography	**Javad JPS Eurocard** ASH700936C_M SNOW	06MAY2003	**Yes** LAB-EL Poland	24 h 1h	Ground water level Astrometry Gravity GPS/GLONASS
BOR1	12205M002	**Borowiec** Space Research Centre, PAS	**Rogue SNR-8000** AOAD/M_T	01JAN1994	**Yes** NAVI Ltd. Poland	24 h 1h	SLR GPS/GLONASS
JOZE	12204M001	**Jozefoslaw** Inst. of Geodesy and Geod. Astr., WUT	**Trimble 4000SSE** TRM14532.00	03AUG1993	**Yes** LAB-EL Poland NAVI Ltd. Poland	24 h 1h	Ground water level Astrometry Gravity tidal GPS
JOZ2	12204M002	**Jozefoslaw** Inst. of Geodesy and Geod. Astr., WUT	**Ashtech Z18** ASH701941.B SNOW	02JAN2002	**Yes** LAB-EL Poland NAVI Ltd. Poland	24 h 1h	Ground water level Astrometry Gravity tidal GPS/GLONASS
KRAW	12218M001	**Cracow** AGH UST	**Ashtech μZ-12** ASH701945C_M SNOW	01JAN2003	**Yes** LAB-EL Poland	24 h 1h	GPS
LAMA	12209M001	**Lamkowko** Inst. of Geodesy, UWM	**Ashtech ZXII3** ASH700936F_C SNOW	01DEC1994	**Yes** LAB-EL Poland	24 h	Gravity GPS
WROC	12217M001	**Wroclaw** Agriculture Academy	**Ashtech Z18** ASH700936D_M	28NOV1996	**Yes** LAB-EL Poland	24 h 1h	Ground water level GPS/GLONASS

Table 2. Characteristics of Polish stations participating in the EUREF IP pilot project

Location	Appr. lat. [deg]	Appr. long. [deg]	RTCM message types (update rate [s])	Bitrate [bits/s]	Site log file
Cracow	50.01	19.92	1(1),3(30),16(60),18(1),19(1),22(60)	1900	KRAW
Jozefoslaw	52.10	21.03	1(1),3(60),18(1),19(1),22(60),31(1)	1200	JOZ2

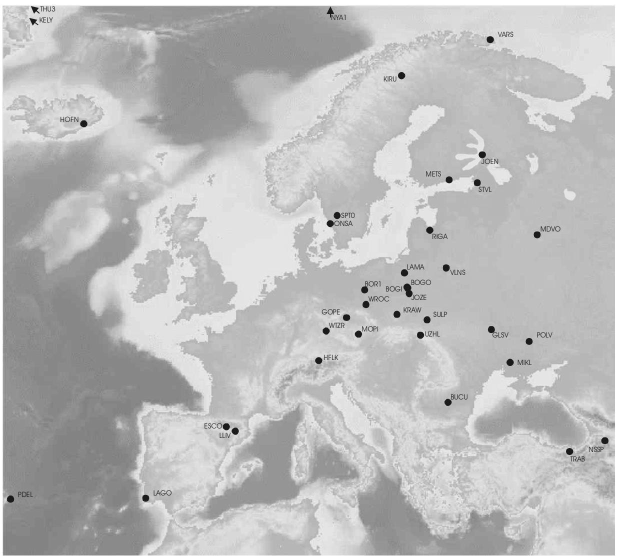

Fig. 3. Network of EPN stations providing data for processing at WUT EUREF LAC

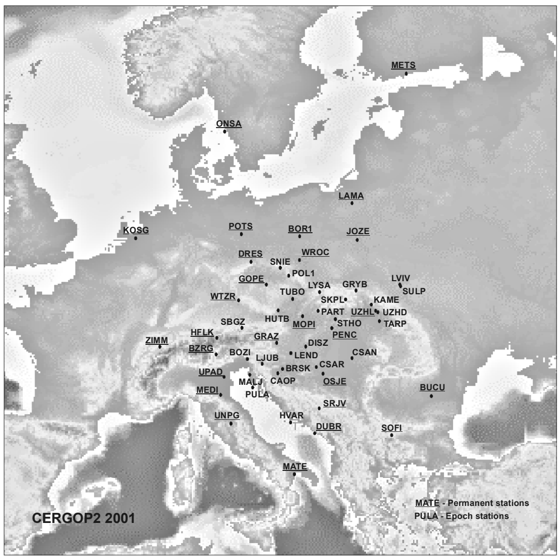

Fig. 4. CERGOP-2 2001 network

WUT EUREF LAC as one of 17 local analysis centres provides parameters for ionosphere model and conducts works on determination of water vapour content in troposphere (Kruczyk and Rogowski, 2002) advancing towards becoming a member of IGS ionosphere modelling service (Figurski and Wielgosz, 2002).

