

# What is The CORS Situation in Turkey?

Rahmi Nurhan ÇELİK, Esra TEKDAL and Özgür AVCI, Turkey

**Key Words:** CORS, GPS, permanent stations, network

## SUMMARY

Global Positioning System (GPS) motivated the new technologies to take place in positioning techniques by offering certain accuracy related with the measurement strategy. The accuracies that can be achieved are limited with the type of measurement. By using a single GPS receiver man can achieve a measurement accuracy of between 10 and 15 meters, but if two or more receivers are used the accuracy problem is solved. However the only problem is not the accuracy there are also other problems like cost, experienced crew, coverage and more.

The problems mentioned above made people to find new and permanent solutions one of which is the Continuously Operating Reference Station (CORS). CORS has a wide range of availability in various topics, because of that many developed countries have already established their national CORS networks and even begin condensing.

Turkey is one of these developed countries planning to establish a national CORS network. In order to establish the mentioned CORS network the preliminary works should be carried out. In this paper the studies being carried out for this subject will be explained and furthermore the steps of establishment, the advantages that the CORS will bring to Turkey, the current situation, the already established networks being used for various purposes, the importance of having CORS Networks in an earthquake country, market potential will be explained and hence their benefits for recovering geodetic infrastructure, producing large and small scale maps, collecting Geographical Information System data, navigation, governing municipalities and the country, etc., will be discussed and underlined.

# What is The CORS Situation in Turkey?

Rahmi Nurhan ÇELİK, Esra TEKDAL and Özgür AVCI, Turkey

## 1. INTRODUCTION

The invention of the GPS opened a new window in the area of science and technology. The biggest help of the GPS is its ability to obtain 3D positional coordinates in a very short time and economical way compared to the conventional positioning techniques. However, there is a more economical way to cope with the GPS based positional data and it is establishing GPS networks for various purposes. One of these effective solutions is a network of Continuously Operating Reference Stations (CORS) that are used to solve for the cost, accuracy, time consuming problem that came up with the traditional use of GPS positioning techniques. CORS almost supports all applications of GPS some of which are the Real Time Kinematics (RTK) and Differential GPS (DGPS).

## 2. WHAT IS CORS?

CORS is a term introduced by the National Geodetic Survey (NGS) for Continuously Operating Reference Stations performing GPS code and carrier phase measurements for providing 3D coordinates of a point (Tekdal et al. 2006). The requirements of a typical CORS are a GPS receiver and antenna that is dual frequency, supporting both carrier phase and code range measurements, generally a choke ring antenna that is specially designed to reduce the multipath effects, nowadays high-tech much smaller antennas that are also reducing multipath effects are also in use instead, an uninterruptible power supply for providing continuous power for GPS receiver, data storage and communication devices like the radio modem etc. for transmitting the data and corrections.

All countries that have been already established their national CORS network have some rules and legal issues in order to accept a newly established a CORS as a member of a national CORS network. Moreover those countries that have varies kind of more potential users have also cooperative or regional CORS networks for serving data regarding market demands and these are also run based on legal issues. Similar approach also exists in Turkey. However it is on beginning stage. There is a regulation that was approved last year in 15<sup>th</sup> July 2005 in Turkey called Large Scale Map and Map Information Production Regulation for large scale geodetic and mapping applications. An item of this regulation (item 43) explains the criteria that should be met by the specs of a CORS in order to become a national CORS network member. These general rules are as follows (Anonym 2005):

- Coordinate accuracy of the station must be at least similar accuracy of A, B or C1 order control stations.
- It must have an antenna which is mounted on a pillar or on a monument that has equivalent stability to pillar.

- The ground where monument is established must be strong and stable, and should be located on a place where the maximum number of satellites can be tracked and no multipath effects occurred.
- The receiver and the antenna at the station must be continuously operating dual frequency geodetic type GPS receiver.
- The receiver must supply 1 or less than 1 second data collection interval and has the ability of storing, archiving and when it is required it must produce data in the RINEX format using present and past data in archive.
- The data of the station (at least 30 seconds interval ones) must be achieved via internet.
- The document that containing the standards (the coordinate category of the station, velocity vectors, the standard of the data produced, accuracy and the reliability) are certified, that the station is suitable to be used within the coverage of the regulation, should be renewed by the General Command of Mapping in every two years period of time.

