

CERGOP-2/ENVIRONMENT, SUMMARY OF THE THIRD YEAR

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Summary. The project "CERGOP-2, a multipurpose and interdisciplinary sensor array for environmental research in Central Europe" was approved by EU within the 5th Framework Program and started April 1st, 2003. The official end of the project is March 31, 2006. However we applied for a prolongation of another 6 months and we are waiting for a relevant decision of EU. In 17 work packages we extended a high quality GPS network in a region covering about 15 % of Europe. It will be operational for the next decade. Velocity field and strain maps for geodynamical investigations and hazard mitigation, data for climate research and weather forecast, data for real time navigation and a seamless data bank for scientific and public access were established. This report gives a final summary of the project and some perspectives of the future. The last semi-annual meeting of the project was arranged in Sarajevo, Bosnia Herzegovina (in November 2005), which included a Governing Board Meeting of the CEGRN Consortium (CCGB). Discussions included site quality issues related to site acceptance for CEGRN – the basic reference network, and an open forum on future potential project initiatives. The ADRIA, the GMES (Global Monitoring for Environment and Security), the GEO (Group on Earth Observation), the GALILEO, WEGENER and TOPO EUROPE topical project areas were identified, where the Consortium could participate/contribute significantly. Candidate coordinators were assigned for each area.

We have also to think about the continuation of this project – after its termination end of March 2006 or end of September 2006. Driven by the many natural disaster during the last 2 years people expect that science will strengthen its efforts to find solutions for explaining the influence of the forces leading to crust displacements and to determine the location, magnitude and the “date” of future expected sudden displacements, a task, which may take another century of scientific investigations, if even possible.

Preamble of the coordinator:

This project was signed by EC March 31, 2003 and has been started, consequently, April 1st, 2003 with a run time of 3 years. The proposal was based on the experience of 14 countries of the Central European Initiative (CEI) which established a highly sophisticated monitoring network CEGRN within the Central European Regional Geodynamic Project (CERGOP) during the last nine years. Furthermore a Memory of Understanding (CEGRN Consortium) was signed by all partners during the IAG General Assembly in Budapest, September 2001, indicating the willingness to support this project for at least 5 further years. A new decision enlarges this commitment until 2010.

Yearly symposia organised in the framework of the EGS/EGU as well as semi-annual meetings carried out in Warsaw, Sofia and Sarajevo serve as the basis for primary distribution of results to the scientific public. The proceedings of all meeting were published in the Reports on Geodesy, Warsaw University of Technology, and sent to the scientific officer in Brussels.

Updated working plan 1.4.2003 to 31.7.2006

The working plan will not change too much as the consortium regards the project CERGOP-2/Environment as an intermediate step leading from CERGOP-1 (1993 – 2003) to CERGOP-3 (2007 – 2010 or longer). We have the situation that geodynamic investigations had to start sometime and should be continued, ideally, unlimited. That means that the content of the CPF will not be changed substantially but we have some delay in the deliverables which mainly were caused by the unlucky end time of the project (March 2006) and the hard winter which did not allow for measurements in the field starting with November 2005. The prolongation of 4 months will considerably help to lead to a successful project end and to hand the open subjects over to 2007 where the consortium will try to finance the required expenses by the 7th FP and national assistance. In the following I summarize the works for the last 4 months as described by the work package leaders:

WP-1: Internet based seamless data bank for environmental studies

The extension of CERGOP2/Environment in 2006 will be used mainly for construction of log sheets of all epoch station and of those permanent stations which do not have yet one. The log sheets are compatible to the international ones of IGS and EPN and will be stored electronically at the server. Because the project CERGOP will continue it is not necessary to make a sharp cut after the end of the project concerning the data centre. However, apart from some minor changes (hard disks, web pages, improvement of the database) preparations have to be made to make the most items public. How the complete data set should be divided into a public part and a part still private must first be discussed. Also the public data should be left at the same server, but must be reorganized somehow. The main addresses are:

<http://cergops2.iwf.oeaw.ac.at>

login: cergop2@cergops2.iwf.oeaw.ac.at

Password : Please contact me

<http://www.fomi.hu/cegrn>

WP-2: Station quality assessment and upgrade

Site inspections in the Czech Republic, Poland, Slovakia, and Germany. Date: May and June 2006. The summary evaluation of site inspections and the conclusion need some more man months. End: July 2006.

