

# TURKISH SEA LEVEL MONITORING ACTIVITIES

**Ayhan TEKGÜL<sup>1</sup>, Hasan YILDIZ<sup>1</sup>, Mehmet SİMAV<sup>1</sup>, Emin ÖZSOY<sup>2</sup>**

**ayhan.tekgul@hgk.mil.tr**

<sup>1</sup>General Command of Mapping, Geodesy Department, Cebeci-Ankara/Turkey

<sup>2</sup>Institute of Marine Sciences, Middle East Technical University, Erdemli – Mersin/Turkey

## 1. INTRODUCTION

Sea level monitoring activities in Turkey dates back to the 1930s. The General Command of Mapping (GCM), having the responsibility of establishing and maintaining geodetic control networks in Turkey, installed the first float operated tide gauge at the Antalya harbor in 1935 in order to determine the vertical datum. Right after the establishment of the second one at Karşıyaka/İZMİR in 1937, responsibility of the sea level monitoring in Turkey was transferred to General Directorate of Meteorological Affairs (GDMA) along with existing stations. By this institution, several float operated tide gauges namely Karadeniz Ereğlisi, İskenderun, Trabzon, Samsun and Bodrum were installed in 1948, 1952, 1956, 1961 and 1967 respectively.

The responsibility of installation and operation of tide gauge stations in Turkey with available historical sea level charts was transferred to GCM from GDMA in 1983. Since the existing stations listed in Table-1 lost their capability of producing satisfactory and reliable data due to many reasons, GCM has stopped operating them and installed four new float operated stations, Erdek in February 1984, Antalya-II in October 1985, Bodrum-II in November 1985 and Menteş in November 1985.

Table-1: List of the float operated tide gauges operated between 1935-1984.

Name of site	Lat	Lon	First Record	Last Record	Years of data Available	Revised local reference
Antalya-I	36 53 N	30 42 E	09.01.1935	30.05.1977	43	Available
Karşıyaka/İzmir	38 24 N	27 10 E	05.07.1936	13.12.1977	42	Not Available
Karadeniz Ereğlisi	41 17 N	31 25 E	01.03.1948	28.03.1976	28	Not Available
İskenderun	36 37 N	36 07 E	28.04.1952	31.12.1965	14	Not Available
Trabzon	41 00 N	39 43 E	15.05.1956	24.11.1976	21	Not Available
Samsun	41 17 N	36 20 E	05.04.1961	28.11.1983	23	Not Available
Bodrum	37 02 N	27 25 E	01.05.1967	31.12.1979	13	Not Available

## 2. TURKISH NATIONAL SEA LEVEL MONITORING SYSTEM (TUDES)

GCM changed the existing float operated tide gauges (Antalya-II, Bodrum-II, Menteş and Erdek) with the acoustic tide gauges in 1998 and 1999 and Turkish National Sea Level Monitoring System (TUDES) was established. To achieve sea level data continuity after the tide gauge system change, the datum connection between the floated operated and acoustic systems was provided by precise leveling.

Currently, TUDES consists of 11 tide gauges listed in Table-2 and shown in Figure 1. As an example, Marmara Ereğlisi and İskenderun tide gauge stations are shown in Figure-2. Sea level and ancillary meteorological data (air pressure, air temperature, relative humidity, wind speed and direction) are measured under the frame of TUDES. The data, sampling at every 10 seconds and averaged over 15 minutes, are saved in the datalogger and transferred to the data center by telephone lines. At the data center, the activities of transferring, quality control and analysis of tide gauge data are carried out.

Table-2: List of tide gauges operated under the frame of TUDES (All station now has AQUATRAK acoustic sea level sensors).

Name of site	Coast	Lat	Lon	First Record	Years of data Available	Revised local reference
İskenderun	Mediterranean	36 35 N	36 10 E	17.12.2004	2	Available
Erdemli		36 34 N	34 15 E	07.05.2003	4	Available
Antalya-II		36 50 N	30 37 E	28.10.1985	22	Available
Bodrum-II	Aegean	37 02 N	27 25 E	25.11.1985	22	Available
Menteş		38 26 N	26 43 E	25.11.1985	22	Available
Erdek	Sea of Marmara	40 23 N	27 51 E	03.02.1984	23	Available
Marmara Ereğlisi		40 58 N	27 58 E	23.07.2004	3	Available
İğneada	Black Sea	41 53 N	28 01 E	29.06.2002	5	Available
Amasra		41 26 N	32 14 E	13.06.2001	6	Available
Sinop		42 01 N	35 09 E	18.06.2005	2	Available
Trabzon-II		41 00 N	39 44 E	14.07.2002	5	Available

