SEA LEVEL OBSERVING ACTIVITIES
Spanish national report for GLOSS
Paris, 5 Jun 2007

María Jesús García, Instituto Español de Oceanografía (IEO)
Begoña Pérez, Puertos del Estado (PE)
María Angeles Fraile, Instituto Geográfico Nacional (IGN)

Summary

Sea level is monitored in Spain by various agencies for different applications: control of the national levelling system, oceanographic studies, climate change, operational purpose, harbour operations, navigation, etc. In 1870 the first tide gauge was installed in Alicante (Spain) by the Instituto Geográfico National (IGN) in order to determine the mean sea level of Alicante as a reference of the National Leveling Network. A few more gauges were installed along the coast for the primary levelling network. In 1943 the Instituto Español de Oceanografía (IEO) established a large network for oceanographic studies and navigation purposes. Finally, in 1989 the public agency, Puertos del Estado (PE), decided to create a permanent sea level monitoring system for operational purpose and harbor operations. Nevertheless historical data from the three networks have been continuously processed and stored in the corresponding data base, contributing to the regional and global sea level centres and to the permanent mean sea level service.

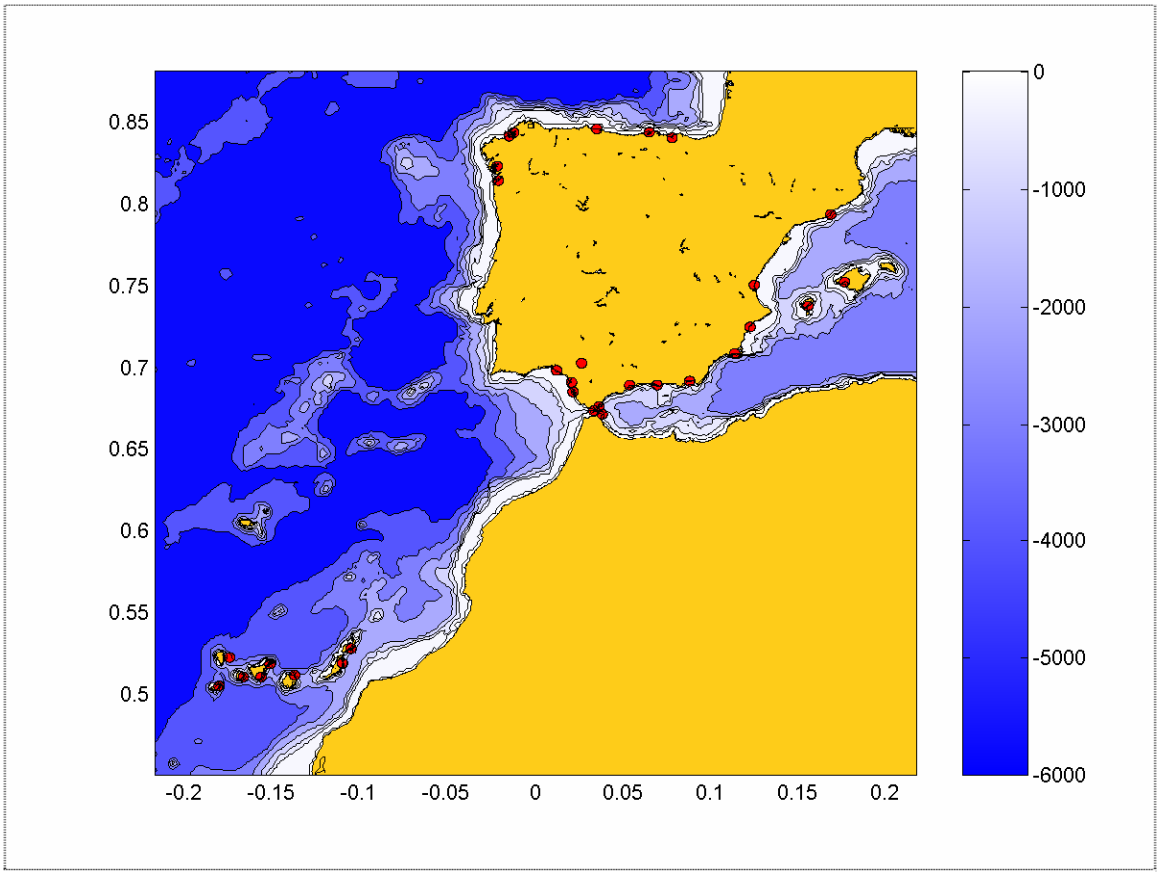

Figure 1: Spanish sea level network

The measurement systems installed in these networks were basically of two types: stilling well float gauge with digital output for the IEO and IGN network, and, acoustic gauges and a few pressure sensors for the PE network. Nowadays there are some radar sensors already in operation. In some stations have also oceanographic and atmospheric parameters sensors, mainly sea temperature, air temperature and barometric pressure. The data are transmitted to the operational data centre by ftp or by modem.

Since February 2005, relevant activity related to observing sea level system have been taking place in Spain in order to upgrade the measurement systems, by moving to radar system, and to improve the transmission system for sending data in real/near real time to the data centre/s.

Related to the IEO network, radar sensors have been installed in two stations; Santander and Algeciras, in which the classical system; mechanical float with digital output is also operative. One more radar sensor will be installed this year. The idea is to move to the radar system but keeping, if possible, the classical system. Nowadays, there is telephone line in all the stations and the data are transmitted by modem ones a day or ones a week. In order to provide data in real/near real time the IEO is in the process of contracting internet services at each station; ADSL or UTMS/ GPRS.

