PERMANENT GPS STATIONS - THE BACKGROUND FOR GEODYNAMIC STUDIES AND MAINTENANCE OF GEODETIC COORDINATE SYSTEMS

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INTRODUCTION

Over the past few years many permanent satellite stations, whose positions are determined basing on permanent twenty-four-hour GPS observations of highest accuracy, began their operation. These stations belong, above all, to the International GPS Service for Geodynamics (IGS) and to the EUREF net-work, but also to the national navigation services operating in the Differential Global Positioning System organized for various special economic purposes such as transport, communication, police, medical service, fire department etc. This situation raised new possibilities of using permanent observations to monitor curtain short-term phenomena and made it necessary for us to develop new technological procedures related to the collection and processing of a very extensive observation data. This also brought about a new philosophy of using permanent GPS observations for geodesy and geodynamics.

DIFFERENT APPLICATIONS OF PERMANENT GPS OBSERVATIONS

Currently permanent GPS observations (stations) are mainly used for the following purposes:

1. Determination, accuracy improvement and maintenance of the ITRF (International/IERS Terrestrial Reference Frame). These tasks are carried out nowadays by two global services: IGS (International GPS Service for Geodynamics), whose performance is based on a network of permanent GPS stations, and IERS (International Earth Rotation Service), which uses GPS measurements as complementary to observations made by other satellite and space techniques, mainly by Satellite Laser Ranging (SLR) and by Very Long Baseline Interferometry (VLBI). The most important products offered by these services include precise orbits of the GPS satellites, precise positions of permanent stations (and their velocity vectors) and geodynamic parameters of the Earth rotation; they also provide us with clock corrections of GPS satellites and tracking stations as well as with information on the ionosphere and troposphere.

In Europe the global network is realized by a continental network that is being established by EUREF (European Reference Frame) campaigns. This network constitutes a precisely defined part of ITRF known as European Terrestrial Reference Frame (ETRF). Recently a new category of EUREF points has been introduced, and these are permanently working stations.

2. Establishment of reference control networks (stations) for the connection of the national geodetic frames and newly created national active positioning and navigation systems. Points of the EUREF frame and permanently working satellite stations that belong to the IGS and IERS services constitute the basic international (global and regional) frame in Europe to which all national satellite control networks are connected. The national satellite control networks are therefore established as a densification of the EUREF frames and IGS/IERS frames. National active positioning and navigation systems based on permanent reference stations operating in some countries are known as so-called Precise Active Positioning System and Standard Active Positioning System. A growing demand for active systems for land, marine and air navigation has been expressed by public services such as aviation, navy, transport, communication, police, fire department, health and other emergency services. This demand is satisfied by the satellite services of DGPS (Differential Global

Positioning System) performing their activity in many countries and providing position of moving objects in real time.

3. Establishment of points (stations) for geodynamic research and connection of local geodynamic networks. The new philosophy of geodynamic research consists in analyzing permanent precise GPS observations that are performed at geodynamic points (in observatories). This helps to detect geodynamic effects, including the periodical ones, which occur with various amplitudes and various frequencies (with different periods). Today analysis of changes in the velocity vectors of permanent stations constitutes the basis for the most valuable global and regional geodynamic research. A network established recently in Japan can serve as an example of this kind of geodynamic network. The Japanese network consisting of 900 permanently operating stations, monitors all the short-term changes in the position and provides data for geodynamic interpretation and predictions as concerns any possible occurrence of an earthquake.

NETWORK OF STATIONS OF THE INTERNATIONAL GPS SERVICE FOR GEODYNAMICS (IGS)

Stations of the International GPS Service for Geodynamics (IGS) constitute today a network of permanent stations of highest international standard. In the report recently presented by IGS Bureau in September 1997 (see [9]) there are listed 144 operating stations . The next 22 permanent IGS stations are planned to be put in use in 1997-1998. All the existing stations are located on all continents but their distribution is clearly not even (Fig. 1). It should be noted that the highest density of permanent stations is found in Europe, and a significant shortage of such stations is observed in Asia, Africa and South America. For the IGS service the number of the stations in operations all over the world will be finally limited to approximately 200 (which corresponds to relative distances of about 1000 km between the stations). All the newly established permanent stations in Europe will be used to density the EUREF system. The elements of the IGS service include: (1) Network of tracking stations, (2) Data centres, (3) Analysis and Associate Analysis Centres, (4) Analysis Coordinator, (5) IGS Central Bureau, (6) IGS Governing Board.

