



**TURKISH NATIONAL UNION
OF GEODESY AND
GEOPHYSICS**



**2011 – 2015 TERM REPORT
OF
TURKISH NATIONAL GEODESY COMMISSION**

**GENERAL COMMAND OF MAPPING
ANKARA
2015**

Turkish National Geodesy Commission

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1. Introduction

Directing and promoting the scientific studies in the field of Geodesy, ensuring cooperation and communication among its members, organizing scientific meetings and following international developments and consequently representing Turkey; could be listed among the activities of Turkish National Geodesy Commission (TNGC).

Geodesy has not taken its place which it deserved in earth sciences yet and it is left in the area of interest of geology and geophysics. Science aims discovering nature and explaining natural events. Scientific information and products are adapted and promoted as long as they are about explaining natural events and facilitating the social life. For this reason; it is considered that the Turkish scientists of geodesy; along with their solely scientific aims, ought to take place in the studies which will support the social life and also do their best to avail geodesy take its respectful position among geological sciences.

Along with the social requirements came into place after the destructive earthquakes of Düzce and Gölcük, happened in 1999 in Turkey and the recorded scientific and technological developments, the regulation of Turkish National Geodesy and Geophysics Association was changed. One of the major changes in the regulation is, creating opportunities to sponsor the projects which will be focused on earth sciences.

It has become inevitable to make fundamental changes in the structure and function of TNGC parallel with national requirements and international developments. In the studies which were resulted as re-establishing TNGC the following criteria were initiated;

- a. Ensuring a participating managerial structure for TNGC,
- b. Make it active in national and international levels,
- c. To participate in studies for determining the institutions sponsoring research projects (TNGGU, TUBITAK, DPT, MINISTRIES etc.) in our country to sponsor geodetic projects,
- d. To develop geodetic joint projects and programs,
- e. Helping, obtaining data from national and international centres to be used in the projects.
- f. To encourage its members to publish qualified works in the international scientific journals.
- g. To encourage Turkish scientists of geodesy to be organized in national levels, to take place in activities and producing joint projects.
- h. To ensure the communication among the members of TNGC.
- i. To ensure the information change among the members of TNGC by organizing scientific meetings.

In TNGC's structure; an executive committee, authorized and functioned to implement all sort of organising about the activities of TNGC, a centre office which will be responsible for application of decisions of the executive committee, a candidate determining commission for determining the candidates to take place in the examination for the personnel who will be employed in the organs of TNGC, were established. Additionally; TNGC working groups (WG) are compatible with those of IAG as reference coordinate systems (WG1), Gravity Field (WG2), Earth Rotation and Geodynamics (WG3) and Positioning and Applications (WG4). TNGC has also been organizing annual scientific meetings since 2002.

It is necessary for TNGC to take the appropriate steps and to produce applicable projects along with the National Earthquake Program, which was introduced in the scope of the

changes made in the structure of TNGGU. The earthquakes and the geodynamic events are the most destructive and deforming events for geodetic networks along with their important social consequences. As our country is a natural laboratory for the studies on the crust of earth movements; after the earthquakes whose magnitudes are $M_w \geq 6$, the basic Geodetic networks should be upgraded and the geodetic methods should be used for modelling and interpreting the movements of the crust of the earthquake along with determining the area of velocity. The three methods that are used in geodynamic researches are; Geodesy, Geology and Seismology and in particular taking into account that the geodetic methods are one of the indispensable and essential methods for verification of the researches, the joint earth science projects should be used constructed.

The public institutions and foundations, private sector and the universities are the three major elements of mapping so of Geodesy. Producing everything that the country requires, the geodetic contributions for solving the problems of earth sciences, education, contribution to the development of the universal science and technology, competitive and profitable production, application and development of new competences, study for taking place among the worlds scientists of geodesy and ensuring the resources of the country to be used effectively are representing the major aims and their subdivisions of those three major elements of Geodesy. Expanding the cooperation and cooperation opportunities among the private sector, public institutions and the universities; should be one of the major aims of TNGC. For attaining this goal; producing and applying original projects including country requirements should be seen as the basic solution.

2. Turkish National Geodesy Programme

The long-running studies for forming a national geodesy programme have come to an end in 2015. Turkish National Geodesy Programme has been constituted, and will come into operation after the approval of Executive Committee of Turkish National Geodesy Commission in the annual scientific meeting in 2015.

The purposes of the programme are; to evaluate the situation of the geodetic studies performed in our country so far, to associate them with the global studies and hereby to carry out a requirement analysis, and to suggest studies to meet these requirements. Since the programme introduces the national priorities and needs, it is anticipated that it can be used as a reference document in project applications to funding organizations. Contents of the programme are given below:

1. **PURPOSE**
2. **INTRODUCTION**
- 2.1. General
- 2.2. International Union of Geodesy and Geophysiscs (IUGG) and Turkish National Union of Geodesy and Geophysics (TNUGG)
- 2.3. International Association of Geodesy-IAG
3. **NATIONAL GEODETIC OBSERVATION SYSTEMS AND EVALUATION STUDIES**
- 3.1. Existing Situation
- 3.2. Turkish National Reference Frame
- 3.3. Datum Transformation Studies
- 3.4. Monitoring the Deformation in Geodetic Networks
- 3.5. National Geoid Determination Studies
- 3.6. Current Studies and Projection of Future Studies
- 3.6.1. Deformation of Geodetic Networks
- 3.6.2. Turkish National Fundamental GPS Network
- 3.6.3. Turkish National Permanent Stations Network
- 3.6.4. Marmara Permanent GPS Network
- 3.6.5. Turkish National Permanent Stations Network-Active (TNPGN-Active)
- 3.6.6. Turkish National Sea Level Monitoring System
- 3.6.7. Modernization of Turkish National Height System
- 3.6.8. Monitoring the Gravity Changes
4. **NATIONAL GEODESY AND EXPECTATIONS**
- 4.1. GPS/GNSS Analysis Centre
- 4.2. Development of a web-based GPS/GNSS Analysis Software
- 4.3. Development of a GPS/GNSS Analysis Software
- 4.4. Densification of TNPGN-Active
5. **IMPORTANCE AND PRIORITIES OF FUTURE GEODETICAL STUDIES**
6. **RESULTS**
7. **REFERENCES**

3. Administrative Structure

Turkish National Geodesy Commission (TNGC) acts as one of the sub commissions of Turkish National Union of Geodesy and Geophysics (TNUGG). TNGC activities are carried with respect to TNUGG statutes and TNGC By-Laws.

TNGC Central Bureau

TNGC President
TNGC University Representative
TNGC Secretary

TNGC Executive Committee

TNGC President
TNGC University Representative
TNGC Secretary
TNGC President (past)
TNGC University Representative (past)
Study Group (I) President
Study Group (II) President
Study Group (III) President
Study Group (IV) President
ASCE Representative
TÜBİTAK (The Scientific and Technical Research Council of Turkey) Representative

Working Groups

With the new TNGC By-laws, four Working Groups were constituted according to the present commissions in IAG and national requirements. Also it is possible to constitute Sub Study Groups under the Working Groups.

TNGC Working Groups

Working Group I : Reference Coordinate Systems
Working Group II : Earth Rotation and Geodynamics
Working Group III : Gravity Field
Working Group IV : Point Positioning and Applications

Nominating Committee

Three members of Nominating Committee are selected by TNGC Executive Committee, determined the President and Secretary candidates of Working Groups. On the other hand, Nominating Committee executes its duty for the other subjects determined by TNGC Executive Committee.

4. Working Group Activities of The Commission

There are four working groups that are voluntarily working under Turkish National Geodesy Commission. In this section of the report the reader might obtain information about their activities.

a. Reference Coordinate Systems Working Group

(1) Turkish National Fundamental GPS Network (TNFGN)

TNFGN is the first fundamental geodetic network based on GPS technology in the country. The network consists of about 600 sites (see Fig. 4.1) established through campaign type GPS surveys between 1997 and 1999. Some of the stations were re-surveyed due to the destructive earthquakes after mid-1999. For each station, 3D geocentric coordinates and their associated errors and velocities have been computed in ITRF2008 and transformed into ITRF-96, which is the initial reference frame adopted for TNFGN. Positional accuracies of the stations are about 1-3 cm and the relative accuracies are within the range of 0.1 - 0.01 ppm. The network has been connected to the former horizontal reference network through overlapping sites in order to estimate the transformation parameters between ED-50 and WGS84 systems. Time-dependent coordinates of all stations have been computed in the context of the maintenance of the network with repeated GPS observations.