CORS enables users to collect data in the field with only a single rover GPS receiver and that operation saves time and money. It means that after each country has established their own CORS professionals and also people living in that country do not have to use temporary GPS reference station other than the permanent stations.

### **3. APPLICATIONS OF CORS**

CORS can be established for various purposes, the purpose that it will be used for defines the number of stations, spacing between each station and the data collection rate. For example; if a municipality is going to establish a CORS network to build an infrastructure for a city in order to set up a Land Information System (LIS) it is enough to establish a CORS network covering only that city. But if a country is going to build its own infrastructure for Geographical Information System (GIS), the network that is going to be established should be covering the whole country.

There are some other things to consider about while establishing a CORS network, the type of application that the CORS data will be used for. GIS is one of the major application areas of CORS that is widely used. The heart of the GIS is the geospatial data that should be accurate and updated in the GIS database. This procedure can be carried out in a quick way by the data obtained from a CORS. CORS provide great support for GPS users who would like to collect accurate and economic geospatial data for GIS

One of the specific applications of CORS is that monitoring of the distribution of water vapor in the atmosphere. Water vapor in the atmosphere is an indicator for the weather conditions. The information obtained from the CORS is used for predicting weather conditions like tornados, thunderstorms, etc.

The other specific one is that CORS data is used for monitoring the distribution of free electrons in the atmosphere. Ionosphere parameters change with the location of the sun

relative to the earth. This data obtained from CORS can be used for eliminating the ionospheric errors in GPS applications by predicting and modeling the ionosphere.

The crustal velocities or land movements can be monitored online or by evaluating the data archived by the CORS data managing center. Geographical location of Turkey is at the critical region on the earth regarding faults situations. Therefore the data collected by CORS can be beneficial to monitor understand crustal movements in the country. Hence many different applications can be run based on facilities provided by CORS; such as setting up an emergency management systems, earthquake prediction research projects, analysis center for determining coordinate changes and etc. (Celik et al., 2004).

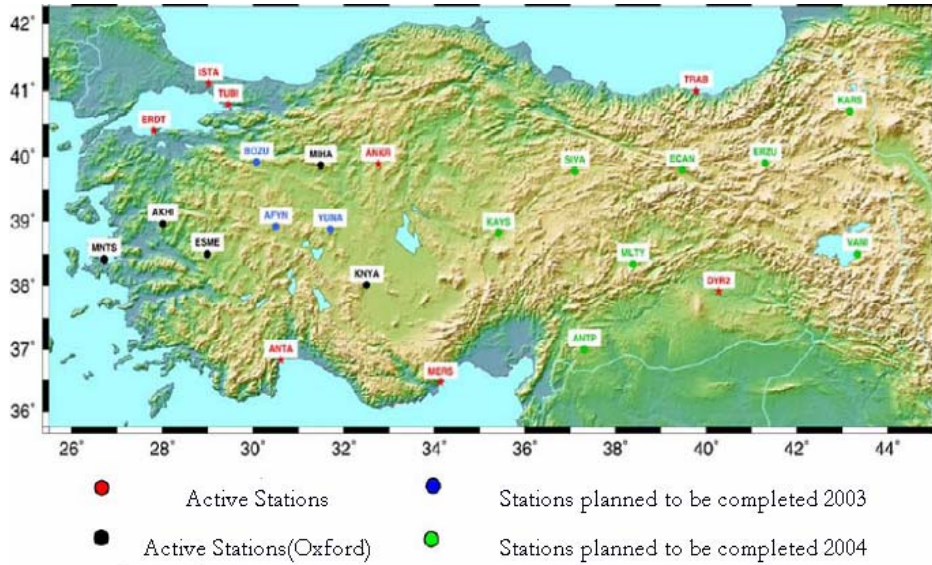
The CORS data can be used for various purposes like updating the navigation maps, determining the path of a vehicle like car, train, aircraft, watercraft, etc., precise farming applications, communication systems and so on. It might be truth to say that the number of applications of CORS is limited with the dream power of human beings. With the development of new technologies new applications of CORS will also take place and power up the dream power.