Concerning to PE, during the last couple of years the network has increased the number of stations, which are based on FMCW radar Miros with 1-min real-time data transmission by Internet to Puertos del Estado that provide also agitation data (waves). Since 2006 new stations have been established in Almería, Ferrol, La Palma and La Gomera. During 2007 Melilla (North of Africa) and Arrecife (Lanzarote - Canary Islands) will be installed. Concerning the renovation of old stations, Valencia has been upgraded to radar in 2006, and Barcelona, Bilbao and Motril, at least, will be upgraded during 2007.

The IGN, in May 2007, is going to establish a small network of three stations in the Tenerife island: one in Santa Cruz de Tenerife, already in operation since 1926, and two new stations in Puerto de los Cristianos and Puerto de la Cruz. The main purpose of theses stations is the control of the volcanic activity in Tenerife. At each station will be installed a radar sensor and a GPS system. The data will be stored in a computer connected by ADSL to the main office in Madrid.

Recently a national committee for hazards warning system has been created in Spain to coordinate the national activities. The above mentioned institutes (IGN, IEO and PE) are members of this committee. Puertos del Estado offers sea level data for the European Tsunami Warning System (ICG/NEAMTWS-IOC UNESCO) from the following stations: Melilla, La Palma, Ferrol, Huelva, Almería, Barcelona and one station in the Balearic Islands (Ibiza or Mahon). Data sampling could be lower in the near future for these stations if necessary for tsunami applications. The small network that is going to be established by the IGN in Tenerife island is a component of the hazards warning system. The IEO commitment in the frame of the GLOSS Program, is to upgrade the transmission system at the GLOSS and MEDGLOSS stations (Puerto de la Luz (G. Canarias), Ceuta, A Coruña and Palma de Mallorca). But as mention above, the complete IEO network will be upgrade by moving to radar sensor and to internet data transmission. The data sampling is 1, 5 or 10 minutes but both measurement systems; mechanical float and radar can be configured to 1 minute sampling.

Concerning to the data processing, in the IEO a software for quality control have been developed, in which the Foreman package for tidal analysis and tidal prediction has been migrate from MS-DOS to windows. The historical data is being processing with this software and statistics of extremes values and tidal ranges are being calculated.

The Instituto Hidrográfico de la Marina (IHM) is being calculating or recalculating the Hydrographic Zeros.