WP-3: Periodic improvement of the reference frame CEGRN
Work package closed.

WP-4: Creation of new observation facilities in CEI countries
Continuation of the work of one employee for 4 months

WP-5: GPS data analysis and definition of reference frames

Quality tests of GPS-Measurements; Analysis of permanent GPS stations;
Interpretation of significant discrepancies.

WP-6: Analysis of long term co-ordinate time series

Continuation of time series development.

WP-7: Geo-kinematical modelling and strain analysis

Determination of velocity vectors of horizontal and vertical movements; Determination of boundary risk zones.

WP-8: Impact of atmospheric effects on GPS-height determination

Final report including the data of a final campaign carried out in Austria during spring 2006.

WP-9: GPS-based rapid service for meteorology and hazard assessment

Complete the comparison of GPS with INSAR data on landslide areas; perform 2 other GPS campaigns in Aliano and Avigliano; Continue the estimation of zenith total delay for meteorology in the area of Matera.

WP-10: Geodynamics of Central Europe

Editing and printing the final Monograph on Geodynamics of Central Europe; Editing and printing the Monographs prepared by the subgroups 10.i; Computation of final coordinates from CEGRN 2005 and 2005.

WP-10.1: Crust movements in the Eastern Alps and the Northern Mediterranean

Performance of an epoch campaign in May 2006 covering permanent sites in Austria, Slovenia, Croatia, Bosnia, Serbia, Romania and Bulgaria; Computations until end of July 2006.

WP-10.2: Three dimensional plate kinematics in Romania

See WP 10.1; Security update of the Romanian permanent stations; Establishment of a GPS Data processing centre in cooperation with SRI Graz; final velocity estimation for plate kinematics in Romania.

WP-10.3: Integration of present geodynamic investigations in the Pannonian basin

Combined solutions of CEGRN'05 with the solutions of independent processing centres; comparison of site velocities; software development.

10.4: International geodynamic test area Plitvice lakes

Final measurements and computations in the Plitvice lakes area.

WP-10.5: Geodynamics of the Tatra mountains

Last observation campaign in the Tatra Mts, final interpretations.

WP-10.6: Geodynamics of the Northern Carpathians

Last observation campaign in the Northern Carpathians; final interpretations.

WP-10.7: Geodynamics of the Balkan peninsula

Participation in the WP 10.1 activities during May 2006; update of permanent GPS stations establishment of the monograph for Bulgaria.

Conclusion

The kind of deliverables will not change as the sequence was carefully prepared. What did change is, for some of the deliverables, the date. The bad date of the beginning of the project led to some delays during the end of the project, accompanied by the usual delay of monographs, which are one of the basic outputs. The bad winter time prevented some

final epoch campaigns which are necessary to be carried out. The prolongation gives a good chance to solve these problems.

In a nutshell: The project is running quite satisfactorily, and we expect to continue it with the same premises during the next 5 years. We all hope that this effort will lead to a remarkable corner stone for giving impacts for the further geodynamic investigations in a considerable area of Europe. We all know that future work will rely on new upcoming techniques which I cannot estimate nowadays. I do not know if the physical understanding of our earth will grow with the same speed as the technological progress. Earth-science is very complicated, and the change from kinematics to geodynamics will require a lot of work, observations and interpretation. When we can understand the forces driving the earth crust and the energy transported by them we would be one important step further to earthquake prediction and an escorting mitigation for our mankind.

B1. Work package list

| Work-package No ¹ | Work package title | Lead contract or No ² | Person-months ³ | Start month ⁴ | End month ⁵ | Deliverable No ⁶ |
|------------------------------|---|----------------------------------|----------------------------|--------------------------|------------------------|-----------------------------|
| 1 | Internet based seamless data bank for environmental studies | AAS/SRI | 16 | 5 | 24 (40) | 1, 2a |
| 2 | Station quality assessment and upgrade | FOMI | 21 | 0 | 36 (40) | 2a, 10,11 |
| 3 | Periodic improvement of the reference frame CEGRN | FOMI | 81 | 5 | 32 | 8,13 |
| 4 | Creation of new observation facilities in CEI countries | UBW | 59 | 4 | 36 (40) | 17,18 |
| 5 | GPS data analysis and definition of reference frames | FCESUT | 24 | 0 | 36 (40) | 9,13 |

¹ Workpackage number: WP 1 – WP n.