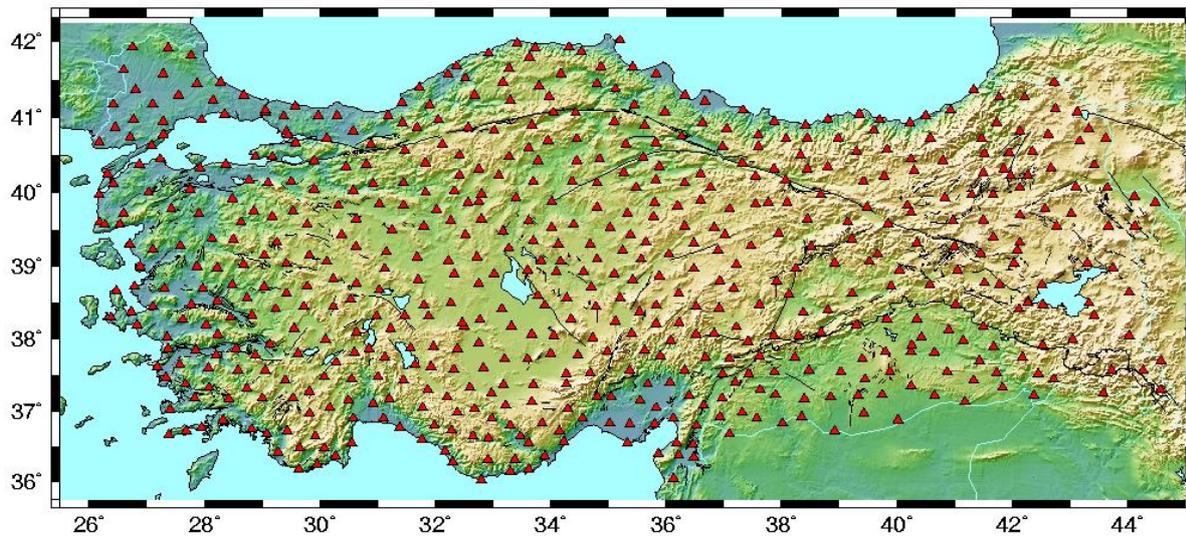


Figure 4.1 Distribution of TNFGN stations

(2) Turkish National Permanent GPS Network and Turkish National Permanent RTK Network (TNPGN and TNPGN-Active)

TNPGN is the permanent GNSS network consisting of 20 stations (see Fig. 4.2) established particularly to serve as a realization of ITRF-96 in Turkey which is adopted as the Turkish reference frame. In this network, ANKR (Ankara) GNSS station continues to send its hourly and daily data to IGS and EPN while no real-time data streaming at the moment. Also ISTA GPS (Istanbul Technical University) and TUBI GPS (TUBITAK Marmara Research Center) are operational as well. TNPGN-Active, contrary to TNPGN, is a web based RTK network consisting of 146 sites (see Fig. 4.2) to serve real-time positioning information for the variety of applications such as mapping, GIS and cadastral applications. System operations and

computations of coordinate correction parameters are being held in control centers located in General Command of Mapping and General Directorate of Land Registry and Cadastre in Ankara. GNSS data collected at all stations are transferred to the control center via ADSL, GPRS/EDGE and correction parameters are transferred to the users in the field after computation in the center. RTK correction parameters which are in current RTCM and CMR+ formats are transferred to the rovers via GPRS and NTRIP (For VRS; CMR+ and RTCM3.1, for SAPOS FKP; RTCM 2.3, for MAC; RTCM 3.1Net and for DGPS; RTCM 2.1).

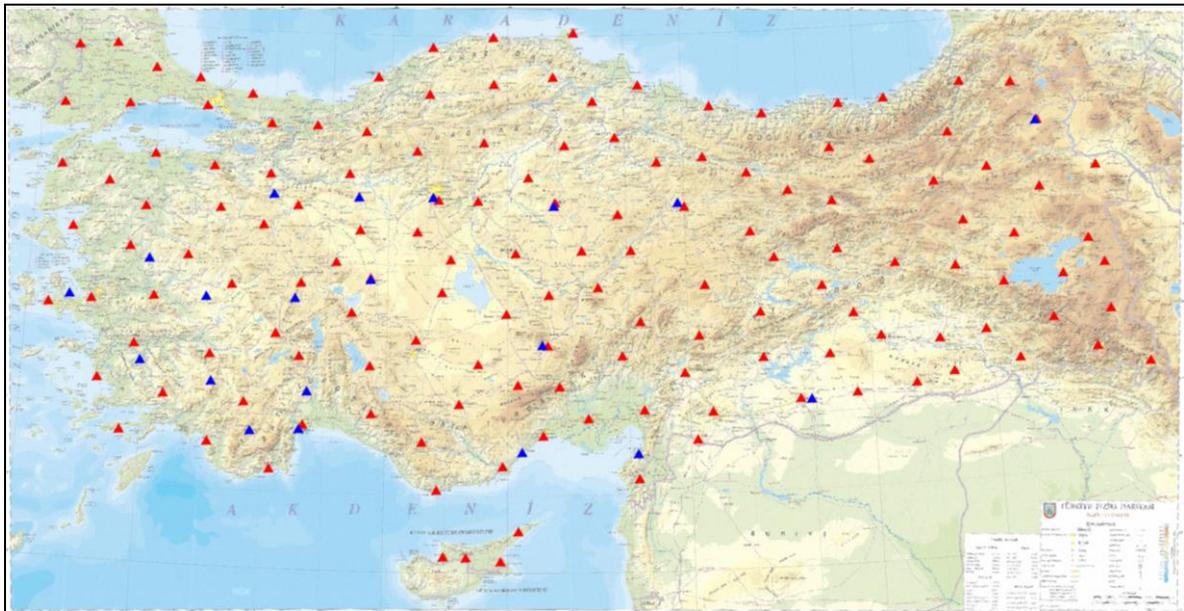


Figure 4.2 Distribution of stations. Red triangles: TUSAGA, blue triangles: TUSAGA-Active.

Data collected at continuous stations are processed via GAMIT/GLOBK V10.5 software on a daily basis and coordinate time series are created. Since its installation in late 2008, more than 6 years of static data have been collected in TUSAGA-Active network up to now. Permanent stations are also contributing to regional ionosphere modeling, GNSS meteorology, and tectonic studies.

In terms of ionosphere modeling, a group of researchers of various disciplines from General Command of Mapping, Hacettepe University and Bilkent University Department of Electrical and Electronics Engineering got together and constituted IONOLAB (www.ionolab.org). IONOLAB group estimates Total Electron Content (TEC), interpolate (mapping) TEC regionally, makes statistical analysis of TEC and investigates lithosphere-ionosphere relation through seismic activity by using TUSAGA-Active stations. Thus, monitoring of ionosphere with a dense, homogeneous GNSS network provides important possibilities in characterization and modeling of electron density and TEC.

(3) Turkish National Vertical Control Network (TNVCN)

Levelling studies in Turkey started with the establishment of Antalya tide gauge station in June 1935. Following a long time interruption after 1936, the works resumed in 1944 and the vertical control network was physically established based on the first phase spirit levelling

measurements till 1970 carried out along the main and collateral roads and even along the railroads throughout the country. Since the studies on the gravity network begun in 1956, no gravity measurement was made at vertical control benchmarks until 1970.

The second phase measurements of the network including gravity were commenced in 1973 in order to renew the existing lines destructed due to infrastructure works and to establish new lines in necessary places. After the re-adjustment of most recent levelling observations of the first and second period campaigns in 1999, Turkish National Vertical Control Network-1999 (TNVCN-99) has been devised, consisting of 243 lines and 25680 benchmarks with 29316 km long (see Fig. 4.3). The datum of the network is based on the sea level records of Antalya tide gauge averaged between 1936 and 1971.

The benchmarks of the network are inevitably exposed to destruction due to the road enlargement and urban construction activities. While the ratio of destruction is about 49% between 2000 and 2006, it is now estimated to reach up to 63% based on the results of the reconnaissance surveys at 9000 benchmarks in 2011.