IGS tracking stations perform permanent GPS observations and transmit them at least once daily to the data centres. There are three categories of data centres: operational, regional and global. The operational centres are to maintain communication with observation stations, collect, format and compress the obtained data and then transmit the data to regional and global centres for further processing. The regional centres collect data from several operational centres and they are the element of the IGS service that allows us to avoid a multiple cross transmission of the same data from various stations to various analysis and associate analysis centres by electronic mail. The regional centres transmit the data to respective global centres. The global centres are responsible for archiving and on-line availability of data to/from operational or regional centres as well as for archiving and on-line availability of IGS products obtained from the analysis and associate analysis centres. Currently there are five IGS Operational & Regional Data Centres, three IGS Global Data Centres and seven IGS Analysis Centres. They are listed in Tables 1, 2 and 3.Today this original "classical" structure of the IGS analysis centres has undergone some changes, which is due, above all, to the rapidly growing number of permanent tracking stations and accumulation of a huge amount of observation materials, particularly in some regions of the world, e.g. in Europe. This brought about a new problem: how to use such a rich observation material? It has been decided that the IGS global network will consist of approximately 50 evenly distributed permanent stations (core stations), and the other 150 IGS stations are to make up so called IGS regional networks. The total development of IGS network is based on combining solutions applied to regional and global networks. It has also been decided that in Europe a part of the newly established permanent GPS stations will be used for permanent monitoring of the EUREF reference system. Thus one can note a further tightening of cooperation between IERS/IGS and EUREE. This also brought about a necessity to reorganise the initially established network of analysis centres. During discussions, still unconcluded, several concepts have been put forward on the methodology of processing a very rich and broad observation material obtained at the permanent stations. It is envisaged that the processing of observations will be conducted by several analysis centres in Europe *(distributed processing)* where each of the centres will process a definite part of the European permanent network *(subnetworks).* It will be possible to use several processing options: either each part of the European network that includes at least three points of the global network will be processed independently, or each such a part will be processed as a minimum constrained network, and the computed coordinates and variance-covariance matrices will be included in the global solution, which will contribute to the improvement of the accuracy of the ITRE system. Another option which was considered concerns the use of data obtained from the analysis centres at the stage of normal equations, but this option calls for even more complex coordination and standardization of all operations conducted by analysis centres.

NETWORK OF THE EUREE STATIONS

Over the past years the number of the permanent GPS stations in Europe has been rapidly growing. This tendency is still observed and steady and it creates great difficulties in organizing all the current day-to-day data processing of such a broad and extensive observation material. Moreover, it should be noted that the distribution of the observation stations is also important for the purpose of the IGS service; a dense network of stations located on a relatively small area is not only disadvantageous but also unnecessary. For this reason, following the decision made in 1995, these permanent European stations which will not be included in the IGS network, will be incorporated into the network of permanent stations of the EUREF and will be used for the maintenance of the European Reference Frame (EUREF). The Royal Observatory of Belgium, Brussels, has been made responsible for the coordination of works of the EUREF stations. As it is said in [2], the EUREF analysis is done following recommendations which were set at the EUREF Analysis Workshop held in Brussels in April 1997:

adopt a common data sampling interval (180 sec),

use a common elevation cut-off angle (15°),

use precise satellite orbits such as IGS or CODE orbits (all analysis centres perform a fixed-orbit processing),

use consistent orbits and Earth Rotation Parameters,

adopt the IGS tables for the modeling of the constant and elevation dependent antenna phase eccentricity variation tables,

adopt similar strategies for the modeling of the troposphere, estimation of a tropospheric zenith path delay/2 hours.

