

**GPS IN GEODETIC AND GEODYNAMIC PROGRAMMES  
OF THE CEI WG „SCIENCE AND TECHNOLOGY” SECTION C „GEODESY”  
(Updated information on CEI programmes)**

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**Abstract**

Geodetic and geodynamic programmes based on satellite global positioning system GPS realised in the frame of international cooperation of seventeen CEI (Central European Initiative) member countries are described in the paper. The objectives, realisation of the second phase of the Project CERGOP-2 (Central Europe Regional Geodynamics Project), current status of the establishment of the Central European Reference GPS Network (CEGRN) and near-term plans will be given. The GPS related activities of the Section’s Working Groups on University Education Standards and Satellite Navigation Systems will be briefly described. The cooperation with European Geophysical Society and International Association of Geodesy will be shortly summarised.

**1. INTRODUCTION**

Almost all seventeen CEI member countries take part in the international cooperation in geodesy and geodynamics. At the moment (as on 1 May 2001) the scientists from thirteen CEI countries are very active and participate in many actions initiated and organised by the Section. Up to now only three CEI member countries do not participate in realisation of Section C programmes. They are Belarus, Macedonia and Moldova. Yugoslavia, that was lately re-admitted to the CEI will join the geodetic programme soon. We do hope that also other countries will be able to undertake the cooperation in the near future. On the other hand two other non-CEI countries, Germany and Finland, closely cooperate in realisation of CEI geodetic and geodynamic programmes.

At the moment, the most active work of the CEI WGST Section C “Geodesy” can be observed in the following areas:

- Geodynamic programmes
  - Regional European programmes
    - \* CERGOP = Central Europe Regional Geodynamics Project;
    - \* UNIGRACE = Unification of gravity system in Central and Eastern Europe.
  - Local geodynamic projects
    - \* projects realised by the subgroups of the CERGOP Study Group “Geotectonic Analysis of the Region of Central Europe”; they concern the following regions: Eastern Alps and the North and Eastern Adriatic Sea, Romania Plate, Pannonian Basin; Plitvice Lakes, Croatia; Tatra Mountains; Northern Carpathians; Balkan Peninsula;
    - \* projects realised in bilateral/multilateral agreements of CEI countries, e.g. Czech-Polish-Slovak Cross-Border Studies of Regional Geodynamics (Sudetes, Beskydy, Tatra, Pieniny Mts);
    - \* other CEI projects, e.g. UNIHIP (Unified National High Precision GPS Networks in Central Europe).

- Working Group on University Education Standards;
- Working Group on Satellite Navigation Systems;
- Cooperation CEI Section C - European Geophysical Society (EGS);
- Cooperation CEI Section C – International Association of Geodesy (IAG).

Below you will find a short concise information on some of above mentioned areas of activity related to the use of satellite positioning techniques.

## **2. PROJECT CERGOP (Central Europe Regional Geodynamics Project)**

The first phase of the Project was concluded on 30 June 1998 and now the second phase of the Project is being realised. The following 14 countries participate in the second phase of the Project: Albania, Austria, Bosnia & Herzegovina, Bulgaria, Croatia, the Czech Republic, Germany, Hungary, Italy, Romania, Poland, Slovakia, Slovenia and Ukraine. The Project is headed by Hungary (Istvan Fejes) and Poland (Janusz Sledzinski). The main objectives of the project are: to integrate the geodynamic research in the Central European region based on high accuracy space geodetic measurements, to investigate the most profound geotectonic features in the Central European region, as well as to provide a stable Central European GPS Reference Network (CEGRN) for sub-regional, local or across the borders investigations and deformation studies.

The extension of the project in its second phase results in accepting in total more than 60 CERGOP (CEGRN) sites. It is also envisaged to introduce CEGRN network as a subnetwork of the EUREF (European Reference Frame) permanent satellite GPS network that is used for maintenance and permanent monitoring of the European geodetic coordinate system. The calculation and interpretation of the 3D tectonic velocity field covering the Central European Region will be continued; the geodynamic investigations of interesting regions of Central and Southern Europe will be extended.