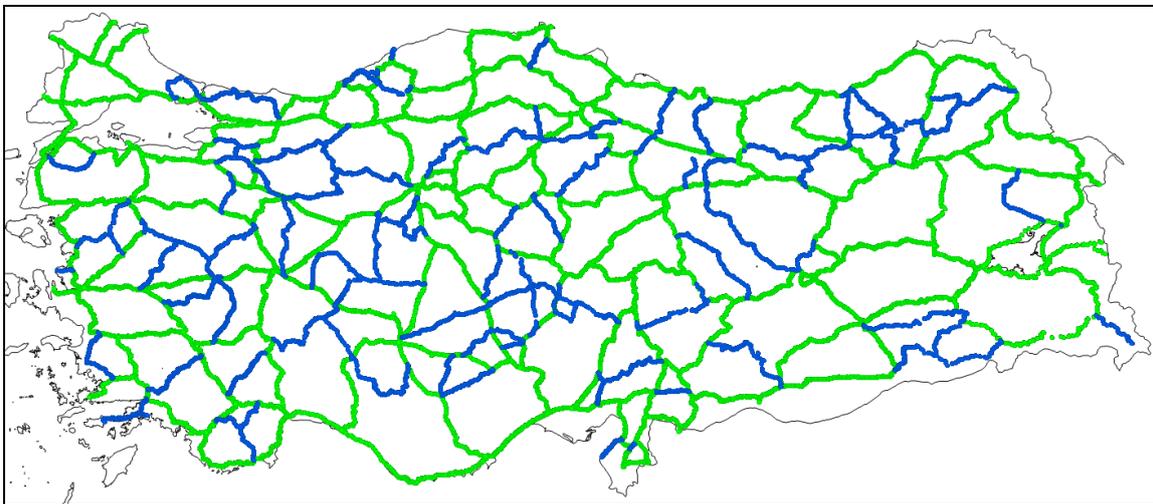


Figure 4.3 Turkish Vertical Control Network. Green lines: first order, blue lines: second order network.

(4) Turkish Sea Level Monitoring System (TSLMS)

Many coastal countries deploy and operate tide gauges along their coasts to meet sea level related practical and scientific needs. Tide gauges in Turkey are established and operated by General Command of Mapping in order to determine the tidal datums including mean sea level and meet the sea level data needs of scientific and engineering communities. Sea level observations have been carried out by float operated gauges till 1998, since then the gauges have been upgraded and changed with acoustic ones with sounding tubes and Turkish National Sea Level Monitoring Network has been established. At present TSLMS consists of one data center and 20 tide gauge stations shown in Figure 4.4.

Sea level and other ancillary meteorological parameters are collected at stations and stored in data loggers every 15 minutes and then transmitted to data center via GPRS. Quality control and the data analysis operations are performed at the data center in Ankara.

Since the tide gauges measure sea level relative to land upon which they are located, observed sea level contains true sea level along with any vertical land movement signal. Periodic

geodetic measurements such as GPS, continuous GPS, and precise levelling are carried out at all TSLMS tide gauges at 1-2 years interval to separate vertical land movements from true sea level and to monitor absolute sea level relative to earth center.

Besides geodetic objectives, these stations are also contributing to regional oceanography, meteorology and tsunami early warning center.

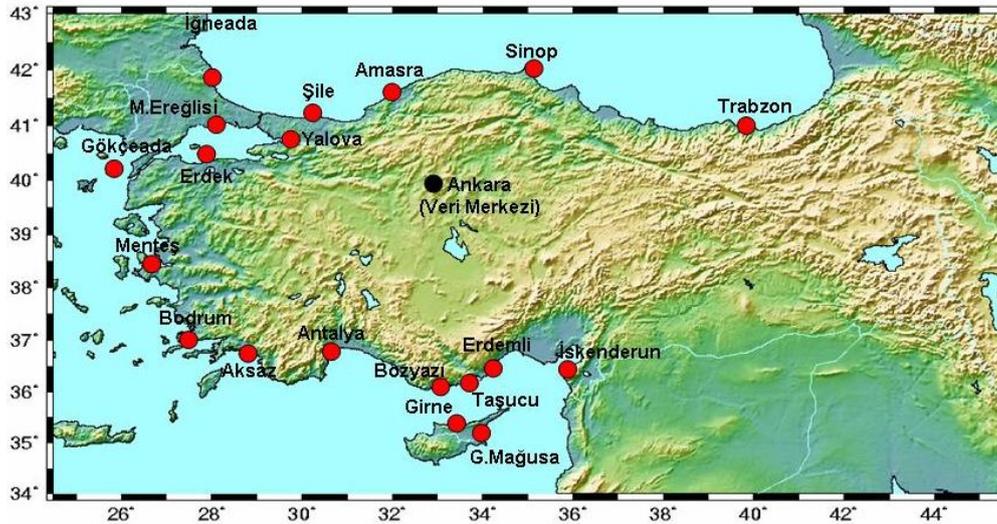


Figure 4.4. Locations of the existing tide gauge stations of TSLMS.

(5) Papers, Presentations, Posters, Master and PhD Thesis, Projects and Technical Reports, Other Activities

Papers in International/National Journals

Papers in International Journals

Altuntas C., Karabork H., Tusat E. (2014) “**Georeferencing of ground-based LIDAR data using continuously operating reference stations**”. *Optical Engineering* 53(11), 114110.

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Raposo-Pulido V., Nilsson T., Karbon M., Soja B., Heinkelmann R., Tanir Kayikci E., Lu C., Mora-Diaz J., Schuh H. (2014) “**Impact of celestial datum definition on EOP estimation and CRF orientation in the global VLBI session IYA09**”. 143 of the IAG Symposia Series, Editor Chris Rizos, Assistant Editor-in-Chief Pascal Willis, 2015 (paper accepted for publication).

Çakır L., Yılmaz N. (2014) “**Polynomials, radial basis functions and multilayer perceptron neural network methods in local geoid determination with GPS/levelling**”. *Measurement (SCI-E)*, ISSN 0263-2241, Volume 57, November, 148-153. DOI: 10.1016/j.measurement.2014.08.003.

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Tanır Kayıkçı E., Yalçınkaya M. (2012) "**Determination of Horizontal Movements by Static Deformation Models: A Case Study on the Mining Area**". Experimental Techniques, ISSN: 1747-1567, Wiley, DOI:10.1111/j.1747-1567.2012.00869.x.

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Ulukavak M., Yalçınkaya M. (2014) “**Deprem Kaynaklı Toplam Elektron İçeriği Değişimlerinin Araştırılması: Ege Denizi Depremi (24.05.2014 Mw:6.5)**”. Harita Teknolojileri Elektronik Dergisi Cilt: 6, No: 3, 2014 (10-21).

Ulukavak M., Yalçınkaya M. (2014) “**Toplam Elektron İçeriği (TEC) Değerleri ve Deprem İlişkisinin İncelenmesi**”. Gümüşhane Üniversitesi Fen Bilimleri Enstitüsü Dergisi, Cilt 4 Sayı 1, 107-116.

Yıldırım F., Kaya A., Kaplan Y. (2011) “**Jeodezik Dik ve Coğrafi Koordinat Dönüşüm Yöntemlerinin Karşılaştırılması**”. Harita Dergisi, Sayı:146, s. 1–7.

Presentation in International/National Symposium

Presentations/Poster in International Symposiums

Ulukavak M., Yalçınkaya M., Zengin Kazancı S., Tanır Kayıkçı E. (2015) “**Investigation of Total Electron Content Variations Before the Aegean Sea Earthquake (24.05.2014 Mw 6.9)**”. 26th General Assembly of the International Union of Geodesy and Geophysics (IUGG), June 22- July 2, 2015, Prague, Czech Republic.

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Zengin Kazancı S., Tanır Kayıkçı E., Ulukavak M., Yalçınkaya M. (2015) “**Investigation For Spatial and Temporal Variations of Daily Mean Temperatures of Black Sea Region, Turkey**”. 26th General Assembly of the International Union of Geodesy and Geophysics (IUGG), June 22- July 2, 2015, Prague, Czech Republic.

Karaaslan Ö., Tanır Kayıkçı E. (2015) “**Determining The GPS/Levelling Geoid Undulations By Interpolation Methods And Artificial Neural Networks Method For Region of Trabzon, Turkey**”. 26th General Assembly of the International Union of Geodesy and Geophysics (IUGG), June 22- July 2, 2015, Prague, Czech Republic.