Therefore we can assume that the European EUREF network of permanent stations is a densification of the IGS network. At present it consists of more than 60 stations located in 23 European countries (Fig. 2). Approximately 40% of the above mentioned stations are not included in the IGS network. The EUREF network is processed by 10 EUREF Local Analysis Centres, and each of these centres processes a determined part of the EUREF network (a dozen of points) and transmits the SINEX (Software Independent Exchange Format) results (free-network solution) to the EUREF Regional Processing Centre CODE in Bern, Switzerland. Based on all the solutions obtained from individual local centres, the Regional Centre CODE processes and offers a joint "European" solution and sends it to the IGS. This kind of weekly reports on joint solutions have been prepared by the EUREF CODE Centre since April 1996. This EUREF solution is submitted to the IGS where the Global Network Associate Analysis Centres combine all global IGS solutions with several regional solutions like EUREF. This work is done within the frame of the IGS densification pilot project (see [2]). The processing performed by CODE are known for their high accuracy: the accuracy of the computed coordinates is 1-2 mm for the north and east components and 4 - 6 mm for the height component.

The list of EUREF Data and Local Analysis Centres is given in Tables 4 and 5.

It is worth mentioning that it has been lately decided that the realisation of the European Height System (EHS) would be a part of the activities of the EUREF Working Group [II]. A special sub-group chaired by Prof. W. Augath was established to fulfil this task. The EHS will use the normal heights and will be based on the tide gauge of Amsterdam. The first task will be the readjustment of the West European part of UELN (Unified European Levelling Network) with new levelling data from Holland, Germany, Austria, Poland, the Czech Republic, Slovakia, Hungary and Slovenia. To establish a unified height system in Europe a large supporting GPS campaign EUVN-97 was performed 21-29 May 1997. It contained about 190 GPS stations (74 EUREF stations, 56 new selected points close to the first order levelling lines, 61 GPS sites close to tide gauges, [II]).

PERMANENT STATIONS IN THE RESEARCH PROGRAMMES OF THE CEI.

The great importance of permanent stations for practical geodetic works in every country and for research has been fully recognized in the research programmes of the Central European Initiative (CEI). It is worth mentioning that at the Conference of the National Representatives of all the countries participating in the CEI Section C cooperation held in Warsaw, 24-25 March 1995, a resolution was adopted on the organisation of permanent stations in CEI countries.