ANNEX. STATUS OF THE TIDE GAUGE NETWORKS

REDMAR: Spanish Harbours Tide Gauges Network: it is the more recent one, in operation since 1992. It was originally composed of 14 acoustic gauges (SRD) especially devoted to harbour applications and real-time use at the harbour. Nevertheless historical data have been continuously processed and stored in a data base and data are provided freely for different research activities and with a symbolic price for commercial purposes. The network has been growing since year 2001 due to the demand of the ports authorities, and the actual number of stations is 24 (13 acoustic SRD gauges and 5 Aanderaa pressure sensors and 5 Miros radar sensors: details in http://www.puertos.es). Along the years the need appeared of receiving near real time sea level data not only by the personnel of the harbour but also by the responsible of the network in Madrid, in order to provide a better maintenance and increase the service to the public. Since year 2000 data are transferred automatically via ftp or modem to Madrid, where an automatic quality control process is run before displaying data on the web page and assimilating them in the storm surge forecasting system.

Table 1: REDMAR network (Spanish Harbours)

Site	Latitude	Longitude	Data available
Bilbao	43º 20' 14" N	03º 02' 09" W	1992-
Santander	43º 27' 45" N	03º 47' 22" W	1992-
Gijón	43º 33' 33" N	05º 41' 50" W	1996-
A Coruña	43º 21' 31" N	08º 23' 17" W	1992-
Villagarcía	42º 35' 58" N	08º 46' 12" W	1997-
Vigo	42º 14' 33" N	08º 43' 35" W	1992-
Huelva2	37º 08' 00" N	06º 49' 56" W	1996-
Sevilla (Bonanza)	36º 48' 14" N	06º 20' 10" W	1992-
Sevilla (Esclusa)*	37º 19' 57" N	37º 19' 57" W	1992-
Málaga	36º 42' 50" N	04º 24' 52" W	1992-
Motril	36º 43' 23" N	03º 31' 46" W	2004-
Valencia	39º 27' 42" N	00º 19' 33" W	1992-
Barcelona	41º 21' 01" N	01º26' 36" E	1992-
Ibiza	38º 54' 36" N	02º 09' 41" E	2003-
Tenerife	28º 28' 42" N	16º 14' 25" W	1992-
Las Palmas	28º 08' 53" N	15º 24' 27" W	1992-
Hierro	27º 48' 00" N	17º 53' 54" W	2003-
Fuerteventura	28º 30' 00" N	13º 51' 06" W	2003-
Granadilla	28º 05' 00" N	16º 30' 54" W	2003-
Arinaga	27º 51' 00" N	15º 24' 00" W	2003-
Ferrol	43º 28'34'' N	8º 14'54''W	2006
Almería	36º 49' 48'' N	02º 28' 42''W	2006
La Gomera	28º 05' 16''N	17º 06' 26''W	2006
La Palma	28º 40' 40'' N	17º 46' 04''W	2006
Arrecife	≈ 28º 57' N	≈ 13º 34' W	2007**
Melilla	≈ 35º 22'N	≈ 03º 28' E	2007**
Mahon	≈ 39º 52' N	≈ 04º 19'E	2007 **?

* in Guadalquivir river, Sevilla harbour, ** to be installed

Up to now, each of the REDMAR stations provides 5-minutes sea level data and, after a preliminary and automatic quality control, hourly values, harmonic constants, means and extremes are routinely

obtained and published. Nevertheless, it is planned to decrease the time interval of raw data to 1 minute or less, in order to use this information for detection of other local or external phenomena as seiches or tsunamis. In June 2004 the first continuous GPS station of Spanish Harbours was installed collocated with the Ibiza tide gauge (Balearic Islands).

The Spanish Institute of Oceanography Network: established in 1943, most of the longer time series of sea level belong to this network of 12 stations based on mechanical float gauges with digital output. The measurement system is composed of two different instruments: the classical mechanical float tide gauge (AOTT) and an optical or electromagnetic codifier for converting the lineal movement of the wire float to a digital value with a precision of millimetres or centimetres. The acquisition system can be a dataloger or a PC computer both with a modem connexion to transmit the data from the tide gauge station to the data centre in Madrid. In Algeciras and Santander there is also a radar sensor with a dataloger and modem connection. The actual configuration of the stations provide data every 5 or 10 minutes. Only the station of Palma de Mallorca provides data every minute in order to monitories the seiches.