Tornatore V., Tanır Kayıkçı E. (2015) “**Comparison of VLBI and DORIS solutions in view of ITRF2014**”. 22nd European VLBI for Geodesy and Astrometry (EVGA) Working Meeting, at Sao Miguel (Azores), May 17-21, 2015.

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Teke K., Böhm J., Kwak Y., Madzak M., Steigenberger P. (13-17 October 2014) “**GNSS slant delays in the analysis of VLBI Intensive sessions**”. IAG Commission 1 Symposium 2014, Reference Frames for Applications in Geosciences, Kirchberg, Luxembourg.

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Tanır Kayıkçı E. (2014) “**Proposal from Department of Geomatics Engineering at KTU (Turkey) and its Vision in COST ES1206 Umbrella**”. 1st ES1206 GNSS4SWEC Workshop, February 26 - 28, 2014, Munich, Germany.

Raposo-Pulido V., Heinkelmann R., Nilsson T., Karbon M., Soja B., Tanir Kayikci E., Lu C., Mora-Diaz J., Schuh H., Gomez-Gonzalez J. (2014) “**Effects Of The Datum Configuration of Radio Sources On EOP Determined by VLBI**”. The Journées 2013 - Systèmes de référence spatio-temporels, September 16-18, 2013 Paris, France.

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Raposo-Pulido V., Nilsson T., Karbon M., Soja B., Heinkelmann R., Tanir Kayikci E., Lu C., Mora-Diaz J., Schuh H. (2013) “**Effect of the configuration of radio sources on EOP**”. IAG Scientific Assembly 2013, September 1-6, 2013, Potsdam, Germany.

Teke K., Böhm J. (9-10 September 2013) “**Vie_LSM and Vie_LSM_scan (Version 2.1)**”. Fourth VieVS User Workshop, Department of Geodesy and Geoinformation, IVS Special Analysis Center, Vienna University of Technology, Vienna, Austria.

Teke K., Nilsson T., Böhm J., Steigenberger P., Haas R., Hobiger T., Willis P. (3-7 December 2012) “**Zenith troposphere delays and gradients from VLBI, GNSS, DORIS, water vapor radiometer, and numerical weather models during continuous VLBI campaigns**”. 2012 AGU Fall Meeting, USA, Poster: G11A-0909.

Böhm J., Teke K., Willis P. (25-26 September, 2012) “**Tropospheric parameters from DORIS in comparison to other techniques during CONT campaigns**”. International DORIS Service Workshop, Venice, Italy.

Willis P., Bock O., Bar-Sever Y., Teke K. (31 May – 1 June, 2012) “**DORIS Zenith Tropospheric Delays available from the IGN Analysis Center**”. DORIS Analysis Working Group meeting (AWG) of the International DORIS Service, Prague, Czech Republic.

Teke K., Böhm J. (14-16 September 2011) “**VIE_LSM**”. Second VieVS User Workshop, Institute of Geodesy and Geophysics, IVS Special Analysis Center, Vienna University of Technology, Vienna, Austria.

Presentations/Poster in National Symposiums

Tanır Kayıkçı E., Karaaslan Ö. (2015) “**Trabzon İli İçin Jeoid Ondülasyonları Belirleme Amacıyla Enterpolasyon Yöntemlerinin Uygulanması**”. 15. Harita Bilimsel ve Teknik Kurultayı, 24-28 Mart 2015, Ankara.

Zengin Kazancı S., Tanır Kayıkçı E. (2015) “**Konumsal Enterpolasyon Yöntemleri Uygulamalarında Optimum Parametre Seçimi: Doğu Karadeniz Bölgesi Günlük Ortalama Sıcaklık Verileri Örneği**”. 15. Harita Bilimsel ve Teknik Kurultayı, 24-28 Mart 2015, Ankara.

Ulukavak M., Yalçınkaya M. (2014) “**Deprem Kaynaklı Toplam Elektron İçeriği Değişimlerinin Araştırılması: Ege Denizi Depremi (24.05.2014 MW:6.5)**”, 7. Ulusal Mühendislik Ölçmeleri sempozyumu, 15-17 Ekim, Çorum.

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Tanır Kayıkı, E., Teke, K. (2012) "**KTU-GEOD IVS Analysis Center Annual Report 2011**", International VLBI Service for Geodesy and Astrometry 2011 Annual Report, edited by K. D. Baver and D. Behrend, NASA/TP-2012-217505, 2012. <http://ivscc.gsfc.nasa.gov/publications/ar2011/acktu/>

Other Activities on International Level

KTU-GEOD IVS Analysis Center (*Reponsible Persons: Emine Tanır Kayıkı-KTU, Kamil Teke-Hacettepe Uni.*)

The proposal of Karadeniz Technical University (KTU) to become an International VLBI Service for Geodesy and Astrometry Analysis Center (IVS AC) was accepted on March 23,

2009 in a Directing Board meeting during the 19th European VLBI for Geodesy and Astrometry Working Meeting held in Bordeaux, France. Following the approval of being an IVS AC. KTU-GEOD IVS AC has used VieVS (Vienna VLBI Software), which is distributed with its open source code based on MATLAB. We are anticipating the release of a geodetic parameter combination module of VieVS. Main tasks of KTU GEOD AC tasks are to analyze VLBI sessions with different parameterizations, focusing on the European VLBI Network (EVN), to study different stochastic models by means of comparing geodetic estimates derived from the analysis of VLBI sessions and from other space geodetic techniques (see papers at *Scientific Technical Reports*)

Analysis Center For Near Real-Time GNSS Troposphere Monitoring In Turkey within COST Action ES1206, (Reponsible Person: Emine Tanır Kayıkçı-KTU)

One of the main goals of the WG1 “Advanced GNSS processing techniques” of the GNSS4SWEC Project (COST Action Es1206) is the transfer of knowledge, tools, and data exchange in support of new analysis centers and new networks. Dr. E. Tanır Kayıkçı suggested to set up a new processing center for all available national stations in Turkey and asked for support within the COST Action during 1st ES1206 GNSS4SWEC Workshop, February 26 - 28, 2014, Munich, Germany. Therefore, new analysis center was set up in Karadeniz Technical University for near real-time GNSS troposphere monitoring in support of numerical weather forecasting within a short-term scientific mission by Dr. Jan Douša at Geodetic Observatory Pečny (GOP) of the Research Institute of Geodesy, Topography and Cartography (RIGTC) in September 2014. New network with Turkish national permanent GNSS stations will significantly improve the coverage of near real-time tropospheric products in Europe and national processing center is an optimal way for access to all such data.

TRAB Permanent GNSS Station at KTU (Responsible Person: Emine Tanır Kayıkçı-KTU)

As a Geodesy division of KTU Geomatics Engineering department, TRAB permanent GNSS station (was operated in both EUREF Permanent Network (EPN) and IGS network between 1999-2007 and in-active since 2007) support the operation of TRAB permanent station with our university budget to contribute increasing IGS and so EUREF station densities in Turkey. So, TRAB station has operated actively with new receiver at site since February 2015. In near future, we are wishing to be included in EPN and join also IGS network

b. Gravity Field Working Group

(1) Gravity Network (TNGN-99)

The fundamental gravity network (TNGN-99), consisting of 68 stations together with a calibration baseline with more than 200 mgal gravity range, has been established between 1993 and 1999 (see Fig. 4.5). 13 of these stations were observed with FG5 (101) absolute gravimeter of German Federal Agency for Cartography and Geodesy (BKG). 132 gravity connections between stations were measured, in so called go-back way, by two LaCoste & Romberg gravimeters (G-347, G-379). Gravimeter readings were converted to gravity values using manufacturer calibration values, and then tidal corrections were applied.

The daily measurements of each gravimeter were adjusted individually and corrected for instrumental drift. All reduced measurements were then adjusted by least squares taking into account the absolute gravity values. The adjustment resulted in standard deviations of gravity points between $\pm 4\text{-}9 \mu\text{Gal}$.