GPS TRACKING NETWORK
International GPS Service for Geodynamics

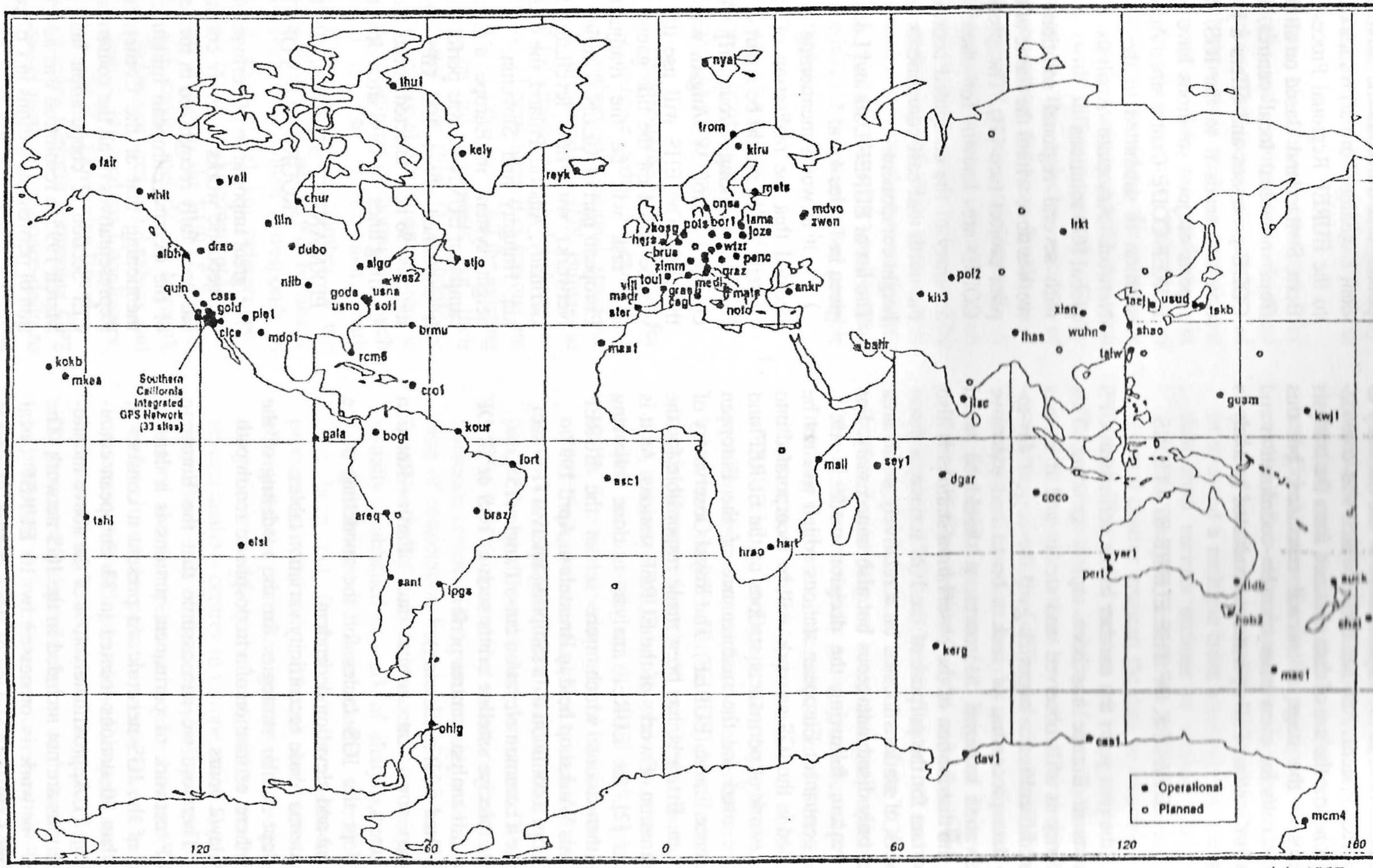

Fig. 1 (after [8])

Table 1.

IGS OPERATIONAL & REGIONAL DATA CENTRES

No.	Institution	Country
1.	National Oceanic and Atmospheric Administration Geosciences Research Lab. Silver Springs	USA
2.	BKG (former IFAG) Frankfurt	Germany
3.	Natural Resources, Canada Ottawa	Canada
4.	Norwegian Mapping Authority Statens Kartverk Henefoss	Norway
5.	Jet Propulsion Laboratory (JPL) Pasadena, CA	USA

Table 2.

IGS GLOBAL DATA CENTRES

No.	Institution	Country
1.	Crustal Dynamics Data Information System (CDDIS) NASA Goddard Space Flight Center Greenbelt	USA
2.	Institut Geographique National Paris	France
3.	Scripps Institution of Oceanography University of California San Diego	USA

Table 3.

IGS ANALYSIS CENTRES

No.	Institution	Country
1.	CODE Center for Orbit Determination in Europe Astronomical Institute University of Berne	Switzerland
2.	European Space Operations Center European Space Agency (ESA) Darmstadt	Germany
3.	GeoForschungs Zentrum Potsdam	Germany
4.	FLINN Analysis Center Jet Propulsion Laboratory Pasadena, CA	USA
5.	National Oceanic and Space Administration Geosciences Research Laboratory Silver Springs	USA
6.	Natural Resources Canada Ottawa	Canada
7.	Scripps Institution of Oceanography San Diego, CA	USA

Below you find the original version of this resolution:

The CEI Section C "Geodesy" recognising the important role of permanent GPS stations for the maintenance of the ITRF, both geodetic and geodynamic practical works and research activities, and the contribution to orbit improvement and permanent monitoring of the Earth rotation and the investigations of the ionospheric effects recommends that each CEI country make efforts to establish at least one permanent station on its territory and requests that all national institutions or agencies responsible for geodetic works and research activities support such action with indispensable financial and any other assistance.

Also the programme of CEI CERGOP (Central Europe Regional Geodynamics Project) recommends that each of the eleven countries participating in the project should establish and maintain at least one permanent station.

A special CERGOP Study Group CSG.5 "CERGOP Permanent and Epoch Stations" was up at the CEI CERGOP Working Conference held in Buda-pest in November 1994. Owing to the works of this study group it was possible to recognise the situation as regards the existing and planned permanent GPS stations in the countries participating in the CERGOP project.