² Number of the contractor leading the work in this workpackage.

³ The total number of person-months allocated to each workpackage.

⁴ Relative start date of the work in the specific workpackage, month 0 marking the start of the project, and all other start dates being relative to this start date.

⁵ Relative end date, month 0 marking the start of the project, and all end dates being relative to this start date.

⁶ Deliverable number: Number for the deliverable(s)/result(s) mentioned in the workpackage: D1 - Dn.

| | | | | | | |
|------|---|--------|-----|---|------------|-------|
| 6 | Analysis of long term co-ordinate time series | UNIPD | 73 | 0 | 36 (40) | 12 |
| 7 | Geo-kinematical modelling and strain analysis | FCESUT | 22 | 0 | 36 (40) | 14,16 |
| 8 | Impact of atmospheric effects on GPS-height determination | VUGTK | 26 | 5 | 36 (40) | 19 |
| 9 | GPS-based rapid service for meteorology and hazard assessment | ASI | 35 | 4 | 36 (40) | 6,7 |
| 10 | Geodynamics of Central Europe | PWWUT | 37 | 0 | 36 (40) | |
| 10.1 | Crustal movements in the Eastern Alps and the Northern Mediterranean | FGG | 32 | 4 | 36 (40) | 15 |
| 10.2 | Three dimensional plate kinematics in Romania | ICGFC | 49 | 4 | 30 (40) | 8,15 |
| 10.3 | Integration of present geodynamic investigations in the Pannonian basin | FOMI | 26 | 0 | 36 (40) | 8,15 |
| 10.4 | International geodynamic test area Plitvice lakes | FGUZ | 19 | 6 | 36 (40) | 8,15 |
| 10.5 | Geodynamics of the Tatra mountains | PWWUT | 23 | 0 | 36 (40) | 8,15 |
| 10.6 | Geodynamics of the Northern Carpathians | NULP | 46 | 4 | 36 (40) | 8,15 |
| 10.7 | Geodynamics of the Balkan peninsula | CLGBAS | 62 | 4 | 36 (40) | 8,15 |
| | TOTAL | | 651 | | | |

B1.

Deliverables list Category 1

“immediately and permanently available”

| Deliverable | Delay | Delivery start in month | Responsible WP leaders (partners) <i>Remarks</i> | Nature | Dissemination value <i>Remarks</i> | D No. |
|--------------------------------------|---------------|-------------------------|---|--------|---------------------------------------|-------|
| Web-based information system | Real time | 24 | WP-leader 1 | Re | PU | 1 |
| GPS raw data from permanent stations | 1 to 24 hours | Now | All partners | Da | PU (30 sec) <i>RE (1 sec)</i> | 2 |
| GPS raw data from | Real time | 23 | All partners, | Da | RE | 2a |

| | | | | | | |
|---------------------------------------|-------------------------------------|------------|---|----|---------------------------|----|
| permanent stations | | | WP-leaders 1 and 2 | | <i>PU to be discussed</i> | |
| Meteorological information | 1 to 24 hours | Partly now | All partners <i>Dependent on site</i> | Da | PU | 3 |
| Meteorological information | Real time | 30 | All partners | Da | PU | 3a |
| Precise station coordinates | 3-4 weeks | Now | WP-leader 5 + <i>analysis centres</i> | Da | PU | 4 |
| Precise station coordinates | <2 days (daily) <9 days (weekly) | 23 | WP-leader 5 + <i>analysis centres</i> | Da | PU | 4a |
| Hourly tropospheric zenith delays | 3-4 weeks | Now | WP-leader 5 + <i>analysis centres</i> | Da | PU | 5 |
| Hourly tropospheric zenith delays | < 2 hours | 23 | WP-leader 5 + <i>analysis centres</i> | Da | PU | 5a |
| RTK corrections for selected stations | Real time | 7-36 | WP-leader 9 <i>Dependent on communication update</i> | Da | PU | 6 |
| Hazard warning indicators | Near real time to some weeks | 30 | WP-leader 9 | Re | PU | 7 |