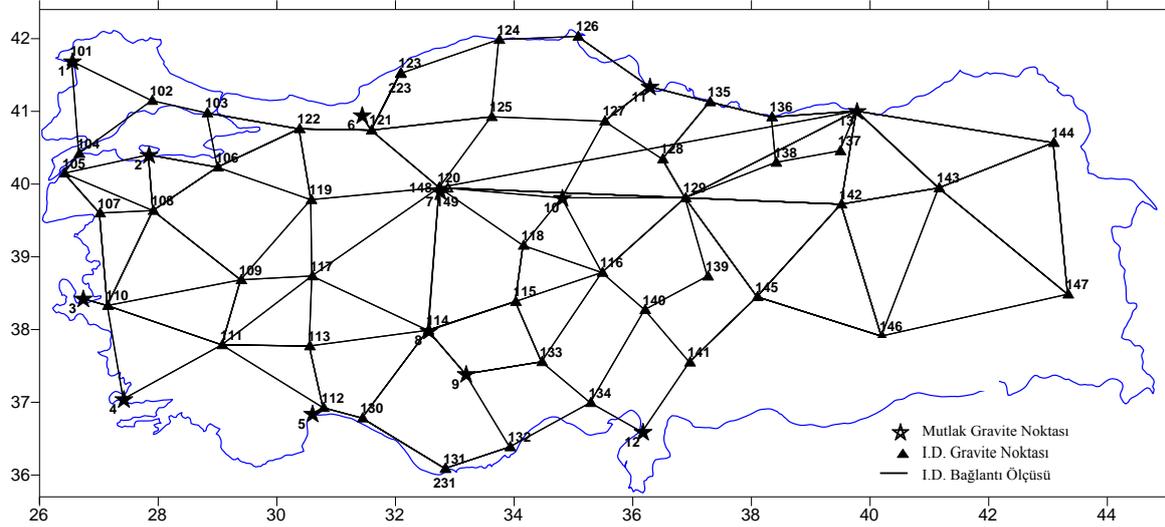


Figure 4.5 Fundamental Gravity Network-1999. Stars: Absolute stations, triangles: network sites.

(2) Turkish Geoid-2009 (TG-09)

Recently released geoid model Turkish Hybrid Geoid-2009 (THG-09) is a gravimetric model based on Remove-Compute-Restore technique (see Fig. 4.6). EGM08 geopotential model to degree and order 2160, DNSC08 satellite altimetry derived gravity anomalies on the sea surface, 3''x3'' digital terrain model including bathymetry, ~2700 GPS/levelling points and ~262400 surface gravity anomalies compiled from the national database are used in the computations.

We used remove-restore procedure based on EGM08 and applied RTM reduction of the surface gravity data. FFT technique was then used to obtain the residual quasi-geoid from the reduced gravity. We restored the individual contributions of EGM08 and RTM to the whole quasi-geoid height. Since the Helmert orthometric height system is adopted in Turkey, the quasi-geoid model was then converted to the geoid model by making use of Bouguer gravity anomalies and digital terrain model. After all we combined gravimetric geoid model with GPS/levelling geoid heights in order to obtain a hybrid geoid model or a transformation surface to be used in GPS positioning applications. Finally, we tested the hybrid geoid model with GPS/leveling data which were not used in the combination to assess the external accuracy. Results show that the external accuracy of the THG-09 is ± 8.4 cm.

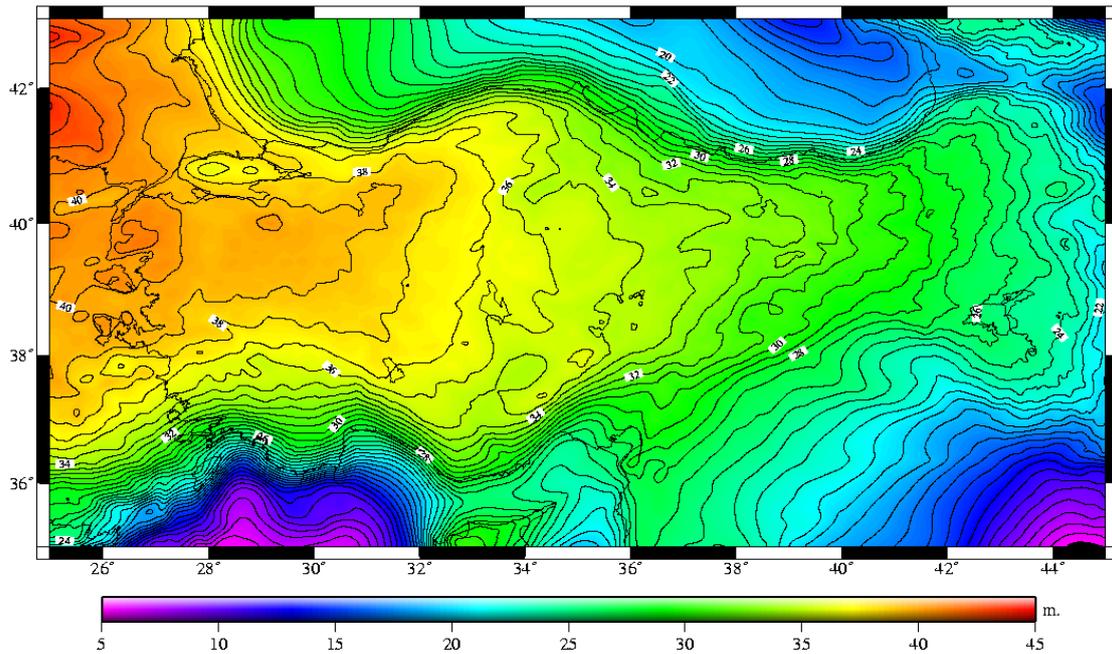


Figure 4.6 Geoid Model of Turkey (THG-09).

(3) Height Modernization Studies in Turkey

A height system adopting the mean sea level of Antalya tide-gauge as the zero-height level and realized with first and second order leveling networks is currently in use within Turkey. With the widespread use of GNSS technology in mapping society, the gravimetric geoid models have been computed and related with national height system. But those models could not reach the accuracy to be used directly in GNSS positioning. Besides, rapid destruction of numerous leveling benchmarks due to the recent reconstruction of roads led to problems in the precise height determination in the country. The mean accuracy of the recently released geoid model THG-09 is about 9 cm and does not operate well enough along the borders, along the coasts, over the water bodies and the inland regions where the large gravity data gaps exist especially on the mountainous areas. Based on the results of the reconnaissance survey at 9000 benchmarks in 2011, it is now estimated that the number of the destroyed benchmarks have reached up to 63% of the leveling network.

To overcome these shortcomings, General Command of Mapping initiated a height modernization project. The intention is to improve the geoid model that will provide a direct determination of physical heights from GNSS observations and no more leveling at the user level.

Terrestrial gravity data in Turkey have been collected by different organizations over many decades. Although the density of these data is sufficient in most part of the country, the poor quality, mainly due to the inconsistent coordinate and gravity reference frames, prevented us to compute a gravimetric geoid model of a few cm accuracy. Therefore, we are now working on the elimination of discrepancies between these historical datasets, developing a national gravity database and preparing guidelines for measuring, reducing, processing and exchanging terrestrial gravity data. In the meantime, new field campaigns were started in 2011 to extend the national gravity standardization network and to increase the amount of control points to be used for the quality check of the historical data.

The extended gravity network will consist of terrestrial points with 30 minutes spacing including the existing network points (see Fig. 4.7).