The present situation is summarized synthetically in attached tables below. These tables indicate that there are 49 permanent stations in operation in Central Europe (15 stations are IGS stations and 21 stations are involved in the maintenance of the EUREF), and that the next 23 stations are to be established within the next two years. The situation should be assessed as very favorable and satisfactory. However the distribution of these stations is not even: all permanent stations are located on the territory of seven CEI (eight if including Germany) countries (Austria, Bulgaria, the Czech Republic, Hungary, Italy, Poland and Slovakia). Nine CEI countries have not yet established any permanent station.

The updated list (as of July 1997) of operating and planned stations of the IGS (International GPS Service for Geodynamics) GPS Tracking Network [8]. It includes fifteen permanent ope-rating GPS stations in CEI countries (incl. Germany) and two planned stations (one in Ukraine and one in Germany).

Status of permanent GPS stations in CEI countries (incl. Germany) are given in Tables 6 and 7.

NEW POSSIBILITIES OF USING PERMANENT GPS STATIONS IN MODERN GEODYNAMIC RESEARCH

In the considerations presented below we shall take into account only these aspects of geodynamic research that refer to analyses of the changes of point positions. The application of permanent GPS observations in determining and improving the accuracy of the global dynamic parameters and in permanent monitoring of the Earth rotation constitutes a separate set of problems which require a separate discussion.

By the time the satellite technology was introduced, geodynamic research had been based mainly on the analysis of stability of special points of geodetic triangulation and trilateration networks measured by means of classical measurement techniques, including, above all, linear (distancemeter) measurements, precise angular measurements, precise levelling measurements and gravimetric surveys. The frequency of the measurements of such networks depended mainly on the expected displacement values and the accuracy of the measurement techniques. In many cases determination of slight displacements was difficult due to the application of insufficiently accurate observation techniques. In fact the same philosophy was used in the analysis of the determined displacements of points of the local and regional networks as well as in research of a global nature while analyzing movements of continents or tectonic plates. Analysis of stability in the position of points of a geodynamic network was often conducted separately for horizontal (triangulation, trilateration) networks and for vertical ones: "horizontal" and "vertical" displacements were determined.

Another serious difficulty which had to be faced consisted in determining a rational frequency of the network measurements: on the one hand, it was possible to detect secular variations using the most accurate observation techniques available at that time but only after a relatively long period of time. On the other hand, the need to detect unexpected sudden changes called for more frequent measurements. The major shortcoming of this kind procedure was the fact that results obtained from analysis reflected only generalized secular changes and they did not reflect time changes that are periodical in their nature, which are sometimes very important (e.g. in the case of analysis for ares of strong seismic activity).

The dense network of permanent GPS stations which was established over the past few years, and which is still being extended, provides us with new possibilities

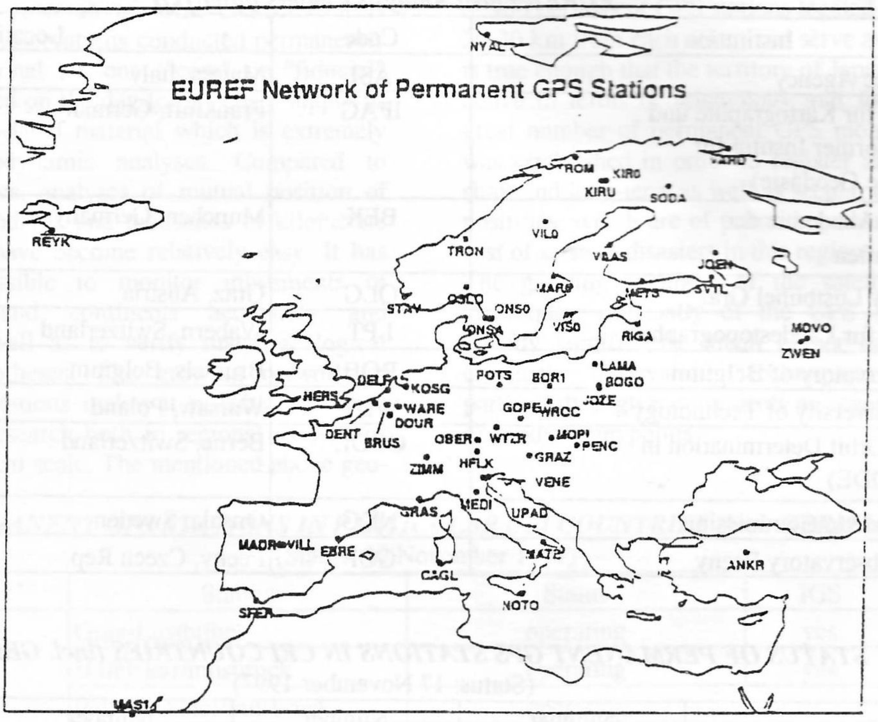

Fig. 2. EUREF permanent GPS network

Table 4.

