



ASG-EUPOS based densification of ETRS89 in Poland



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- Historical conditions
- Steps of introducing ETRS89 in Poland
- National ground augumentation system ASG-EUPOS as reference for measurements
- Integration ground control network with ASG-EUPOS
- Conclusions

Implementation of ETRS89 in Poland

 In 1992 was performed GPS campaign on 30 control points in Europe where 11 points were located in Poland.

• Those 11 points got coordinates in Polish realization of continental datum ETRF89.

• Distances between points were at the level 200-300km, what was not sufficient for standard surveying tasks.

• Next steps was focused on densification of the network to have better avaiability for measurements.



Source: www.cbk.waw.pl





Source: www.codgik.gov.pl





Source: www.codgik.gov.pl

Implementation of ETRS89 in Poland

GŁÓWNY URZĄD GEODEZJI I KARTOGRAFI

year 2001: 6526 points (First Class)



Source: www.codgik.gov.pl





 In 90' of XX century first permanent GPS reference stations have started working.

 In 2003-2004 first regional network ASG-PL was established only for static measurements (providing observations and automatic calculations of coordinates).

• In 2004 was developed scientific project for reference station network for the whole area of Poland.

• In 2007 Directive INSPIRE was released – mandatory application of ETRS89 for geospatial information.

 In June of 2008 national ground augumentation system ASG-EUPOS was opened for users.

• Today in accordance to existing law regulation reference stations included both to EPN and to ASG-EUPOS are the first order points (fundamental network).

Implementation of ETRS89

• ASG-EUPOS includes 100 reference stations in teritory of Poland.

GŁÓWNY URZAD GEODEZJI I KARTOGRAF

• With rules of EUPOS observation data streams from some foreign reference stations are exchanged.

• For highest redundancy of services all calculations are continously performing in two management centers.





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ASG-EUPOS as reference

- With establishing of ASG-EUPOS precise coordinates was calculated by software's supplier.
- First reference stations' coordinates was calculated in ETRF2005 for epoch 2008.13.
- Since beginning of ASG-EUPOS coordinates are being monitored in Bernese software.
- Independent calculation for all stations in the network is provided by Military University of Technology in Warsaw.





ASG-EUPOS as reference



• Existing EPN stations were included to ASG-EUPOS network.

• To achieve better coverage of EPN stations new ASG-EUPOS stations were added to EPN network in 2008.

• Today EPN stations are evenly distributed across the Poland and they are sufficient for geodynamical analyses.







Operational time of Polish EPN stations included to ASG-EUPOS



• Almost all stations have coordinates time series longer then 4 years.

• Some of them are working since 18 years.

• 7 new ASG-EUPOS stations were added to EPN in 2008.





In 2010 for each reference station were established 2 close points (excenters)







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 In 2008 during the ASG-EUPOS' GPS campaign 151 highest class control point were measured.





Integration of control network with ASG-EUPOS



Second GNSS campaign 2010/2011:

142 reference stations (IGS, EPN, ASG-EUPOS, SAPOS, SKPOS, CZEPOS, LITPOS)

391 control points (EUVN, POLREF, EXC1, I Class)

TOTAL 531 POINTS







Draft of vectors measured in 2010/2011.







Calculation was performed according to *Guidelines for EUREF Densifications* Calculations was made by Space Research Center of the Polish Academy of Sciences (SRC)

Independent was calculation performed by Military University of Technology (MUT) and Warsaw University of Technology (WUT).

Calculation made for campaign 2010/2011 and additional calculation for combined campaigns 2008 and 2010/2011.

Strategies:

	2008	2010/2011
GPS 15°	YES	NO
GPS 10°	YES	YES
GPS 5°	YES	YES
GPS+GLONASS 5°	NO	YES





- To transform results from ITRF2005 to ETRF2000 epoch 2011.0 was used procedures from "Memo: Specifications for reference frame fixing in the analysis of a EUREF GPS campaign", Claude Boucher and Zuheir Altamimi Version 8.
- Coordinates from different calculation strategies (5 °vs 10 °, GPS vs GNSS) are consistent and the mean errors of daily repeatability for position is <1,5 mm and for height is 3,7mm. A little better are results for 5 °.
- Results from different institutions are also consistent and the differences between results are less then 2 mm in position and 4 mm in height.
- Comparison with monitoring module in ASG-EUPOS (3 years time series) gives sufficient differences <5 mm in position and < 7mm in height.
- Some errors occurred because of wrong antenna definition and equipment changes between campaigns.





Differences between positions from monitoring module and from GNSS campaign







Differences between heights from monitoring module and from GNSS campaign



200





Differences between coords calculated in ETRF2000 (2011.0) by WUT and SRC







Differences between coords calculated in ETRF2000 (2011.0) by MUT and SRC



Sum





New coordinates of ground control points in ETRF2000 (epoch 2011.0) were compared with existing coordinates in ETRF89 (PL) (epoch 1992.0).







Next step was Helmert transformation with 323 fixed points. Mean residuals for each component are φ =7,3mm, λ =8,3mm h=14,8.

POLREF Helmert Transformation Residuals







•Differences in coordinates in highest class are not very big in point of view that they were calculated 20 years ago.

•To have consistent reference for satellite and classical measurements is necessary to re-adjust existing coordinates of ground network highest class.

•7 parameters Helmert transformation gives good results, but can hide internal movement efects of Euroasian tectonic plate. It should be considerated if don't use 6-parameters transformation (without scale).

•Difference between ETRF2000 and ETRF89 shouldn't be noticed in coordinates of lower classes ground network.





• Since 1992 Poland was implementing ETRS89 into ground control network from the highest to the lower classes.

• Openning of ASG-EUPOS system was big step to achieve ETRS89 as reference for surveyors.

• All EPN stations included to ASG-EUPOS implement ETRS89 system into territory of Poland.

• Two GNSS campaingnes were made to calculate coordinates of all reference stations in ASG-EUPOS and check ground control points of the highest class network.

• Results reached by different scientific institutions are similar and are base for introducing new coordinates of ASG-EUPOS stations in ETRF2000 epoch 2011.0.

• A new realization of ETRS89 is going to be ETRF2000 epoch 2011.0





Thank you for your attension...

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