Table 2: Spanish Institute of Oceanography Network

Site	Latitude	Longitude	Available Data	Electronic Graphical Recorder
Santander	43º 28' N	03º 48' W	1943 -	
A Coruna	43º 22 'N	08º 24' W	1943 -	
Vigo	42º 14' N	08º 44' W	1943 -	
Cádiz	:36º 32' N	06º 17' W	(1945 - 1960 *), 1961-	1944-1998
Tarifa	36º 00'N	05º 36' W	1949-1989,1991-	1949-1989,1991-
Ceuta	35º 54' N	05º 19' W	1944 -	1944-1989
Algeciras	36º 07' N	05º 26' W	1943 – 1950, 1952 – 1956, 1961 – 1978, 1980 - 2002 2007-	1943 – 1953 1967 - 1978 1980 - 1996
Málaga	36º 43' N	04º 25' W	1944 – 1952 (1953 - 1956,1961*) 1962 – 1971 1973 -	1943-1984
Palma de Mallorca	39º 33' N	02º 38' E	(1963 – 1982 *), 1996-	1963-1965, 1069-1971
Arrecife	28º 57' N	13º 34' W	1949 – 1958, 1960-1976 1980 -	
Puerto de la Luz	28º 08' N	15º 25' W	1949 – 1956 (1964 -1974 , 1983-1989 *) 1975 – 1982, 1991-	1969-1973
Santa Cruz de la Palma	28º 41' N	17º 33' W	1949 – 1986 (1987-1989 *) 1997 -2005, 2007-	

The data can be download from http://indamar.ieo.es/mareas/formulario_datos.htm. The data from the GLOSS a MEDGLOSS stations are retrieved daily by call phone and weekly for the rest of the stations. Since 2004, the graphical recorders are being scanned in order to avoid the risk of lost or deterioration of the chart and to facilitate the searching of high frequency signals for future

digitalization of this signals. Furthermore a permanent GPS station is being operative since April 2004 and the RINEX data are sending daily to the ESEAS service and ones a month to the analysis Centre for the pilot project ("GPS Tide Gauge Benchmark Monitoring") of IGS.

The National Geographic Institute Network: this is the older one, with the first tide gauge installed in Alicante in XIX century and used as the reference for altitudes in Spain. The equipments are also classical float gauges with a data logger and modem connection (not automatic). As mention in the summary, this year, just in may, tree radar sensor with internet connexion will be installed. The stations belong to the IGN network are equipped with a GPS system.

Table 3: National Geographic Institute Network

Site	Latitude	Longitude	Data Available
A Coruña	43º 22' N	08º 24' W	1950-1960,1990
Almería	36º 50' N	02º 29' W	1977-1997,2000
Alicante I	36º 20' N	00º 29' W	1927-1939,1943-1946,1950
Alicante II	36º 20' N	00º 29' W	1957-
Cartagena	37º 36' N	00º 58 ' W	2002-
Fuerteventura	28º 30' N	13º 51' W	1999-2001,2005-
Santa Cruz de Tenerife	28º 29' N	16º 14' W	1926-1936,1940-1989,1995-
Puerto de de los Cristianos	≈ 27º 54' N	≈ 16º 18' W	2007 *
Puerto de la Cruz	≈ 28º 21' N	≈ 16º 27' W	2007*

* to be installed

THIS REPORT HAS BEEN PREPARED IN MADRID ON 27, APRIL 2007 BY:

María Jesús García.
Corazón de María 8
28002 Madrid, Spain
Tel: +34 91 347 3612
Fax: +34 91 597 9758
email: mjesus.garcia@md.ieo.es

Begoña Perez Puertos del Estado
Avda. del Partenon, 10
Campo de las Naciones
28042 Madrid, Spain
Tel: +34 91 524 5500 ext. 1430
Fax: +34 91 524 5504
Email: bego@puertos.es

María Angeles Fraile
Gral. Ibáñez Ibero 3
28003 Madrid, Spain
Tel: +34 91 597 9624
Fax: +34 91 597 9758
Email: mafraile@mfom.es