EUREF Data Centers in Europe (after [2])

Institution	Location	Code	Function
Institut Geographique National	Paris, France	IGN	IGS GDC
Bundesamt fur Kartographie und Geodasie (former Institut fiir Angewandte Geodasie)	Frankfurt, Germany	BKG (IFAG)	IGS RDC
Italian Space Agency	Matera, Italy	ASI	EUREF LDC
Delft University of Technology	Delft, The Netherlands	DUT	EUREF LDC
Onsala Space Observatory	Goteborg, Sweden	OSO	EUREF LDC
Institute of Space Research	Graz, Austria	GRAZ	EUREF LDC
Royal Observatory of Belgium	Brussels, Belgium	ROB	EUREF LDC
Royal Observatory of Belgium	Brussels, Belgium	ROB	EUREF CB

GDC - Global Data Center
RDC - Regional Data Center
LDC - Local Data Center
CB - EUREF Permanent Network Central Bureau

Table 5.

EUREF Local Analysis Centers (after [2])

Institution	Code	Location
Italian Space Agency	ASI	Matera, Italy
Bundesamt fur Kartographie und Geodasie (former Institut fur Angewandte Geodasie)	IFAG	Frankfurt, Germany
Bayerische Akademie der Wissenschaften	BEK	Munchen, Germany
Observatory Lustbuhel Graz	OLG	Graz, Austria
Bundesamt fur Landestopographie	LPT	Wabern, Switzerland
Royal Observatory of Belgium	ROB	Brussels, Belgium
Warsaw University of Technology	WUT	Warsaw, Poland
Center for Orbit Determination in Europe (CODE)	CODE	Berne, Switzerland
Nordic Geodetic Commission	NKG	Onsala, Sweden
Geodetic Observatory Peeny	GOP	Peeny, Czech Rep.

Table 6.

STATUS OF PERMANENT GPS STATIONS IN CEI COUNTRIES (incl. GERMANY)

(Status: 17 November 1997)

Country	Number of operating stations	Number of planned stations	Number of IGS stations	Number Of EUREF Stations
Albania			—	—
Austria	8	8	2	3
Belarus	—			
Bosnia &Herzegovina	—	—		—
Bulgaria	1	—	—	1
Croatia		1	--	—
the Czech Republic	1	—	1	1
Germany	10	7	3	3
Hungary	1		1	1
Italy	15	4	5	6
Macedonia	--		--	
Moldova	—		—	
Poland	12	2	3	5
Romania	—	—	—	—
Slovakia	1	—	—	1
Slovenia	—	—	—	—
Ukraine	—	1	—	—
Total	49	23	15	21

as regards geodynamic research, not only global and regional but also research of local character. It is evident that GPS observations conducted permanently at many international stations ("core" or "fiducial" ones) and processed on the day-to-day basis supply us with currently up-dated material which is extremely valuable for geodynamic analyses. Compared to classical techniques, analyses of mutual position of points located hundreds and thousands of kilometers from each other have become relatively easy. It has also become possible to monitor movements of tectonic units and continents accurately and permanently as well as to verify many geological geodynamic hypotheses. The growing network of permanent GPS stations makes it possible for us to conduct similar research both in regional as well as sometimes in a local scale. The mentioned above geodynamic network established in Japan, which consists of 900 permanent GPS stations located at a distance of 20-30 km from each other, can serve as an example. It is true enough that the territory of Japan is particularly active in terms of seismology and for this reason a great number of permanent GPS monitoring stations was established in order to register and monitor any short and long-term as well as secular changes in their positions, which are of prime importance to the forecast of seismic disasters in this region.

The growing accuracy of the satellite observation techniques, especially of the GPS ones, which is already significantly much higher than that of the classical observation techniques, lays down particularly high requirements as regards stabilization of geodynamic points.