The Central European GPS Reference Network of a millimetre accuracy standard was established as a result of five epoch monitoring satellite CERGOP GPS (Global Positioning System) campaigns performed in 1994, 1995, 1996, 1997 (CERGOP-1) and in 1999 (CERGOP-2). The next satellite GPS campaign is scheduled for 18 - 23 June 2001.

### **CERGOP-2 Study Groups (CSGs) and their chairmanship are the following:**

- ◆ CSG.1 CERGOP stations and site quality monitoring - G. Virag (Hungary),
- ◆ CSG.2 Coordination of CERGOP analysis centres - G. Stangl (Austria),
- ◆ CSG.3 CERGOP Reference Frame and geokinematic modelling - J. Hefty (Slovakia),
- ◆ CSG.4 Improvement of height determination to accuracies comparable with horizontal coordinates” - J Simek (Czech Republic),
- ◆ CSG.5 Geotectonic analysis of the region of Central Europe - J. Sledzinski (Poland) and P. Vyskocil (Czech Republic),

Groups for regional investigations:

- ◆ CSG5/1 Monitoring of recent crustal movements in Eastern Alps and the North and Eastern Adriatic with GPS - C. Marchesini (Italy),
- ◆ CSG.5/2 Three dimensional plate kinematics in Romania - D. Ghitau (Romania),
- ◆ CSG.5/3 Integration of present geodynamic investigations in the Pannonian Basin - G. Grenerczy (Hungary),
- ◆ CSG.5/4 International geodynamic test area Plitvice Lakes. - D. Medak (Croatia),
- ◆ CSG.5/5 Geodynamics of the Tatra Mountains - K.Czarnecki (Poland), and M.Mojzes (Slovakia),
- ◆ CSG.5/6 Geodynamics of Northern Carpathians - F.Zablotskij (Ukraine),
- ◆ CSG.5/7 Geodynamics of Balkan Peninsula. - G. Milev (Bulgaria).
- ◆ CSG.6 Real time monitoring by GPS - A. Nardi (Italy).

The CERGOP Data Centre was established in 1994 and is hosted by the Observatory Lustbühel, Graz, Austria. The satellite observational data of the CEGRN monitoring campaigns are processed in the eight CERGOP Processing Centres in Graz, Austria; Penc, Hungary; Warsaw, Poland; Bratislava, Slovakia; Frankfurt, Germany; Matera, Italy; Pecny, Czech Republic and Zagreb, Croatia. The project participants have met regularly at the semi-annual CERGOP-1 Working Conferences and annual CERGOP-2 Conferences. The proceedings of most of these conferences were published in REPORTS ON GEODESY by the Warsaw University of Technology, generally within 3 months following the conference. The scientific results of the project were mainly presented at the bi-annual International Seminars on "GPS in Central Europe", organised by the FÖMI Satellite Geodetic Observatory, Penc, in Hungary. The proceedings of these conferences were also published in the REPORTS ON GEODESY series.

The first phase of the Project CERGOP was partially supported financially from the Programme COPERNICUS of the European Commission. As the Coordinator served Institut für Angewandte Geodäsie (now Bundesamt für Kartografie und Geodäsie), Frankfurt (M), Germany. The EC Coordinator of the second phase of the Project CERGOP-2 is Austrian Academy of Sciences, Graz, Austria. The project will be submitted to EC with the request for financial support.

### **3. PROJECT UNIHIP (UNIFIED NATIONAL HIGH PRECISION GPS NETWORKS IN CENTRAL EUROPE)**

This is a new project proposal initiated by Hungary that consists in an international cooperation among the operators of the precise GPS geodynamic national networks of Czech Republic, Hungary, Poland and Slovakia. The national geodynamic networks in these countries, such as GEODYN in the Czech Republic, HGRN in Hungary, SAGET and EXTENDED SAGET in Poland and SLOVGERENET in Slovakia were developed in the early 90-ties. The international coordination indicated in the project will involve synchronised GPS observations, unified databases structure, standardisation of formats and processing techniques, quality assessment and quality assurance. The product of the project will be a virtual large scale research infrastructure in Central Europe which will attract scientists and students from many disciplines, such as geophysics, geodesy, earthquake research, large scale industrial development projects etc. The initiative is coordinated by I. Fejes, Hungary. Project is submitted to the Visegrad Fund with the request for financial support.