**B1. Deliverables list Category 2
“periodic delivery by date”**

| Deliverable | Periodic date (month) | Delivery start in month | Responsible WP leaders (partners) <i>Remarks</i> | Nature | Dissemination value <i>Remarks</i> | D. No |
|---|-----------------------|-------------------------|--|--------|---------------------------------------|-------|
| GPS RINEX data from epoch stations | 11,23,35 | 8 | WP-leaders 3 and 10.1 to 10.7 | Da | RE | 8 |
| Station velocities | Every 6 months | 6 | WP-leader 5 | Da | PU | 9 |
| Station quality assessments | 12,24,36 | 12 | WP-leader 2 | Re | PU | 10 |
| Station calibration values | 12,24,36 | 12 | WP-leader 2 | Re | PU | 11 |
| Long term coordinate time series analysis | Each third month | 6 | WP-leader 6 | Da, Th | PU | 12 |
| Reference frame for Central Europe | 12,24,36 | 12 | WP-leaders 3,5,6 | Da, Re | PU | 13 |
| Geophysical interpretation of the velocity field | 18, 36 | 18 | WP-leader 7 | Th,Re | PU | 14 |
| Sub-regional geodynamical investigations (monographs) | 12,24,36 | 12 | WP-leader 10, <i>in cooperation with WPs 10.1-10.7</i> | Re | PU | 15 |
| Geo-kinematical maps including strain analysis | 18,36 | 18 | WP-leader 7 | Re | PU | 16 |

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| B1. Deliverables list Category 3 “final product delivered once” |
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| Deliverable | Delivery date (month) | Project start (month) | Responsible WP leaders (partners) <i>Remarks</i> | Nature | Dissemination value <i>Remarks</i> | D. No. |
|---|-----------------------|-----------------------|---|--------|---------------------------------------|--------|
| Multipurpose station prototype | 20 | 2 | WP-leader 4 | Pr | RE | 17 |
| Tools for autonomous site monitoring | 22 | 2 | WP-leader 4 | Me,Si | RE | 18 |
| Improved model for precise GPS height determination | 30 | 6 | WP-leader 8 | Th, Me | PU | 19 |
| Long term observation facilities | 36 | 2 | WP-leaders 1,2,4 | O | PU | 20 |

Remark: O means “ a functional network of observing stations including analysis and interpretation”.

The deliverables can be separated into three categories. According to the nature of the project which in much cases foresee the continuation of presently ongoing activities now being partly supported by EC for the next 3 years and which finally aim at the establishment of a new long-term observation capacity we have two kind of deliverables with opposite character: “immediately available” and “as a result of the project”. The third kind can be delivered step-wise, it depends on periods of regional activity (WP 10.x) and on the work being necessary to work off the past (interpretation) and technical alignments promoted by the issue “Better exploitation of existing data and adaption of existing observing systems”.

There is a logical timely interdependence of most the deliverables stated above dictated by the sequence <station definition (reconnaissance) – operable equipment – measured data – computed positions and zenith delays – screening of time series – computed velocities – strain analysis – geo-kinematical maps – monographs>, which is valid for all permanently observing stations and, in a restricted sense, also for the local/regional campaigns foreseen in work packages 10.1 to 10.7.

THE CEGRN CONSORTIUM ACTIVITIES

The most important event was the CEGRN'05 epoch campaign, 20-25 June 2005, in which more than 80 sites participated. This was the highest number ever in CEGRN history. Figure 1 gives a site occupation statistics since 1994. The number of sites significantly increased in the CERGOP-2 project period (1999-2005) as compared with CERGOP-1 (1994 – 98). Particularly, the sharp increase following 2001 was due to the EU project support in CEGRN extension/densification activities. We note that 18 sites have fully participated in each (8) epoch campaign since 1994. This gives a very valuable 11 years monitoring time base for these stations, a significant part of CEGRN.