Table 7.

PERMANENT GPS STATIONS IN PARTICULAR CEI COUNTRIES (incl. GERMANY)

(Status: 10 November 1997)

Country	Station	Status	IGS	EUREF
Austria	Graz-Lustbilhel	operating	yes	Yes
	Hafelekar/innsbruck	operating	yes	Yes
	Patscherkofel/innsbruck	operating		
	Reisseck	operating		
	Wien	operating		
	St. Polten	operating		
	Linz	operating		
	Waidbofen	planned		
	Pinkafeld	planned		
	Salzburg	planned		
	Sonnenberg	planned		
	Hauser Kaibling	planned		
	Klagenfurt	planned		
	Otz	planned		
	Lienz	planned		
	Pfander/Bregenz	operating	no	yes
Bulgaria	Sofia	operating	...	yes
Croatia	Zagreb	planned	—	—
the Czech Republic	Pecny/Ondrejov	operating	yes	yes
Germany	Wettzell/Koetzling	operating	yes	yes
	Potsdam	operating	yes	yes
	Oberpfaffenhofen	operating	yes	yes
	Darmstadt	planned		
	Karlsruhe	operating		
	Kloppenheim	operating		
	Leipzig	operating		

Country	Station	Status	IGS	EUREF
Germany	Aurich	operating		
	Euskirchen	planned		
	Helgoland	planned		
	Osnabriick	operating		
	Hohenbiinsdorf	operating		
	Kiel	operating		
	Greifswald	planned		
	Dresden	planned		
	Gotha	planned		
	Eriangen	planned		
Hungary	Penc	operating	yes	yes
Italy	Padova	operating	yes	yes
	Matera	operating	yes	yes
	Medicina	operating	yes	yes
	Noto	operating	yes	yes
	Cagliari	operating	yes	yes
	Trento	operating	no	no
	Venezia	operating	no	yes
	Potenza	operating	no	no
	Bolzano	operating	no	no
	Torino	operating	no	no
	Roma	operating	no	no
	Basovizza (Trieste)	operating	no	no
	Perugia	operating	no	no
	Foggia	operating	no	no
	Cosenza	operating	no	no
	Genova	planned		
	L'Aquila	planned		
	Maratea	planned		
	Lampedusa	planned		
Poland	Jozefoslaw	operating	yes	yes
	Borowiec	operating	yes	yes
	Lamkowko (Oisztyn)	operating	yes	yes
	Borowa Gora	operating	no	yes
	Wroclaw	operating	no	yes
	Dziwnow	operating	no	no
	Rozewie	operating	no	no
	Szczecin (DRAGMOR)	operating	no	no
	Krakow (HORYZONT)	operating	no	no
	Katowice (HORYZONT)	operating	no	no
	Wroclaw (HORYZONT)	operating	no	no
	Warszawa (CBK)	operating	no	no

Country	Station	Status	IGS	EUREF
	Grybow	planned		
	Suwaiki	planned		
Slovakia	Modra Piesky	operating	no	yes
Ukraine	Simeiz	planned		
Albania	—	—	—	—
Albania	—	—	—	—
Belarus	—	—	—	—
Bosnia&Herzegovina	—	—	—	—
Macedonia	—	—	—	—
Moldova	—	—	—	—
Romania	—	—	—	—
Slovenia	—	—	—	—

It appears to be necessary that we should not only consider unambiguous submillimetre centering of antennas of satellite receivers and take account of many other factors that affect the accuracy and univocal nature of observations (e.g. examination of the ground water level, periodical variations in gravity values, atmospheric effects, etc.), but there is also a growing need to use deep stabilization of points that are of prime importance. This stabilization is not a stabilization just "below the ground freezing level", it is a stabilization based on poles - foundations that are approximately 25-30 metres deep. It had been found out that the 30 m deep subsurface ground layer is subject to periodical displacements depending on the time of the day, the season of the year, the humidity level, etc. The aforementioned phenomena can be investigated only by using permanent observations conducted at a geodynamic station.