### **4. CZECH-POLISH-SLOVAK CROSS-BORDER STUDIES OF REGIONAL GEODYNAMICS**

Long border line between Poland, Czech Republic and Slovakia coincides generally with very interesting geotectonic formations of different age that give an excellent opportunity to undertake a comparative studies that have a significant scientific and practical value. The main general objectives of the Project have been defined as follows:

- Long-term investigation of variations of the recent crustal movements and periodic monitoring of the horizontal and vertical displacements in the structural active tectonic zones of the Polish and Czech parts of the Sudetes Mts. and the Western Carpathians as well as in the regions located close to the existing and planned investments and technical constructions (water reservoirs and dams, power stations, communication lines, etc.).
- In the Tatra Mts., that represent the youngest tectonic formation of the area of Central Europe, a study of tectonic movements and relatively significant velocity vectors as well as determination of the location of the geoid (the quasi-geoid) related to the geocentric reference ellipsoid.
- Geodynamic research and investigation of the whole area will be directed to both scientific and practical outputs. The geodynamic hazard map of the area will be considered to assess regional mobility characteristics. The obtained data will be used for regional and urban planning.
- Establishment of the test control networks in Sudetes Region and in Tatra Mts. that can be used by Polish, Czech and Slovak geodesists and surveyors for testing new technologies and upgrading the practical quick methods of satellite and geodetic positioning procedures applicable for geodesy and navigation, in particular in hilly and mountainous areas. The established geodetic test fields

will also be used by geodetic departments of Czech, Polish and Slovak technical universities for student training in surveying and geodesy.

- Preparation and publication (in the series REPORTS ON GEODESY edited by the Institute of Geodesy and Geodetic Astronomy of the Warsaw University of Technology) of exhaustive geotectonic monographs of the Polish and Czech Sudetes as well as Polish and Slovak Tatra Mts. containing last geodetic and geophysical studies, experiments with interpretation of their results.

It is to mention that several pilot projects related to geodynamic studies of the Sudetes Region and Tatra Mts. have been already performed in joint cooperation of Czech, Polish and Slovak scientists, also in the frame of cooperation within CEI WGST Section C "Geodesy". The geodynamic studies of Sudetes Mts. and Tatra Mts. are included to the priority CEI programme CERGOP (Central Europe Regional Geodynamics Project). A special CERGOP Study Group CSG.5/5 "Geodynamics of the Tatra Mountains" ("Tatra Mts. without border") was set up within this Project to initiate and carry out the geodynamic research on the Tatra Mts. region. The research on geodynamics of Sudetes Mts. is included to the Study Group CSG5 „Geodynamics of the Regions of Central Europe“. New project is submitted to the Visegrad Fund with the request for financial support.

## **5. WORKING GROUP ON UNIVERSITY EDUCATION STANDARDS**

The Section C Working Group on University Education Standards is chaired by Profs. K. Czarnecki/Poland and F. Vodopivec/Slovenia. This group organised so far successfully four international GPS meetings: in 1996 an "International Symposium on Education in GPS Application to Geodesy and GIS" and in 1997 a symposium "International Symposium on DGPS in Engineering and Cadastral Measurements Education and Practice", both organised by F. Vodopivec in Ljubljana/Slovenia. Next action of this group, an International Summer Seminar "Education in GPS Application to Geodesy and GIS/LIS", was organised in June 1998 Grybów, Poland (organiser: K. Czarnecki). Last event organised by the Section was the international workshop on satellite DGPS techniques and field training for students from CEI countries in Sarajevo, Bosnia&Herzegovina in September 2000 (organisers: M. Mulic, F. Vodopivec). Next seminar/workshop will be organised in Lwow, Ukraine in September 2001 (organisers: F. Zablotiskij, F. Vodopivec, K. Czarnecki).

