

# SEA LEVEL MONITORING IN SPAIN

## National report for GLOSS

Begoña Pérez, Puertos del Estado, Spain  
 María Jesús García, Instituto Español de Oceanografía, Spain

At this moment there are 3 different institutions running the main tide gauge networks in Spain: Spanish Harbours (Puertos del Estado, PE), Spanish Institute of Oceanography (Instituto Español de Oceanografía, IEO) and the National Geographic Institute (IGN).

**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 23 (15 acoustic SRD gauges and 8 Aanderaa pressure 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 responsables 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. For this last application data are required each 12 hours only, but data availability varies between 1 and 6 hours depending on the station.

Table 1: REDMAR network (Spanish Harbours)

Site	Latitude	Longitude	Data available
Bilbao	43° 20' 14" N	03° 02' 09" W	1992-
Santander	43° 27' 45" N	03° 47' 22" W	1992-
Gijón	43° 33' 33" N	05° 41' 50" W	1996-
A Coruña	43° 21' 31" N	08° 23' 17" W	1992-
Villagarcía	42° 35' 58" N	08° 46' 12" W	1997-
Vigo	42° 14' 33" N	08° 43' 35" W	1992-
Huelva2	37° 08' 00" N	06° 49' 56" W	1996-
Sevilla (Bonanza)	36° 48' 14" N	06° 20' 10" W	1992-
Sevilla (Esclusa)*	37° 19' 57" N	05° 59' 41" W	1992-
Málaga	36° 42' 50" N	04° 24' 52" W	1992-
Motril	36° 43' 23" N	03° 31' 46" W	2004-
Valencia	39° 27' 42" N	00° 19' 33" W	1992-
Barcelona	41° 21' 01" N	02° 09' 41" E	1992-
Ibiza	38° 54' 36" N	01° 26' 36" E	2003-
Tenerife	28° 28' 42" N	16° 14' 25" W	1992-
Las Palmas	28° 08' 53" N	15° 24' 27" W	1992-
Hierro	27° 48' 00" N	17° 53' 54" W	2003-
Fuerteventura	28° 30' 00" N	13° 51' 06" W	2003-
Granadilla	28° 05' 00" N	16° 30' 54" W	2003-
Arinaga	27° 51' 00" N	15° 24' 00" W	2003-

\* in Guadalquivir river, Sevilla harbour

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.

