NATIONAL REPORT OF SLOVENIA

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1 Introduction

This paper is the review of activities in Slovenia during the period 2003–2004, with the emphasis on activities to the adoption the new geodetic reference system in Slovenia.

2 Official adoption of the ESRS in Slovenia

After certain period of non-consistent activities at the field of the maintenance the national coordinate system, and according to the call and proposal of research institutions i.e. University of Ljubljana, Faculty of Civil and Geodetic Engineering, Geodetic Institute of Slovenia and few geodetic enterprises to perform the inevitable activities within the state, which could lead to the establishment of a new geodetic reference system in Slovenia, SMARS (Surveying and Mapping Authority of the Republic of Slovenia), Ministry of the Environment, Spatial Planning and Energy, prepared the strategy of the Geodetic System in Slovenia. The strategy was accepted from parties involved in geodetic positioning from professional organisations and private enterprises to the governmental and research institutions in Slovenia. In may of 2004 the proposed strategy was accepted by the Government of the Republic of Slovenia. Some emphases from the strategy are:

- decision to the establishment of the ESRS in Slovenia,
- decision to establishment the National GPS network and GPS service,
- decision that procedures for the transformation from existing coordinate system to the new one have to be defined for all the types of geodetic data,
- necessary legislation and regulations for the adoption of ESRS and transformation of all spatial data to the new reference system have to be prepared according to the results of thorough testing on a considerable number of test areas.

The strategy should present the basis for more consistent and coordinated activities needed for the establishment of a new national (European) geodetic reference system in Slovenia.

3 Status of EUREF non Permanent Network

The development of a new reference coordinate system in Slovenia, started with the connection of the horizontal and levelling geodetic networks of Slovenia to the ETRS and EVRS in the frame of four EUREF GPS campaigns. At the EUREF 2003 Symposium in Toledo, with the Resolution No. 1 the "Combined Solution" of three EUREF Campaigns (CRO-SLO'94, SLOVENIA'95 and CROREF'96) on Slovenian territory, was accepted as an official EUREF solution. The final solution was performed within ITRF96, epoch 1995.55, and then transformed to ETRS89 coordinate system (Berk et al., 2003). According to the final solution, five official EUREF sites exist in Slovenia: Velika Kopa, Kucelj, Korada, Malija and previous official EUREF site Lendavske gorice was changed with the new official EUREF site Donačka Gora. The complete number of EUREF sites in Slovenia is 49, among them 35 are the first order triangulation points, 12 are geodynamic points, 1 is the point at the tide gauge in Koper, and one is second order triangulation point. All these points are treated as zero order ETRS89 network.

Since 1996 all the densification networks were connected to the 1st order triangulation network, which ETRS89 coordinates computed in the EUREF Slovenia '95 GPS Campaign (Altiner et al., 1997) were used. With the new solution of EUREF Campaigns in Slovenia (Berk et al., 2003), coordinates of zero order ETRS89 network points in ETRS89, changed. The extreme coordinate changes are -12.7 mm in N-direction, -13.2 mm in E-direction, and 13.5 mm in height component. Because of theese quite big

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differences between both sets of coordinates, the recomputation of all the densification network campaigns became inevitably. In last seven years app. 1600 densification points coordinates were determined in ETRS89. SMARS (Surveying and Mapping Authority of Slovenia) is now performing the recomputation of all densification networks connected to ETRS89 zero order network.

A the moment the ETRS89 coordinates are still transformed to the existing national coordinate system. Different strategies for the transformation (Stopar et al., 2003) are under consideration and at the moment it seems that the most promising results could be obtained with the direct usage of normal orthometric heights within the existing national coordinate system, and the ellipsoid heights in the ETRS89 system. Normal orthometric heights of transformed positions are computed independently of the transformation procedure with the direct usage of elipsoid heights and absolute (Pribičević et al., 2000) geoid model. The problem which is still open is the quality of the geoid model. The problem is that with the recomputation of whole precise levelling network of Slovenia, the normal orthometric heights of bench marks changed in the range from –80 to +80 mm (Vardjan, 2001), and these changes were not taken into the last geoid model computation. The impact of newly computed heights of bench marks in levelling network to the geoid model, and the impact to the heights of geodetic points all over the country was not yet finally estimated.