#### **4. CURRENT SITUATION IN TURKEY**

There are currently some GPS networks operating in Turkey. While mentioning about the current situation two networks should be mentioned. The first one is the Turkish National permanent GPS Network (TNPNG) which consists of stations spread all over Turkey. The main purpose of the TNPNG is to solve for the datum problem in geodetic applications and understanding tectonic structure of the country. It is established in order to collect data as a reference for geodetic and geodynamic purposes and to serve for differential GPS purposes by broadcasting differential corrections under the control of General Command of Mapping. It has currently 23 stations and soon will be extended with additional 7 to 10 stations.

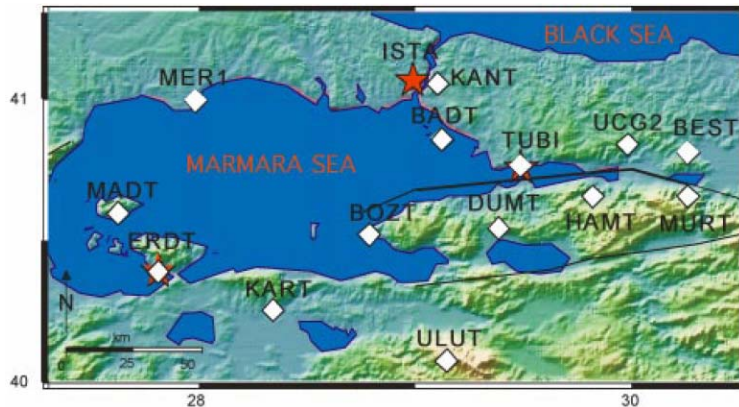
Location of Turkey is geographically in the intersection of three important plates: Eurasian, African and Arabs. Therefore it is critical about the earthquakes or even crustal movements that cause the positions of the points to change. The TNPNG network, quits the need for measuring the points more than once by enabling the user to calculate the velocity parameters of change from the stations of the network. It also enables the monitoring of earthquakes. For example in the 17 August 1999 the data and hence information about the earthquake were obtained from the IGS station is also the station of TNPNG called TUBI where is located at Gebze at the garden of Scientific and Technological Research Council of Turkey (TUBITAK) (Kılıçoğlu et al., 2003).

The complete TNPNG will be consisting of 80 stations; however most of these stations have not been established yet. Some of these operating stations are ISTA, TUBI, MERS, ANTA, and ERDT. ANTA and ERDT stations are located near the sea therefore support also the mean sea level determination measurements (see Figure 1).



**Figure 1:** Turkish National Permanent GPS Network (TNPNG) status in 2003

The second permanent GPS network is Marmara Region Continuous GPS Network (MAGNET) that is administrated TUBITAK and Earth and Marine Sciences Research Institute for scientific purposes (Lenk et al. 2003). The main goal of the project is to determine the stress accumulation and the earthquake risk in the North Anatolian Fault Zone's west part and the middle part where the industry is highly developed. For this purpose the movements and the stress distribution and accumulation of the critical faults that may cause earthquake are being monitored (see Figure 2).



**Figure 2:** Marmara Region Continuous GPS Network (MAGNET)

CORS is also necessary in Turkey for renewing and keeping update the geodetic infrastructure. In the current situation the cadastral maps are not up to date and do not show the current situation. However there are many works going on in the cadastral side to finalize the cadastral infrastructure of the country. If a well designed for multi purposes CORS network is established it would be easy and much more economical to update cadastral, large

and also small scale maps. Nevertheless a project is on going to establish such national CORS network; but unfortunately the design concept and realizing approach are not going to compensate the many needs of the country and might not be sufficient for cadastral works within many different regions of the country. Since the dense of the network is so wide apart.