There is one more issue that needs discussing in our considerations on geodynamic analysis, namely the question of using traditional techniques along with modern (satellite) observation techniques. It is obvious that when fast, more precise and extremely economical satellite measurement technology came into use, triangulation methods (with angular and linear measurements) almost completely ceased to be used and also linear measurements have been significantly limited since that time. Also the role which should be played by precise levelling in modern geodynamic research requires a special discussion. Precise levelling used to be one of the basic observation techniques in traditional geodynamic research. As confirmed by research performed by e.g. the British school from Nottingham, it appears that determination of heights between points located at significant distances by means of precise levelling is not so accurate; when the distances between points are equal to hundreds of kilometres better results can be obtained today by using satellite and space methods (SLR, VLBI or even GPS levelling). This is related to the need of determining the so-called "centimetre" geoid. The conclusion to be drawn from the above is that precise levelling can and should be still used today in investigations of displacements and movements in local networks within an area limited to several score kilometres.

CONCLUSIONS

The following conclusions can be drawn from what has been said above:

1.The function of the classical geodynamic networks should be taken over by permanent GPS stations, at which permanent GPS observations are carried out and subject to currently up-to date processing and analysis.

2.Up-to-date analysis of permanent GPS observations helps to detect and monitor both secular and short- and long-term phenomena occurring at the station.

3.The high accuracy of modern observation techniques allows us to examine individual phenomena (components) and not only their summary combined impact.

4.The purposefulness of conducting measurements by classical measurement techniques should be subject to special careful considerations. This refers particularly to linear measurements by means of distancemeters and to precise levelling measurements. These can be used in local geodynamic networks of a limited size.

5. Today, in the face of the fact that precise GPS

Table 8.

CONTRIBUTION OF CEI COUNTRIES (incl GERMANY) TO IGS AND EUREF

(status: 10 November 1997)

Number of all operating permanent GPS stations	49
Number of planned permanent GPS stations	23
Contribution to IGS (Number of stations)	15
Contribution to EUREF (Number of stations)	21
Number of CEI countries with operating permanent GPS stations	7
Number of CEI countries with no permanent GPS stations	9

technologies are commonly accessible and easy to use, the establishment of so-called "national" geodynamic networks of a classical type seems to be unjustified both from the scientific and economic viewpoints. The function of the geodynamic networks should be taken over by permanent GPS stations located in properly selected areas. However, it is purposeful to maintain local geodynamic test networks, but these networks should be connected to the networks of permanent GPS stations and periodically controlled.

6. For economic reasons, it is advisable that permanent GPS stations should also constitute at the same time a network of permanent reference stations of the national DGPS navigation system emitting differential corrections for the land, air and marine users and various economic services of the country.

7. Taking into account what has been said before it is to be stressed that in the scientific programme CERGOP-2 the permanent GPS sites should be considered as main stations of the Extended Central European GPS Reference Network ECEGRN. This reference network can be regarded as subnetwork of IGS and/or EUREF. Extensive observation data collected at these stations should be carefully processed and analysed within the scientific programme of CERGOP-2.

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Я.Слєдзінські

ПЕРМАНЕНТНІ GPS СТАНЦІЇ – ОСНОВА ДЛЯ ГЕОДИНАМІЧНИХ ДОСЛІДЖЕНЬ І ПІДТРИМУВАННЯ ГЕОДЕЗИЧНИХ СИСТЕМ КООРДИНАТ

Резюме

Обговорюється нова роль перманентних GPS станцій в геодинамічних дослідженнях і створенні геодезичних мереж. Приводиться сучасний стан перманентних GPS станцій в країнах Центральної Європи, а також перелік запланованих перманентних станцій для роботи в рамках програм IGS і підтримування Європейської референцної системи EUREF. Дається загальний опис організації служб IGS і EUREF.

Я.Следзински

ПЕРМАНЕНТНЫЕ GPS СТАНЦИИ – ОСНОВА ДЛЯ ГЕОДИНАМИЧЕСКИХ ИССЛЕДОВАНИЙ И ПОДДЕРЖАНИЯ ГЕОДЕЗИЧЕСКИХ СИСТЕМ КООРДИНАТ

Резюме

Обсуждается новая роль перманентных GPS станций в геодинамических исследованиях и создании геодезических сетей. Приводится современное состояние перманентных GPS станций в странах Центральной Европы, а также перечень планируемых перманентных станций для работы в рамках программ IGS и поддержания Европейской референцной системы EUREF. Дается общее описание организации служб IGS и EUREF.