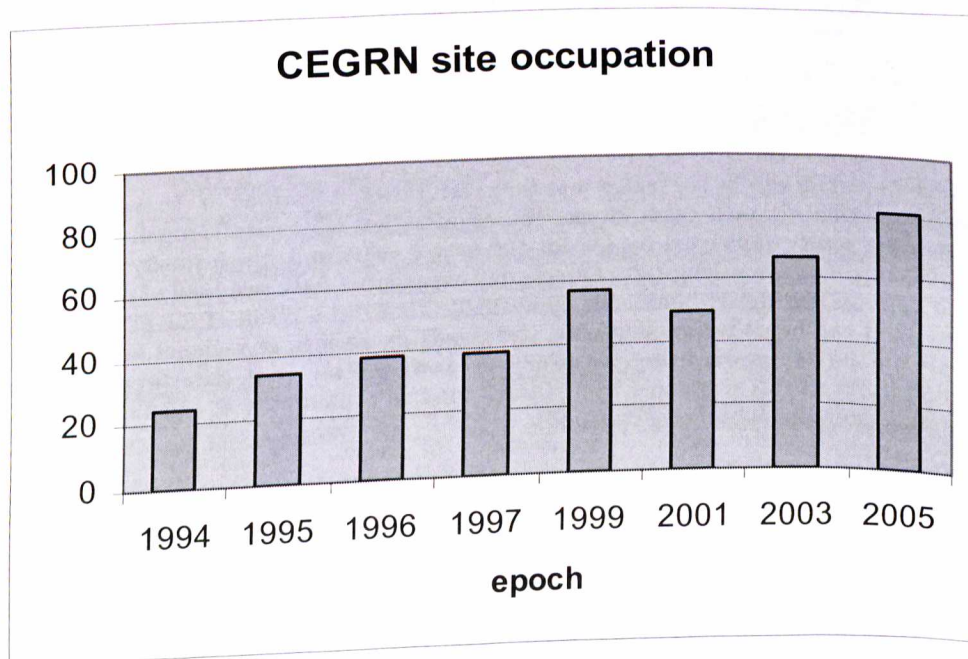


Fig. 1 The number of sites participated in the CEGRN epoch campaigns

A CEGRN Consortium Governing Board (CCGB) meeting was held in Sarajevo, Bosnia Herzegovina on 12 November 2005. Nine new CEGRN sites were formally accepted by the Board (TRFB, RHOZ, VARN, SNEC, SUME, ASIA, CAME, ROVI, COST). Further 13 new candidate sites are in the pipeline considered for acceptance. The agenda and the minutes of the CCGB meeting can be found on the Consortium's website (www.fomi.hu/cegrn).

The CEGRN site documentations were regularly updated by the Webmaster Dr. Bence Takacs (bence@agt.bme.hu) in collaboration with WP 2 (Gábor Virág - virag@sgo.fomi.hu). The Consortium website (www.fomi.hu/cegrn) was maintained by the SGO, Penc, Hungary.

The present (2005) update of the CEGRN map is displayed on Fig. 2. Here beside the accepted sites, the candidate sites are also included. Although the total number is presently 91, we have to note that some of these are so called “close by” or “twin” sites. This category means distances from a few meters up to a few ten km-s between the sites. The twin stations are generally not representing different tectonic units. They came to existence by the way, when in the vicinity of an epoch station a new permanent station was established. Presently we have identified 10 such twin sites in CEGRN but the number is expected to grow as new permanent stations are being planned near “historical” epoch sites. We consider twin sites very valuable for checking site stabilities and for a number of other purposes e.g. reliability tests, keeping historical time bases etc. Therefore we recommend monitoring all twin site components in the future if resources allow. Fig. 2 contains also inactive sites as KIRS, BASO, UPAD, LEND and damaged monument sites as GIL2, IAS3, VAT1.