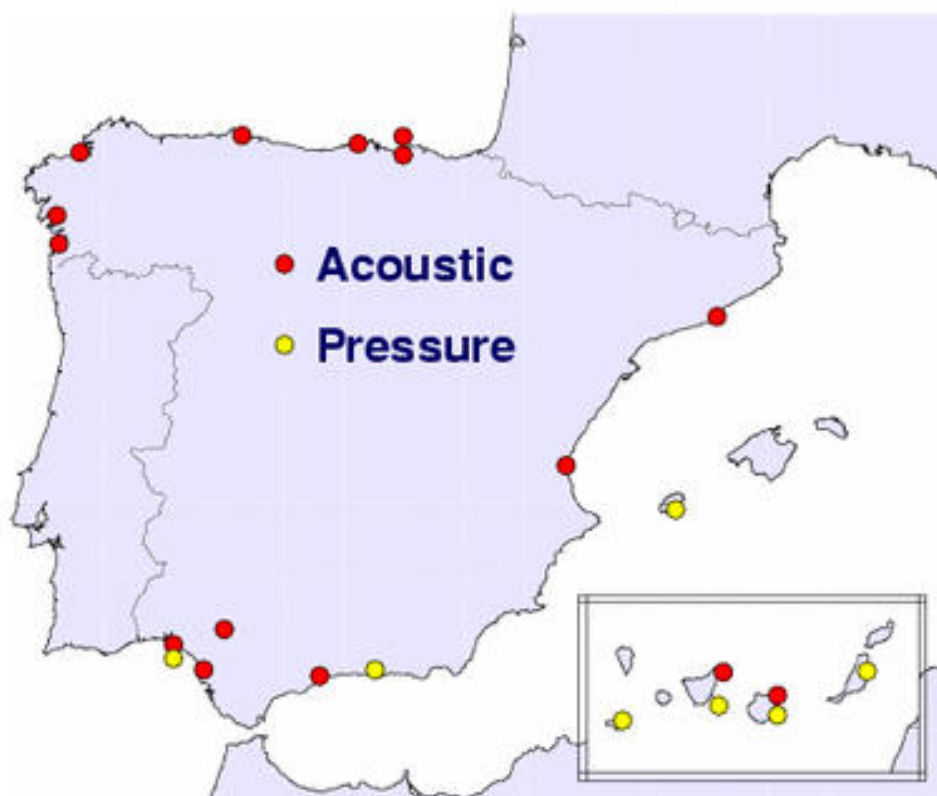


Figure 1: sea level stations belonging to the REDMAR Spanish Harbours Network

During the ESEAS-RI project a test station was established at Villagarcía de Arosa harbour (North West coast of Spain) in order to test different tide gauge technologies and especially to check the performance of the new radar gauges. Details of this experiment can be found on the web page of ESEAS-RI project (<http://www.eseas.org>). It is possible that future REDMAR network will be based in some of the radar gauges tested there.

In June 2004 the first continuous GPS station of Spanish Harbours was installed collocated with the Ibiza tide gauge (Balearic Islands), also within the ESEAS-RI project.

Table1 shows coordinates and data availability of the different tide gauges of REDMAR.

**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 float gauges. The complete equipment is composed of two different instruments: the classical mechanical float tide gauge (AOTT) and the data logger (Allgomatic). The mechanical float tide gauge is constituted by a set of pulleys that transmit the movement of the float to a continuous graphical recorder. The Allgomatic data

logger is a system controlled by a microprocessor that registers, stores and transmits the data. It is connected to the float by a codifier that converts the lineal movement of the wire float to a digital value, with millimeter precision. This system has a telephone modem for data transmission from the station at the sea to the headquarter office. Sometimes the datalogger is a computer.

Table 2: Spanish Institute of Oceanography Network

Site	Latitude	Longitude	Data available
Santander	43° 27' 45" N	03° 47' 22" W	1943-
A Coruña	43° 22' N	08° 24' W	1943-
Vigo	42° 14' 16" N	08° 43' 51" W	1943-
Cádiz	36° 32' N	06° 17' W	1949-
Tarifa	36° 00' N	05° 36' W	1943-1961,1963-1989,1991-
Ceuta	35° 54' N	05° 19' W	1943-
Algeciras	36° 07' N	05° 26' W	1943-1955,1961-2002
Málaga	36° 42' 50" N	04° 24' 52" W	1943-1959, 1961-
Palma de Mallorca	39° 33' N	02° 38' E	1973-1982,1989-1993,1996-
Arrecife	28° 58' 18" N	13° 31' 48" W	1949-1975,1980-
Puerto de la Luz	28° 08' 53" N	15° 24' 27" W	1949-1956,1971-1989,1991-
Sta.Cruz de la Palma	28° 40' 47" N	17° 45' 59" W	1949-1989,1997-

Table 2 shows the positions and availability of data of this network.