## **6. CEI SECTION C WORKING GROUP ON SATELLITE NAVIGATION SYSTEMS**

The Working Group on Satellite Navigation Systems was established in 1997. The Chairmen of this Working Group were elected Profs. Stanislaw Oszczak (Poland) and Giorgio Manzoni (Italy). First working meeting of this international group was held in Nice (France) in April 1998. Next meeting organised by this Working Group was held in Trieste, Italy on 9 March 1999, jointly with the Workshop on "DGPS and GLONASS techniques and application on safety (transport safety, rescue services, landslide monitoring etc.) in CEI area" (organiser: G. Manzoni). The Workshop was attended also by the representatives of the European Commission Brussels Office and Directorate of the GNSS (Global Navigation Satellite Systems). Further activities of this Working Group and in particular actions initiated by Prof. G. Manzoni are also worth mentioning, e.g. a new project proposal "No border DGPS in view of Galileo" presented at the CEI Economy Forum in Prague in November 1999; Prof. G. Manzoni has organised a session devoted to DGPS and GLONASS procedures in the CEI area during the symposium ISPRS (International Society of Photogrammetry and Remote Sensing) held in Ljubljana, Slovenia in February 2000. Last international workshop on DGPS and other navigation systems was organised in Olsztyn, Poland in July 2000 (organiser: S. Oszczak).

## **7. COOPERATION BETWEEN CEI SECTION C "GEODESY" AND THE EUROPEAN GEOPHYSICAL SOCIETY (EGS)**

Since 1997 there have been organised every year by the CEI Section C "Geodesy" special symposia on geodetic and geodynamic programmes realised in the frame of the international cooperation of CEI countries. They are included to the programme of annual General Assemblies of the European Geophysical Society. Symposia "Geodetic and Geodynamic Programmes of the CEI (Central European Initiative)" were held in Vienna, Austria, 1997; in Nice, France, 1998; in The Hague, The Netherlands, 1999, in Nice, France, 2000 and 2001. Next Symposium will be held again in Nice,

France, 22-26 April 2002. The Convener of these symposia is Prof. Dr. Janusz Sledzinski (Warsaw, Poland) and the Co-Convener Prof. Dr. Jan Kostecky (Prague, the Czech Republic). About 45 papers on EUREF campaigns in CEI countries, CERGOP, UNIGRACE, activities of the CSGs, contribution of permanent GPS stations in CEI countries to international programmes, etc. are usually presented at the oral and poster sessions of the EGS-CEI symposia.

#### **8. COOPERATION BETWEEN CEI SECTION C "GEODESY" AND THE INTERNATIONAL ASSOCIATION OF GEODESY (IAG)**

The cooperation with the International Association of Geodesy resulted in 1996 in creation of IAG Subcommission "Geodetic and Geodynamic Programmes of the CEI". After reorganisation of the IAG Commissions work, now the Subcommission "Geodetic and Geodynamic Programmes of the CEI" is acting within the IAG Commission XIV "Crustal Deformation" of the IAG Section V "Geodynamics". At the moment there are eight subcommissions acting within the Commission XIV. They are:

- WEGENER (Working Group of European Geoscientists for the Establishment of Networks for Earth Science Research), Chairperson: Luisa Bastos;
- APSG (Asia-Pacific Space Geodynamics programme), Chairperson Ye Shuhua;
- North America, Chairperson: Jim Davis;
- Canada, Chairperson: tbn;
- Central and South America, Chairpersons: Rodrigo Barriga and Alejandro Gutierrez;
- Africa, Chairpersons: M. Unis and L. Combrinck;
- Antarctica, Chairperson: Alessandro Capra;
- Geodetic and Geodynamics programmes of the Central European Initiative (CEI), Chairperson: Janusz Sledzinski.