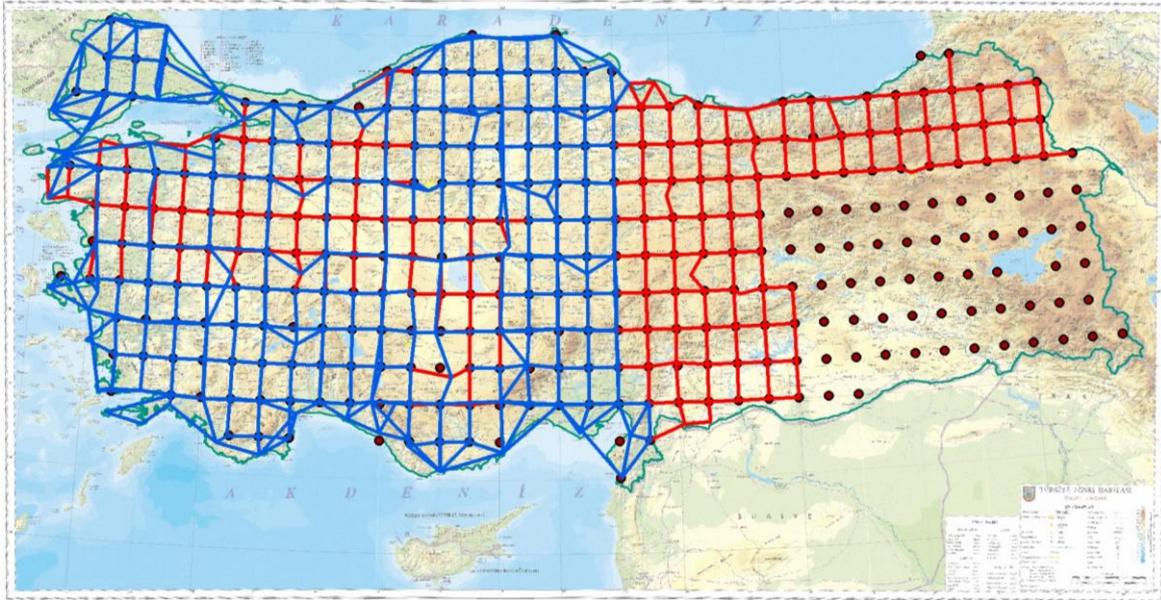


Figure 4.7 Extension of the gravity network. Red and blue lines: gravity ties.

Besides, a protocol for a densifying the gravity network between GCM and 4 other national institutes namely, General Directorate of Mineral Research and Exploration, Turkish Petroleum Corporation and TÜBİTAK Marmara Research Center and TÜBİTAK National Metrology Institute has been signed. The main purpose of this national collaboration is to make relative gravity measurements at 5 minute spatial resolution.

c. Geodynamic Working Group

Anatolia, which takes place among major plates Africa, Arabia and Eurasia, is an ideal place to study both inter-plate tectonic and the deformation. GPS studies in Turkey which date back to late 1980's, have revealed the current northward motion of Arabia with respect to Eurasia and eastward escape of Anatolian Plate due to compression along East Anatolian Fault where the two plates collide. This rigid body rotation gives an upper bound of 24 mm/yr along North Anatolian Fault with an Euler pole near Sina, Egypt as well as compression in Marmara region which was implication of the catastrophic earthquake sequence (17 Aug 1999 $M_w=7.5$ İzmit and 12 Nov 1999 $M_w=7.5$ Düzce Earthquakes) in 1999. Figure 4.8 shows a recent velocity field of Anatolia in a Eurasia-fixed frame. Survey-type GPS observation campaigns initiated just after the earthquakes enabled the precise determination of co-seismic displacements reaching up to a few meters. While the post-seismic phenomena is still under investigation by survey-type campaigns and a continuous network, current results have not proved any significant change in the inter-seismic velocity field after the earthquakes possibly due to the on-going post-seismic signals.

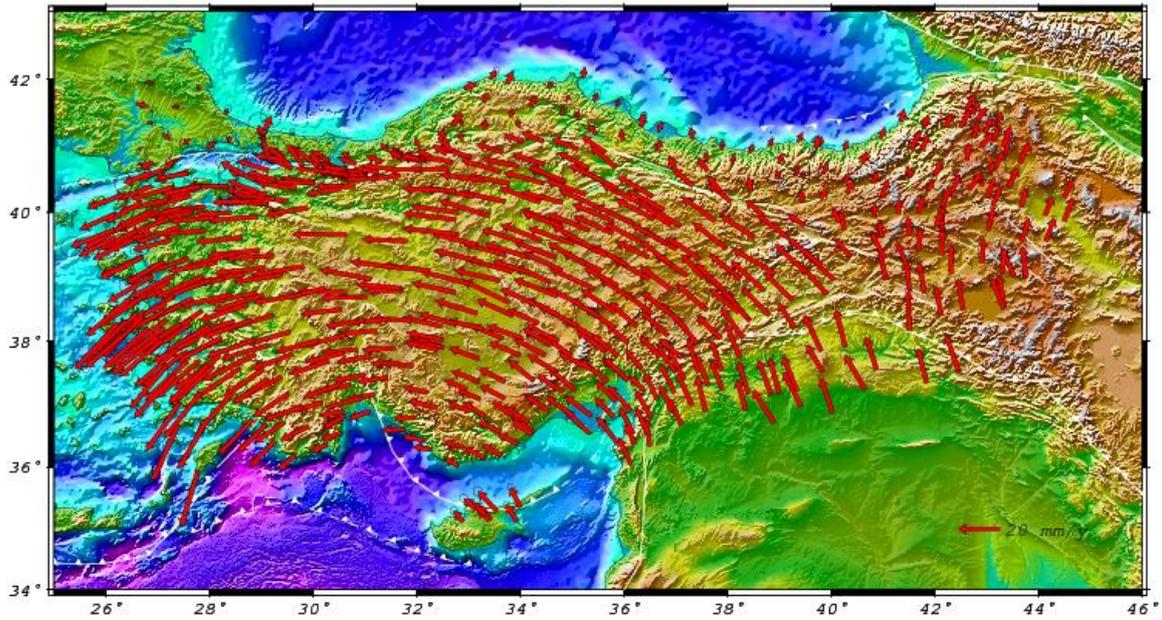


Figure 4.8 Horizontal Velocity Map of Turkey acquired from inter-seismic data before the earthquakes (Eurasia Fixed)

Interseismic deformation is monitored by periodic GPS and leveling measurements across Turkey while specific densified networks are established for local and regional secular deformation in certain regions. Analyses of velocity field have been carried out to expose areas of secular deformation and seismic hazard. Strain analyses utilizing secular movements shed light on rigid block rotations, local compression and faulting areas that well conform to the geological and geophysical evidence of Anatolia. Shear strain rates and rigid-body rotation rates are given in Figure 4.9 and Figure 4.10, respectively. Due to high seismic activity, co-seismic and post-seismic deformation is also monitored by independent GPS campaigns. Earthquakes with magnitude equal and higher than M_w 6.0 cause surface displacements that should be taken into account in high-precision geodetic studies.

