# NATIONAL REPORT OF SLOVENIA

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#### 1 Introduction

This paper is the review of geodetic activities in Slovenia during the period 2001–2003, with the emphasis on activities to obtain the final solution of EUREF GPS Campaigns in Slovenia.

#### 2 The status of EUREF GPS Campaigns

The development of a new reference coordinate system in Slovenia, that should comply all the needs of the contemporary geodesy regarding state and unified European coordinate system, started with the connection of the horizontal geodetic network of Slovenia to the ETRS in the frame of three EUREF GPS campaigns. All the campaigns were performed with the substantial contribution of the Institute for Applied Geodesy (Institut für Angewandte Geodäsie), Frankfurt now federal Agency for Cartography and Geodesy (Bundesamt für Kartographie and Geodäsie) to the Surveying and Mapping Authority of the Republic of Slovenia (Geodetska uprava Republike Slovenije).

Four different computations of EUREF GPS Campaigns at the territory of Slovenia were performed, and results were published: EUREF 1994 Croatia and Slovenia campaign (Altiner et al., 1995), EUREF Slovenia '95 campaign (Altiner et al., 1997-a), CROREF '96 Campaign (Altiner et al., 1997b) and the results for Combined solution af all three EUREF Campaigns (Altiner et al., 1999). Only the results of the first EUREF Campaign, were officially accepted by the EUREF Technical Working Group (TWG) (Resolution No. 1, EUREF Symposium, Helsinki, 1995). In the time when the results of the "Combined Solution" are going to became the official EUREF solution for Slovenia, a new problem was identified (Seeger, 2001). The problem is that the "Combined Solution" produced the new coordinates only for points which were observed in more than one campaign. Coordinates of all other points remained unchanged. This problem was the motivation for a completely new computation of the "Combined Solution" of EUREF GPS campaigns in the Republic of Croatia, which produced new coordinates in ITRF96 (1995.55), for all points observed in all EUREF campaigns in Croatia (Marjanović, Bačić, 2001). At the time Slovenia just realized its own "Combined Solution" of all three EUREF Campaigns at its territory, where all EUREF campaigns territory were handled properly. The final solution was performed within ITRF96 epoch 1995.55 (Berk et al., 2003), and the results are going to be submited to the EUREF TWG at the EUREF symposium in Toledo, as the official solution of EUREF Campaigns in Slovenia.

#### **3** Status of EUREF non Permanent Network

According to the letter "Maintenance of EUREF stations" distributed by the President of EUREF Subcommission, mr. João Agria Torres, the status of EUREF non permanent network is briefly presented in sequel.

Five official EUREF sites exist in Slovenia (with the EUREF numbers 0720–0724): Lendavske gorice, Velika Kopa, Kucelj, Korada, and Malija. Official EUREF coordinates originate from the first computation of the EUREF Slovenia and Croatia '94 campaign (Altiner et al., 1995). As it was already described, after the first EUREF Camapign another two EUREF Campaigns at the Slovenian territory followed. The combined solution of all the three EUREF Campaign are going to became the official EUREF Solution for Slovenia. Since the 12-meter-high pillar on official EUREF site Lendavske gorice was not stable enough to be able to achieve the required accuracy, the proposal to EUREF

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TWG was made to substitute this site 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 at 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, where ETRS89 coordinates computed in the EUREF Slovenia '95 GPS Campaign (Altiner et al., 1997-a) were used. After the new "Combined solution" of all EUREF Campaigns in Slovenia (Berk et al., 2003), coordinates of points in ETRS89 changed. The extreme coordinate differences between both solutions are -12.7 mm in northing (Malija), -13.2 mm in easting (Blegoš), and 13.5 mm in height component (Krim). Since the coordinate differences between two solutions are quite big, the recomputation of all the densification campaigns, seems to be inevitably. Within the ETRS89 coordinate system app. 400 densification points were determined in last seven years.

A the moment all the ETRS89 coordinates are transformed to the national coordinate system. At the beginning for the transformation purposes the relative geoid solution (Bessel ellipsoid) (Čolić et al., 1992) was used. In the period when new absolute geoid solution (GRS-80 ellipsoid) (Pribičević, et al., 2000) became available, we started to use it for testing purposes. Some tests show, that the transformation between ETRS89 and national coordinate system could obtain better results (smaller residulas on control points) when we perform the transformation with the usage of normal orthometric heights in the national control network and the ellipsoid heights in the GPS network. Normal orthometric heights are then computed independently of the transformation with the usage of elipsoid heights and absolute geoid model.

The EUREF points are regularly maintained, where the special emphasis is put to the points which are frequently used. Points located at the top of high mountains, or points stabilized with high pillars are going to be replaced by markers appropriate for future GNSS usage.

## 4 Status of vertical networks in Slovenia

In last few years six absolute gravimetric points were observed in Slovenia, all of them were connected to the precise levelling network. Very important work connected with the levelling network was the readjustment of the whole Slovenian precise levelling network. The vertical datum was defined according to the tide gauge Triest and fundamental bench mark in Ruše, as a heihtg type the normal orthometric heights were used. For the precise levelling network was used. As a result we acquired newly computed normal orthometric heights of bench marks which differ from the old ones in the range from -80 to +80 mm (Vardjan, 2001). The impact of newly computed heights of bench marks in levelling network to the existing geoid model and the impact to the heights of triangulation points all over the country was not yet estimated.

## 5 **Participation in EUGN**

In the frame of Unified European Gravity Network (UEGN2002) all available gravity data from Slovenia were submitted to the computing centre. Only absolute gravity values (measurements) were submitted which form fundamental gravity network of Slovenia. Unfortunately relative gravity data don't meet the requirements of the UEGN2002 adjustment. All relative data are more then 20 years old (actualy never validated and adjusted appropriately and never tied to IGSN71; only approximate shift is known).

## 6 Permanent GPS network in Slovenia

Another important field of activities was the continuation of the establishment of the Permanent GPS network of Slovenia. The Permanent GPS network should be so called active GPS network, based on

the VRS (Virtual Reference Station) and on FKP (Area Correction Parameter) concepts. It should be a 'multipurpose' GPS network (navigation, GIS, geodesy). At the moment three permanent stations are operational: Ljubljana, which is part of EUREF Permanent Network (EPN), Maribor and Črnomelj. For the year 2003 is planned the instalation of another two stations in Bovec and Koper. Station in Koper will be placed at the tide gauge station and connected to the levelling network and possibly also to the very near absolute gravimetric point. All together the network will be comprised of 10-15 permanent stations. Realization of the network depends on funds available, but the network should be finished in few years.

Besides the network of GPS stations, also the GPS service will be part of Permanent GPS network of Slovenia. It is constituted under the auspices of Surveying and Mapping Authority of the Republic of Slovenia, and operated by the Geodetic Institute of Slovenia.

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