#### **The charter duties of the Subcommission for CEI includes the following items:**

- to integrate the geodynamic research in the region of Central and Southern Europe based on high accuracy space geodetic surveys and to provide a precise geodetic reference frame for studies on geodynamics of Central Europe, in particular on areas Pannonian Basin, Bohemian Massif, Teisseyre-Tornquist Zone, Carpathian Orogenic Belt, Subalpine Region and Balkanides;
- to provide a reliable three-dimensional tectonic velocity field covering the Central Europe region and integrate it into hierarchically higher level (i.e. global) tectonic models as well as to prepare and publish geotectonic monographs highlighting and summarising the latest research and studies on regions under study;
- to contribute to other geodynamic programmes organised and coordinated by International Association of Geodesy related to the region of Central Europe, such as EUREF, WEGENER, EUROPROBE;
- to support local area geodynamic research, environmental studies, seismic hazard assessment, meteorology etc. in Central Europe region based upon the high accuracy space geodetic measurements carried out on an integrated geodynamic network of permanent GPS stations in CEI countries;
- to coordinate and to integrate the international geodetic and geodynamic programmes supported by IAG and CEI;
- to create close links between running projects of IAG and those of CEI, e.g. CEI CERGOP - Central Europe Regional Geodynamics Project and IGS (International GPS Service) and EUREF (European Reference Frame), use of CEI permanent GPS stations within IGS and other programmes for maintenance of the ETRF and ITRF, etc.;
- to initiate common geodetic and geodynamic projects for the region of Central and Eastern Europe;
- to foster the cooperation among universities and research centres from Central Europe and Western countries in the field of geodesy and geodynamics, promoting actions contributing to the development of innovative technologies and participation of CEI scientists in international IAG research programmes;
- to organise scientific symposia, working conferences and workshops on geodetic, gravimetric, geodynamic programmes and satellite techniques to discuss results and future planned actions

(e.g. Working Conferences of the programmes of CERGOP - Central Europe Regional Geodynamics Project, UNIGRACE - Unification of Gravity Systems in Central and Eastern Europe, Symposia "GPS in Central Europe", etc.).

First progress report on the activities of the Subcommittee was presented at the IAG Scientific Meetings in September 1997 in Rio de Janeiro, Brazil. The next report was submitted to the IAG/IUGG-99 in Birmingham, UK in July 1999. The Bureau of the Commission XIV had the meeting in San Fernando, Spain on 21 September 2000 to discuss current plan of action. The research and interpretation of recent crustal movements detected by satellite techniques were recognised as most important and urgent action of the Commission. The primary general objectives of the Commission XIV „Crustal Deformation”, as confirmed by this Commission Bureau Meeting are:

- ◆ to study 3-D motions, in active tectonic regions, post-glacial rebound and sea-level fluctuations and changes in relation to vertical tectonics along many parts of the coastlines and in relation to environmental fluctuations/changes affecting the geodetic observations;
- ◆ to promote, develop and coordinate international programs related to observations, analysis and data interpretation for the three fields of investigation mentioned above;
- ◆ to promote the development of appropriate models.

To contribute to the above mentioned actions of the Commission XIV, the Subcommittee “Geodetic and Geodynamic Programmes of the Central European Initiative (CEI)” declares to supply and release to the aims of the Commission XIV the following results:

- results of the GPS campaigns of the CEGRN (Central Europe GPS Reference network) realised in the frame of the Project CERGOP (Central Europe Regional Geodynamics Project);
- velocity vectors of about 60 sites in Central Europe calculated by CERGOP Processing Centres from the campaigns CERGOP, EXTENDED SAGET, EUREF;
- information on progress in determination of quasi-geoid in the Tatra Mts.;
- information on local geodynamic projects realised in Central Europe in CEI bilateral and multilateral cooperation;
- information on progress of works of all seven CERGOP Study Subgroups CSG.5/i of the CSG.5 „Geotectonic analysis of the region of Central Europe”;
- information on geotectonic monographs prepared by the CERGOP Study Subgroups CSG.5/i „Geotectonic analysis of the region of Central Europe”;
- information on progress in realisation of the UNIGRACE (Unification of Gravity System in Central and Eastern Europe) Project.

## **9. ACKNOWLEDGEMENTS**

The scientific programmes realised by the Section C “Geodesy” are currently highly evaluated and assessed by the CEI Summit Authorities in Final Documents of the Meetings of the Ministers of Foreign Affairs and the Heads of Government of the Member States of the Central European Initiative and are clearly denoted as priority CEI projects. Such notes are very valuable references as annexes to any applications submitted to different national institutions with the request for financial support. The author, as the International Coordinator of the CEI WGST Section C "Geodesy", is indebted to all national representatives of countries participating in the wide CEI cooperation in geodesy and geodynamics and to all project chairmen and working/study group members for their very active contributions and initiatives resulting in very high assessment expressed by the CEI Summit Meetings.

**CENTRAL EUROPEAN INITIATIVE  
WORKING GROUP “SCIENCE AND TECHNOLOGY”  
SECTION C “GEODESY”**

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