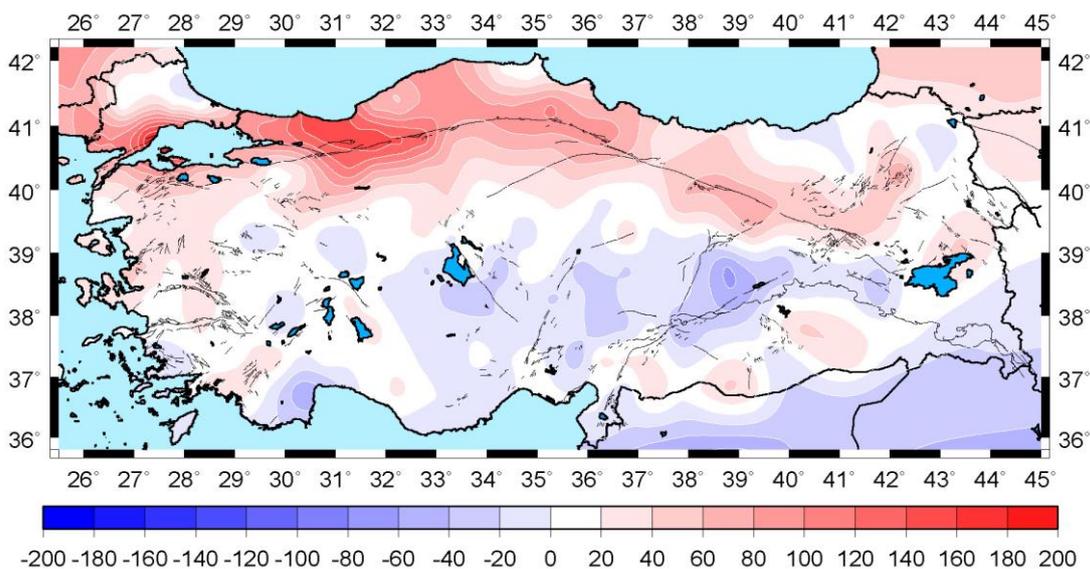


Figure 4.9 Shear strains in nanostrain per year

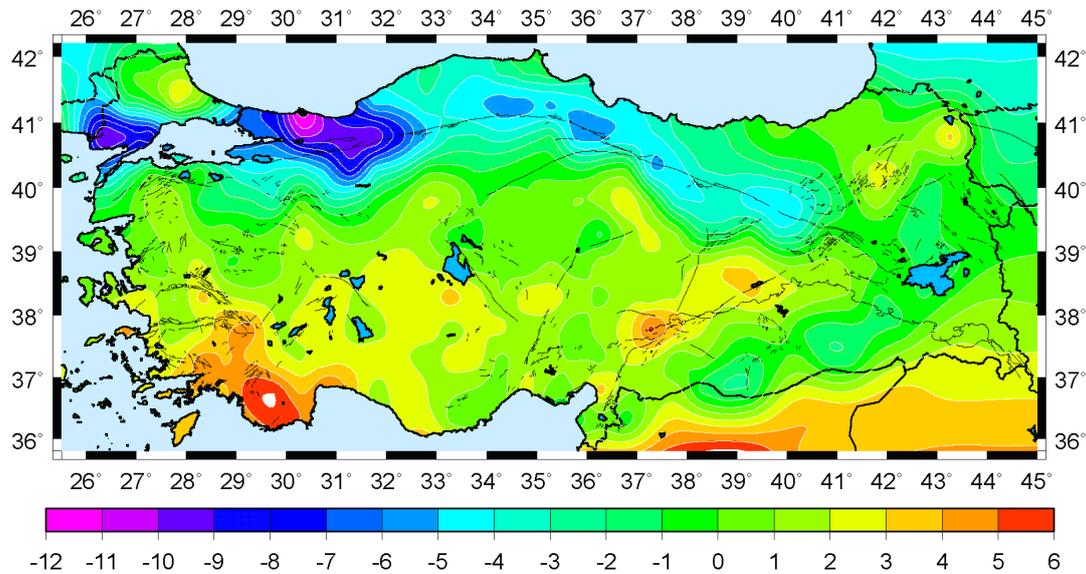


Figure 4.10 Rigid-body rotations in $^{\circ}/\text{Myr}$

Co-seismic surface displacements obtained from survey-type pre-earthquake and post-earthquake GPS observations are analyzed and modelled in an elastic isotropic medium. Depending on the time interval, computed inter-seismic deformation is dispersed from observed co-seismic deformations and published to civilian users surveying in the regions under earthquake influence. TNFGN as well as other existing stations comprises a set of precise coordinates along with their velocities and possible co-seismic corrections for the earthquake prone areas. Specifically, certain parts of Anatolia are still investigated through permanent measurements.

d. Positioning and Applications Working Group

Positioning and Application Working Group is mainly concentrating on collecting information from the institutions and private sectors to identify their technical problems and needs to create a specific project that will compensate their needs and solve for their problems. In order to realise this, the group has determined some subjects and list their titles to get some contribution to turn them back with a real project benefiting to the institutions and professionals. The main titles that are exploited are as follows,

- Providing Geodetic Infrastructure knowledge to the GIS users
- Following contributions are going to be made by the group member for understanding of professionals who are directly practicing Large Scale Map and Map Information Production Regulation.
 - Educational support
 - More explanations and comments will be made to clarify some of the articles (especially on new technologies related ones) of the regulation
 - Alternative solutions will be advised on statistical test
 - Determining local geoid models
 - Way of improving existing local geoid models and also Turkish Geoid-2009
 - Monitoring problems of the regulation in practice and recommending solutions
- Supporting groups who develops standard on engineering surveying and engineering geodesy.

Currently Large Scale Map Making Regulation is used in Turkey. However this does not fit the needs of surveying authorities. It was approved in 1988 and therefore it mostly covers conventional surveying standards rather than modern standards. Therefore new and updated one has been prepared. It is called Large Scale Map and Map Information Production Regulation. It is going to bring new and extended technical standards to surveying profession.

Firstly it has been design to cover all current needs of surveying authorities. Moreover its design is suitable to cover coming technologies and technical developments in the profession. Moreover two additional national standards have been developed and integrated as its appendix to the regulation. One of them is XML based “*National Data Exchange Format*” for Digital Maps and the other one is “*Detail and Attribute Catalogue*”. Both are prepared to fully compensate the national needs; but compatible with international standards.

The advantage of this regulation against the previous one is its approval authority. It is going to be approved by the Cabinet. The meaning of this is: It is going to be a regulation for all kind of large scale map making and map information collection. Therefore all will be in a single standard.

5. Annual Scientific Meetings

Commission agreed to organise annual scientific workshops. Therefore since 2002, workshops have been organized under the directive of TNGC. National scientists from geodesy, geology and geophysics disciplines, graduate and undergraduate students and professionals are participated in these workshops. Invited and selected submitted papers are presented, discussed and knowledge is shared by different professional disciplines. The scientific meeting between 2011 and 2015 are as follows:

- Permanent GNSS Stations Network and Analysis – Istanbul 2011
- Height System Modernization of Turkey – Zonguldak 2012
- Determination of Local Geoids – Afyonkarahisar 2012
- Natural Disasters and Geodesy – Sivas 2013

A scientific meeting on geodesy education in Turkey will be held in Ankara in autumn this year.

One of the main philosophies of Turkish National Geodesy Commission is to contribute and organise educational activities for professional surveyors and students in Geodesy and Photogrammetry departments. Therefore it organises annual scientific workshops and encourages institutions and private firms to provide quality training periods for undergraduate students who might have found a chance to observe both practical and theory combination on real professional applications. More on to that, encourage working groups to concentrate on some educational based projects that are generally drawn as follows

- Supporting researchers such as providing data, information and etc.
- Contributing course programs for updating and/or extending their coverage
- Supporting national and international accreditation works at the universities
- Encouraging researchers and surveying engineers to publish or present their works on quality national and international journals and symposiums
- Organising activities that professionals can discuss and criticise technical problems

- Contributing to develop common terminology for surveying profession
- Establishing data base to distribute and share commissions' paper works such as minutes, publications, technical reports and etc.

6. List of Articles Published in the Surveying Journal

In this section only title of the publications are given. Full copy of the articles can be obtained via General Command of Mapping web site, <http://www.hgk.msb.gov.tr>. This journal is an official journal of General Command of Mapping and published twice a year. Full text of these articles is in Turkish. However English Abstracts exist for all of them.

2011 Issue: 145

- Computation of The Actual Coordinates And Velocities of Turkish National Fundamental GPS Network
Bahadır AKTUĞ, Serdar SEZER, Soner ÖZDEMİR, Onur LENK, Ali KILIÇOĞLU
- Data Quality Control & Management System of Turkish Sea Level Monitoring Network
Mehmet SİMAV, Ali TÜRKEZER, Erdiç SEZEN, Serdar AKYOL, Mustafa İNAM, Ayhan CİNGÖZ, Onur LENK, Ali KILIÇOĞLU
- A Calculation Model For Fisheye Lens Distortion Used In The Camera Cluster
Cumhur ŞAHİN
- A New Approach On The Usage of Internet-Based Gis For Civil And Military Applications In Emergency
İbrahim ARAS, Ferruh YILDIZ
- Analysis of The Prediction Method Used In Environmental Noise Mapping From Gis Data
Erdem Emin MARAŞ, Hadi Hakan MARAŞ, Süleyman Sırrı MARAŞ, Zübeyde ALKIŞ

2011 Issue: 146

- Comparison of Different Algorithms between Geocentric and Geodetic Coordinates
Faruk YILDIRIM, Ahmet KAYA, Yasin KAPLAN
- Datum Transformation between ED-50 (European Datum-1950) and TUREF (Turkish National Reference Frame)
Bahadır AKTUĞ, Salih SEYMEN, Mustafa KURT, Erdem PARMAKSIZ, Onur LENK, Serdar SEZER, Soner ÖZDEMİR
- Computation of High Degree Associated Legendre Functions and Derivatives Using Extended Double Precision
Nevin Betül AVŞAR, Aydın ÜSTÜN
- Designing a National Ortophoto Information System: Turkey Example
Özlem AŞIK Hakan MARAŞ, Altan YILMAZ
- Implementation of Comprehensive Modeling Techniques on *KartoGen* Generalization Software
Özlem SİMAV, Serdar ASLAN, O.Nuri ÇOBANKAYA