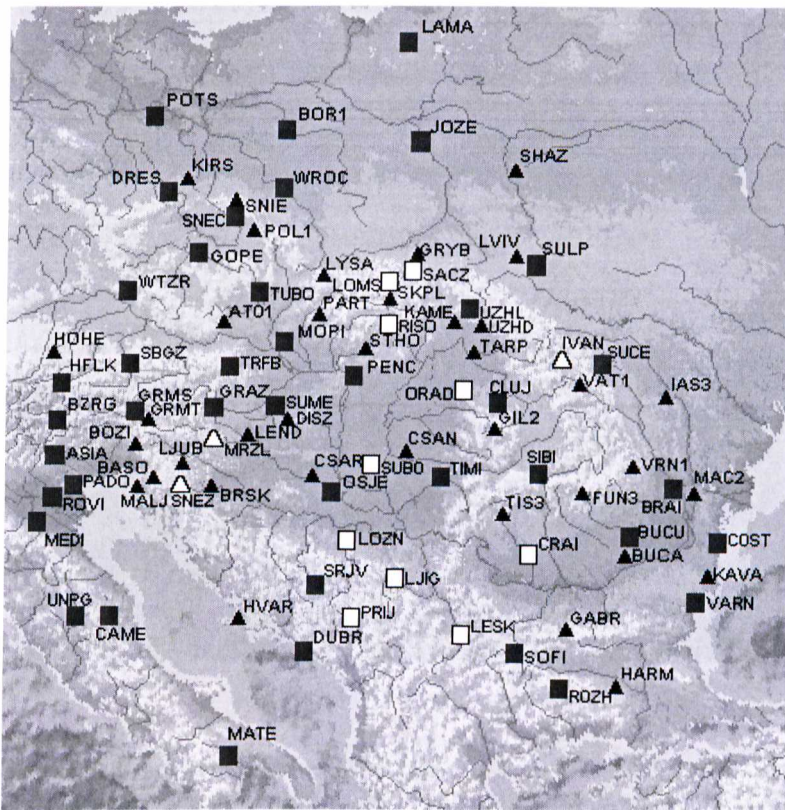


Fig. 2 The location of permanent (shaded squares) and epoch CEGRN sites (shaded triangles) in 2005, including the new candidate sites (white symbols)

SITE QUALITY AND INTERFERENCE MONITORING

Site inspections and the RFI monitoring program has been continued in the frame of WP 2 (Virág, 2006). The Hungarian task force visited Romanian, Italian, Slovenian and Hungarian CEGRN sites and carried out radio spectrum measurements, horizon mask observations and updated site documentations. Monitoring results assist data reduction and analysis. In case of interference, the national frequency management authority is alerted. The monitoring is presently carried out with an Advantest spectrum analyzer and the measurements are archived as function of location and time. The monitoring routine besides the GPS L1 and L2 includes the Galileo frequency bands. Up to now 51 sites have been inspected (Fig. 3) and the number of RFI monitoring spectra sets reached 63. Each set contains 6, sometimes more, different spectrum measurements.

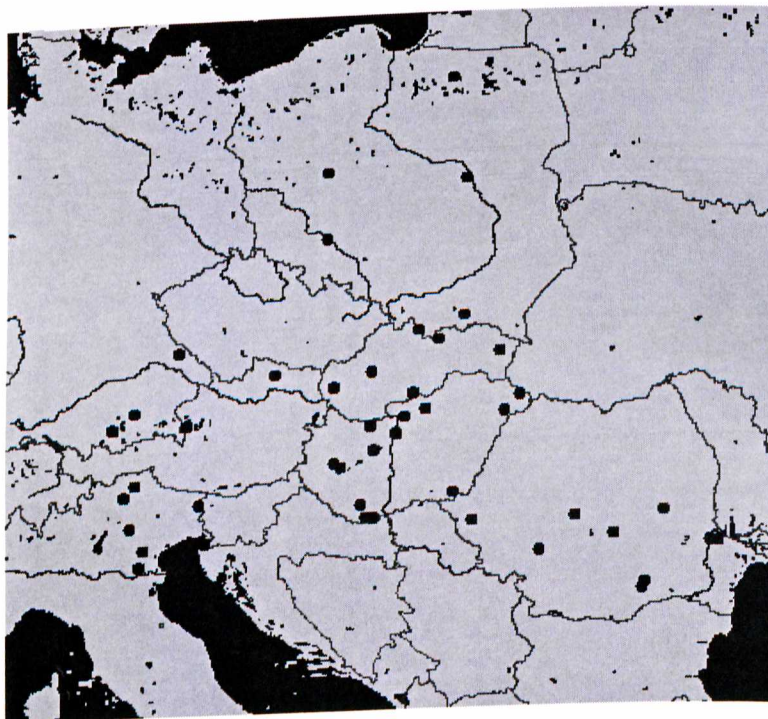


Fig. 3 The Central European sites where interference-monitoring measurements were carried out by WP 2 experts till March 2006 (some of the locations overlap).

NEW INITIATIVES

The long time base and high quality of CEGRN makes it a valuable partner in new Earth science projects in the region. At the Sarajevo CEGRN Consortium meeting the group discussed participation and assigned liaisons in present initiatives in the following areas. The Adria project (Gy. Grenerczy), GMES (F. Vespe), GEO (national contacts), GALILEO (M. Becker), WEGENER (M. Becker), TOPO EUROPE (Gy. Grenerczy).

References

Virag G. 2006 : Annual Report CERGOP-2/ Environment WP 2, Station Quality Assessment and Upgrade, Period April 2005- March 2006. (This issue.)