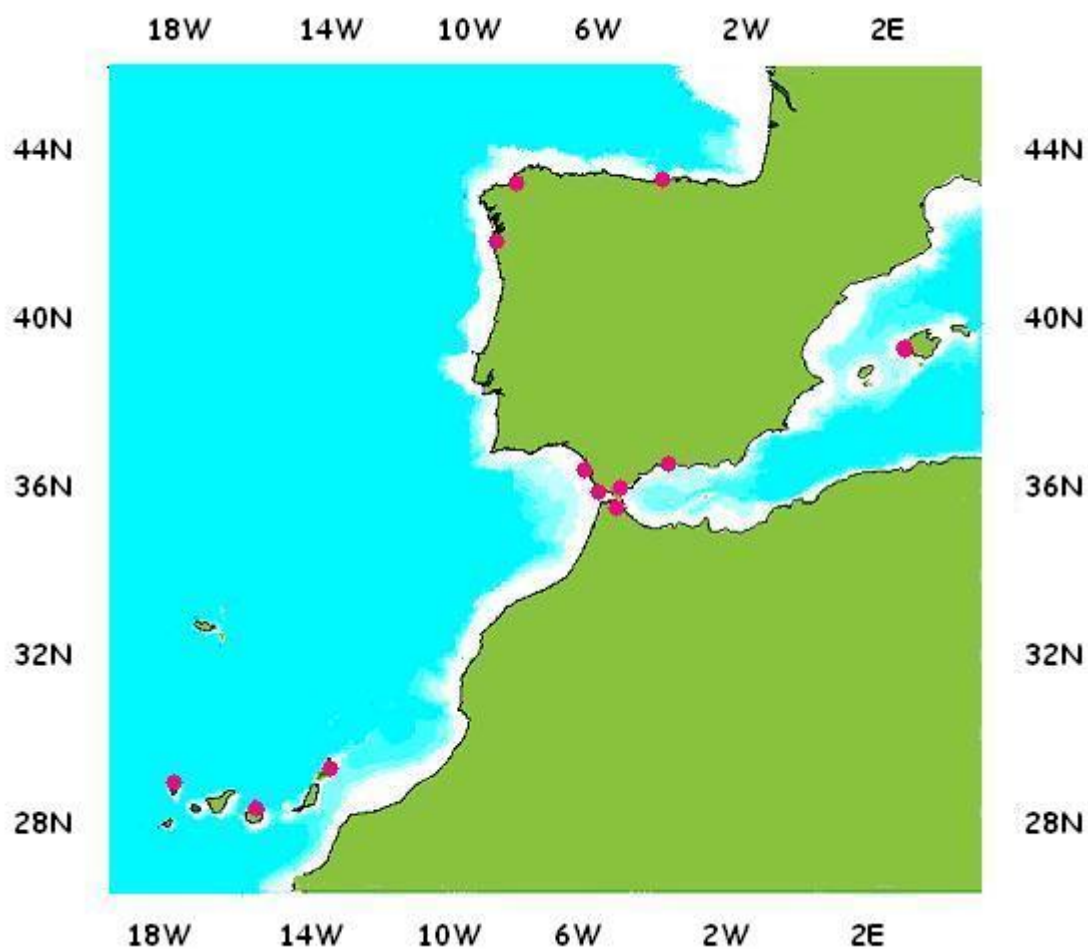


Figure 2: position of IEO sea level stations

During two years an experiment has been carried out by this institution for testing the radar technology and as a result of this, plans have been made for renewing the equipment. This year two complete stations based on the radar will be purchased including sensor, datalogger or computer and real time data transmission. Most of the data from this institution can be downloaded from [http://indamar.ieo.es/mareas/formulario\\_datos.htm](http://indamar.ieo.es/mareas/formulario_datos.htm).

A permanent GPS station was also established by IEO during ESEAS-RI in Puerto de la Luz station (Canary Islands).

Data are retrieved weekly by phone, only occasionally this done daily. Plannings for this year include instalation of ADSL telephone line in several stations for real time data transmission.

**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). The following table shows the stations and data availability, although exact coordinates of three of the stations are not available at the moment of doing this report. The other two are exactly at the same position than the corresponding REDMAR station.

Table 3: National Geographic Institute Network

Site	Latitude	Longitude	Data available
A Coruña			1950-1980,1990-
Almería			1977-1999
Alicante			1927-1939,1943-1946,1950-
S.C Tenerife	28° 28' 42" N	16° 14' 25" W	1926-1936,1940-1991,1995-
Fuerteventura	28° 30' 00" N	13° 51' 06" W	1999-2002