2012 Issue: 147

- Height Modernization Approach: An Evaluation For Turkey
Hasan YILDIZ
- Searching The Possibilities of Large Scale Photogrammetric Map Production via Model Aircraft
Serkan KARAKIŞ
- Assessment of Landslide Susceptibility Using Regression Trees: The Case of Trabzon Province
Taşkın KAVZOĞLU, Emrehan Kutluğ ŞAHİN, İsmail ÇÖLKESEN
- A New Proposal on the Definition, Naming and the Limits of the Oceans on Turkish Maps
Erdem BEKAROĞLU, Murat ATAOL, Hakan YİĞİTBAŞIOĞLU
- Military Applications On The Virtual Globe
Mehmet ERBAŞ, Hakan ŞAHİN, Feyzi KANTAR, Zübeyde ALKIŞ

2012 Issue: 148

- The Restricted Solutions of Circular and Parabolic Vertical Curves Sebahattin BEKTAŞ, Yasemin ŞİŞMAN
- Spectral Analysis of Real Time Kinematik GPS Data
Hüseyin PEHLİVAN
- The Effects of Spatial Resolution and Image Homogenisation on Classification Accuracy
Arzu ERENER, Gülcan SARP
- History of Mapping in Turkey-1:200.000 Scale Maps Ali TÜRKEZER, Selman ÇOBANOĞLU

2013 Issue: 149

- Subsidence Monitoring in Zonguldak Coal Mining Area with SAR Interferometry Saygın ABDİKAN, Mahmut ARIKAN, Füsun BALIK ŞANLI, Ziyadin ÇAKIR, Hüseyin KEMALDERE
- Spectral Analysis of Real Time Kinematik GPS Data
Hüseyin PEHLİVAN
- Monitoring the Mass Variations within the Earth System from GRACE Satellite Data
Mehmet SİMAV, Hasan YILDIZ, Ersoy ARSLAN
- Investigation Of The Effects Of Different GPS Solutions And Different Base Distances To The Orientation Accuracy in Kinematic GPS Supported Aerial Triangulation
Ahmet ÇAM, Murat UYSAL
- Mathematical Models Of Catadioptric Systems In Panoramic Imaging
Cumhur ŞAHİN, S. Özgür UYGUR, Bahadır ERGÜN
- Serving Database of Populated Places' Names Over The Internet
Mehmet ERBAŞ

2013 Issue: 150

- Investigating the Accuracy of RASAT Satellite Imagery Geometric Correction According to the Number and Distribution of Ground Control Points Mustafa ERDOĞAN, Altan YILMAZ, Oktay EKER
- A Comparison of Resolution Merge Techniques According To Preservation of Spectral Value and Image Excellence: Worldview-2 Application
Bekir GÜL, Çağlar YILDIRMIŞ, Abdullah DEĞER, Mustafa ERDOĞAN, Ali ULUBAY
- Comparison Of Orthophoto And Mosaicking Operation Steps With Different Image Processing System As Part Of Process Optimization For Orthophoto Production
İsmail ŞAHİN, Zübeyde ALKIŞ
- Information System for Aerial Photograph Archive
Mehmet ERBAŞ
- Configuration of Development Planning Business Process within the Scope of TNGIS
Derya ÖZTÜRK, Fatmagül KILIÇ

2014 Issue: 151

- Digital Surface Model Production: Photogrammetry versus LiDAR
M.Sabri ŞEHSUVAROĞLU, Oktay EKER, Mustafa ERDOĞAN, Ferruh YILDIZ
- A 3D City Model Implementation: AŞTİ
Gökhan ARASAN, Levent İŞCAN, Oktay EKER
- Technical Investigation of Range Imaging Camera and Evaluation of Measurements from SR4000 and CamBoard nano Camera
Cihan ALTUNTAŞ
- Topographic Data Preparation and Presentation
Mustafa CANIBERK, Abdullah OKUL, Abdullah SAYGILI, Bekir YÜKSEL
- An Investigation of the INSPIRE Metadata Model for Geospatial Web Service:Proposals for TNGIS
M. Sabri ŞEHSUVAROĞLU

2014 Issue: 152

- Weighted Total Least Squares Solution: Three Different Algorithms and Application to 2-Dimensional Affine Transformation
Cüneyt AYDIN, Merve UYGUR, S.Özgür UYGUR
- The Use of Worldview-2 Imagery and Auxiliary Data for Land Cover and Land Use Mapping
İsmail ÇÖLKESEN, Tahsin YOMRALIOĞLU
- Updating in Multiple Representation Databases. Model Generalization and Object Matching Stage
Osman Nuri ÇOBANKAYA, Necla ULUĞTEKİN
- Internet Based GNSS Processing Services
Berkay BAHADUR, Aydın ÜSTÜN

2015 Issue: 153

- Determining the Endangered Fields of Turkish Coasts with Coastal Vulnerability Index
Özlem SİMAV, Dursun Zafer ŞEKER, Ayşegül TANIK, Cem GAZİOĞLU
- Examination of the Relationship Between Urban of Forest and Agricultural Areas with
Historical Orthophotos
Mustafa CANIBERK, Erdem Emin MARAŞ, Temel DURĞUT
- GOKTURK-2 Satellite Imagery Tests
Veysel Okan ATAK, Mustafa ERDOĞAN, Altan YILMAZ
- Fuzzy Classification for Land Cover Detection: a Case Study in Ankara
Dijle BOYACI, Mustafa ERDOĞAN, Ferruh YILDIZ
- Results of LIDAR Test Performed by OPTECH HA-500 and RIEGL LMS-Q1560
Abdullah KAYI, Mustafa ERDOĞAN, Oktay EKER

7. List of Articles Published in Journal of Geodesy and Geoinformation

Journal of Geodesy and Geoinformation is a peer-reviewed, semiannual, open access and widely distributed periodical, published by UCTEA Chamber of Surveying and Cadastre Engineers, Turkey. The Journal was published under the name of "HKM Jeodezi, Jeoinformasyon ve Arazi Yönetimi Dergisi" between 2003 and 2011, and "Harita ve Kadastro Mühendisliği" during the period 1965 - 2002. Detailed information can be found in <http://www.hkmodergi.org/jgg/index.php/JGG>.

2012 Issue : 105

- Regional spatio - temporal modeling of the ionospheric Vertical Total Electron Content (VTEC) using Multivariate Adaptive Regression B-Splines (BMARS)
Mahmut Onur KARSLIOĞLU, Murat DURMAZ
- Modelling Very Long Baseline Interferometry (VLBI) observations
Kamil TEKE, Emine Tanır KAYIKÇI, Johannes BÖHM, Harald SCHUH
- A novel image fusion method using IKONOS satellite images
Deniz YILDIRIM, Oğuz GÜNGÖR
- Destriping of GRACE solutions by fitting high-degree polynomials
Emine SİMAY ATAYER, Cüneyt AYDIN
- Comparison between simple and complete Bouguer approaches in interpolation of mean gravity anomalies
Ramazan Alpay ABBAK, Aydın ÜSTÜN, Artu ELLMANN

2012 Issue : 106

- Seasonal and intraseasonal polar motion variability as deduced from atmospheric torques
Michael SCHINDELEGGGER, Johannes BÖHM, David SALSTEIN
- Accuracy improvement and evaluation measures for registration of multisensor remote sensing imagery
Deniz GERÇEK, Davut ÇEŞMECİ, Mehmet Kemal GÜLLÜ, Alp ERTÜRK, Sarp ERTÜRK

- Classification of multispectral images using Random Forest algorithm
Özlem AKAR, Oğuz GÜNGÖR
- Digital zenith camera system for Astro-Geodetic applications in Turkey
Kerem HALICIOĞLU, Rasim DENİZ, Haluk ÖZENER

2013 Issue : 107

- Photogrammetric features for the registration of terrestrial laser scans with minimum overlap
Sibel CANAZ, Ayman HABİB
- An automatic region growing based approach to extract facade textures from single ground-level building images
Emre SÜMER, Mustafa TÜRKER
- Analysis of surface textures of physiographic features extracted from multiscale digital elevation models via grey level co-occurrence matrix
Dinesh SATHYAMOORTHY
- Thematic mapping of urban areas from WorldView-2 satellite imagery using machine learning algorithms
Dilek KOÇ-SAN

2013 Issue : 108

- Automated Detection of Buildings and Roads in Urban Areas 1 from VHR Satellite Images
Ali Özgün OK
- Observed TEC Anomalies by The GNSS Sites Preceding The Aegean Sea Earthquake of 2014
Mustafa ULUKAVAK, Mualla YALÇINKAYA