6 ASG-PL Polish Active Control

The study group appointed in mid 1990's by the Polish Academy of Sciences recognised that the number of active multifunctional permanent GPS stations in Poland should be increased in the future. The distances between stations should amount about 50 km. The stations should form a new generation geodetic network, adequate for many social and economical needs (Baran and Zielinski, 1998). The local analysis centres in co-operation with national analysis centre should be engaged in processing of permanent GPS observations. The technical project of ASG-PL network ordered by the Head Office for Geodesy and Cartography in Poland was reviewed by the study group (Baran et al., 2000a; 2000b). By the end of 2002 a sub-network of the ASG-PL with a processing centre was established in Upper Silesia as a pilot project of governmental and local (regional Silesian) authorities and it has reached a preliminary operational stage in February 2003. The map of this network is given in Fig. 5. The network consists of 6 permanent stations and is recently linked to EPN (BOGI, BOGO, JOZE, KRAW, LAMA, WROC) stations and two other permanent GPS stations (CBKA, INS1) that provide GPS data at 5 s sampling rate (Fig. 5). The ASG-PL network stations are equipped with Ashtech μZ-12-CGRS receivers with ASH701945C_M SNOW antennas. Observations are made at 5 sec sampling rate and are transferred to the processing centre hourly.

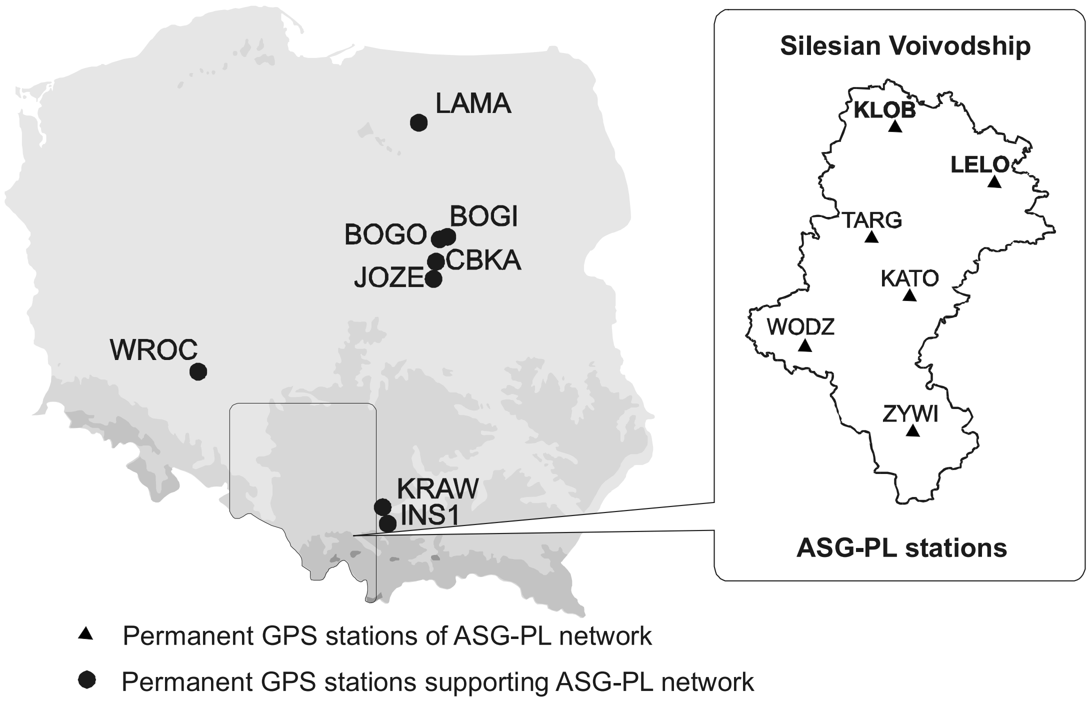

Fig. 5. Map of the operating in 2003 part of the Polish Active Control Network

The system of automatic processing of GPS data for ASG-PL network designated for the users is under testing.

Another local network that may become a part of ASG-PL has been established in three Baltic seacoast cities: Gdańsk, Sopot and Gdynia. The system consists of 3 reference stations, located in those three towns. Each reference station is equipped with a GPS receiver, radio system for transmission of correction data, and modems for providing mutual link between stations and the vehicles.
More details can be found in the paper (Zielinski et al., 2003) presented at this Symposium.

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