4 Permanent GPS network in Slovenia

Another important field of activities was the continuation of the establishment of the Permanent GPS network and GPS service of Slovenia (acronym SIGNAL: SI-Slovenia, G-Geodesy, NA-Navigation, L-Location). The Permanent GPS network will be so called active GPS network, based on the VRS (Virtual Reference Station) and on FKP (Area Correction Parameter) concepts and it should be a "multipurpose" GPS network (navigation, GIS, geodesy). At the moment four permanent stations are operational: Ljubljana, which is part of EUREF Permanent Network (EPN), Maribor, Črnomelj and Bovec. For the end of 2004 is planned the instalation of another five permanent GPS stations in Koper, Nova Gorica, Radovljica, Ravne na Koroškem and Knežji dol near Ilirska Bistrica. Permanent GPS station in Koper will be collocated with the renoved tide gauge station, which is included in the ESEAS project, station Knežji dol will be collocated with the newly established seismological station, and is included in the CERGOP-2 project. All together the network will be comprised of 15 permanent stations. Realization of the network depends on funds available, but the network should be finished in 2006. Besides the network of GPS stations, also the "GPS service" is the part of SIGNAL. It is constituted under the auspices of Surveying and Mapping Authority of the Republic of Slovenia, and operated by the Geodetic Institute of Slovenia in Ljubljana. It started to operate in spring of 2004, with the function to control the network operation.

Figure 1: Locations of Permanent GPS Stations in Slovenia

Data from permanent stations are simultaneously transfered to the central workstation at the GPS service in a raw format through VPN (Virtual Private Network) tunnel, and permanent internet connection. Management with the GPS data: receiving raw data from receivers, processing data in a network module (VRS or/and FKP), distributing processed data to the field users in real time, storing and archiving the data, enable the availability of the data for post processing are at the moment the tasks performed by GPS service. In may of 2004 GPS service started to participate within EUREF-IP project. Data from 3 permanent stations from Slovenia are distributed to the main broadcaster in Frankfurt.

5 Geodynamic resesearch project PIVO 2003

In 2003 we started PIVO (Periadriatic fault-Istria Velocity Observations) geodynamic research project, which was designed to study the neotectionics in SE (Slovene) Alps and Istria (Adria) microplate motion. Knowing how Adria moves is most critical for understanding the kinematic boundary conditions that drive circum-Adria active deformation in the Apennines (Italy), the western, central, eastern, and southern Alps: France, Switzerland, Italy, Slovenia, Austria, and in the Dinarides: Slovenia, Croatia, Bosnia-Herzegovina, Serbia and Montenegro, Albania.

For our research we used decade-scale episodic GPS data from 35 points in Slovenia and northern Croatia, mounted in a bedrock, together with 15 continuous GPS data from several permanent GPS sites in the surrounding countries. Field measurements were performed in september and october of 2003 with the duration of observations from of 48 to 72 hours. We processed GPS data using GIPSY-OASIS II software (release 2.5) at the University of Miami, Rosensthiel School of Marine Geology and Geophysics, Geodesy Lab and at the University of Ljubljana, Faculty od Civil and Geodetic Engineering, using Bernese GPS software (release 4.2). All the computations were performed in ITRF2000 reference frame. Computed velocity vectors were transformed to “stable Eurasia” (Altamimi, et al., 2002), where the analysis of computed velocity field, velocity gradients and computed strain were performed. Besides the geological and gephysical importance of obtained reults, the results could be very interesting also from the geodetic point of view and could lead us to the first approximation of the geo-kinematic model of the slovenian territory.

6 References

ALTAMIMI Z., SILLARD P., BOUCHER C., (2002): *ITRF2000: A new release of the International Terrestrial Reference Frame for earth science applications*, Journal of Geophysical Research, 107 (B10), 2214, doi:10.1029/2001JB000561, 2002.

ALTINER Y., FRANKE P., HABRICH H., MIŠKOVIĆ D., SEEGER H., SELIŠKAR A., TAVČAR D., (1997): *Results of the Slovenia’95 GPS-Campaign*, Proceedings of the Symposium of the IAG Subcommission for Europe (EUREF), Sofia, June 4–7, 1997, eds. Gubler E. and Hornik H., Verlag des BAW, 58, 124–131.

BERK S., KOMADINA Ž., MARJANOVIĆ M., RADOVAN D., STOPAR B., (2003): *The Recomputation of EUREF GPS Campaigns in Slovenia*, To be presened at the Symposium of the IAG Subcommission for Europe (EUREF), Toledo, June 4–7, 2003.

PRIBIČEVIĆ B., (2000): *The Use of Geological, Geophysical and Geodetical Databases in Determination of the Shape of Geoid in the Republic of Slovenia*, Doctoral Thesis, Faculty of Civil and Geodetic Engineering, University of Ljubljana.

STOPAR B., REŽEK J., (2003): *National Report of Slovenia for EUREF,* Presented at the Symposium of the IAG Subcommission for Europe (EUREF), Toledo, June 4–7, 2003.

VARDJAN N., (2001): *Preračun in analiza nivelmanskih mrež Republike Slovenije (Recomputation and analysis of levelling networks in Slovenia)*, Diploma Work, Faculty of Civil and Geodetic Engineering, University of Ljubljana.