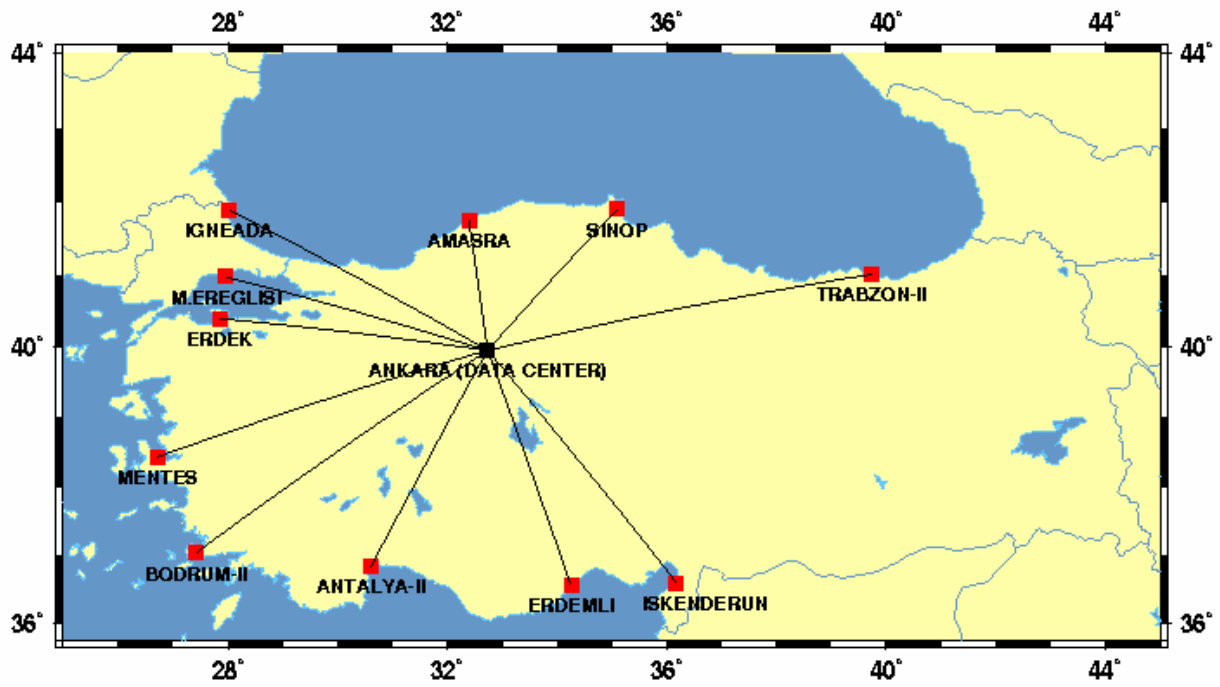


Figure-1: Locations of the existing tide gauge stations of TUDES.



Figure-2. Marmara Ereğlisi and İskenderun tide gauges.

### **3. DATA PROCESSING**

Since the main objective of our organization is to determine the vertical datum of vertical control network and monitor the long term sea level variations, priority has been given to the delayed mode sea level meteorological data. Data are transferred twice a week from TUDES tide gauges. Unexpected anomalies, spikes, instrumental errors, anomalous datum shifts, are checked visually right after data are transferred to the data center.

IOC, ESEAS manuals and PSMLS recommendations are followed for quality control and processing of sea level data. Quality control of sea level data is performed by TASK and SLPR2 software.

Monthly mean sea level data of TUDES tide gauge stations listed in Table-2 are submitted to PSMSL on yearly basis. Hourly sea level data of Antalya-I (1935-1977) and Antalya-II (1985- ) was provided to ESEAS during the ESEAS-RI project. GCM, member of ESEAS which has become a continuous service since 2005, still continue to provide hourly sea level values of Antalya-II tide gauge to ESEAS in delayed mode.

### **4. GEODETIC MEASUREMENTS AT TUDES TIDE GAUGES**

All TUDES sites are surveyed regularly to ensure sea level datum consistency. Episodic GPS campaigns and periodic first order precise leveling measurements are performed at local benchmark networks of the all TUDES tide gauges. Four continuous GPS (CGPS) stations (Erdek in June 2002, Antalya-II in December 2003, Menteş in August 2003 and Marmara Ereğlisi in December 2000) were installed in order to better estimate the vertical land movements. We only have first epoch measurements of absolute gravity in 1996 close to the Antalya-II, Bodrum-II, Menteş and Erdek tide gauges, but the second epoch measurements have not been performed yet.

### **5. PROJECTS AND THE FUTURE**

GCM has participated in European Sea Level Service (ESEAS) and became one of the partners of the ESEAS Research Infrastructure (ESEAS-RI) project which was funded for 3 years in the period of 2002-2005. In this project, GCM acted as an ESEAS CGPS analysis center responsible for analysis of GPS data obtained at ESEAS tide gauge CGPS stations. GCM also participated in determination of the inter-annual and inter-decadal sea level variations in Black Sea and Eastern Mediterranean Sea by using tide gauge data within this project. For the time being, GCM is a member of ESEAS which has become a continuous service since 2005.

GCM has recently participated in a national project called as "Meteorology / Oceanography Network of Excellence (MOMA) Pilot Project: Development of Satellite and in-situ Observation, Data Assimilation, Prediction, Early Warning and User Services" which is funded by Turkish National Science Foundation (TUBİTAK). The project aims to design and develop satellite / in-situ observation and forecast systems, validation / verification of the data and predictions, and the presentation of some products to the end-user in the form of integrated services. Through this project 9 new tide gauges providing real time sea level and ancillary meteorological data for operational oceanography and meteorology will be installed in the area of Turkish Straits and in Eastern Mediterranean Sea and some TUDES stations will be modernized so as to provide real time sea level data.