As GPS is widely used, because of its major benefits (saving time, money, man power, etc.), many private organizations, governmental and academic institutions are considering establishing their own CORS network in order to realize their projects.

## 5. CONCLUSION

The establishment of CORS network will play an important role in the area of science and technology in Turkey. The use of CORS networks will decrease the need for using a reference receiver, crew and finance. The time needed for carrying out a GPS campaign will also decrease. CORS can be used for updating maps and data in a short time, with less finance. Turkey has a large market potential for the CORS data. The needs for geographical and positional data increase day by day. Almost none of the municipality or governmental institutions have a complete GIS system; but almost all would like to establish one. However the gaps on digital geospatial data prevent their forwarding actions, since it is too costly. However CORS dramatically decrease the cost of geospatial data production. Regional CORS establishment project is in their mind of almost all these organizations. Navigation is also another great potential in the country many people begun interested in having a navigation tool and systems for their car or personal use. These systems need navigation maps and a very few amounts of navigation maps exist. Moreover precise GPS navigation needs real time reference station support. These are all indicating and ringing the needs of CORS in the country. There are many more that might be counted here, therefore indicators show that a great potential exist for benefiting from CORS system. And as is seen there are long way to go in the country.

## REFERENCES

- Anonym (2005) Large Scale Map and Map Information Production Regulation, Turkish Official News Papers, 15<sup>th</sup> July 2005
- Kılıçoğlu A ,Kurt A İ, Tepeköylü S, Cingöz A, Akça E Türkiye Ulusal Sabit GPS İstasyonları Ağı (TUSAGA) (2003) Workshop on Geographical Information Systems and Geodetic Networks, Turkish National Geodesy Commission 2003 Annual Scientific Meeting, 24-26 September, 2003, Konya, Turkey
- Çelik R N , Uluğtekin N N , Guney C, 4D Geo-referenced Database Approach for GIS, FIG Working Week 2004, Athens, Greece, May 22-27, 2004
- Tekdal E , Özarpacı S, Çelik R N, Continuously Operating Reference Stations and the Current Situation in Turkey, Fifth International Symposium, Turkish-German Joint Geodetic Days, March 28-31 2006, Berlin, Germany

Lenk O, Turkezer A, Ergintav S, Kurt A I, Belgen A, Monitoring the Kinematics of Anatolia Using Permanent GPS Network Stations, Turkish Journal of Earth Sciences (Turkish J. Earth Sci.), Vol 12., 2003, pp. 56-65  
Snay R , Gordon A , Chin M , Frakes S ,Soler T, Weston N, The Synergistic CORS Program Continues to Evolve, ION GPS 2002, 24-27 September 2002, Portland, OR, pp 2630-2639  
Stone W A, An Overview of Global Positioning System Continuously Operating Reference Stations, [http://www.geodesy.noaa.gov/PUBS\\_LIB/GPS\\_CORS.html](http://www.geodesy.noaa.gov/PUBS_LIB/GPS_CORS.html).

## CONTACTS

Dr. Rahmi Nurhan Çelik  
Faculty of Civil Engineering  
Department of Geodesy and Photogrammetry  
Division of Geodesy  
Maslak 34469 İstanbul, Turkey  
e-mail: [celikn@itu.edu.tr](mailto:celikn@itu.edu.tr)  
Tel: + 90 212 285 65 60  
Fax: + 90 212 285 65 87

Esra Tekdal  
Faculty of Civil Engineering  
Department of Geodesy and Photogrammetry  
Division of Geodesy  
Maslak 34469 İstanbul  
TURKEY  
e-mail: [esratekdal@yahoo.com](mailto:esratekdal@yahoo.com)  
Tel: + 90 212 285 65 60  
Fax: + 90 212 285 65 87

Özgür Avcı  
System Computer and Technical Services Industrial Inc.  
Eskişehir Yolu 499. Sok. No:26  
Azatbey Sitesi Çayyolu/Ankara,  
TURKEY  
e-mail: [ozguravci@sistemas.com.tr](mailto:ozguravci@sistemas.com.tr)  
Tel: + 90 3122351011  
Fax: + 90 3122350550