Date of Report: 24/04/2009

NATIONAL REPORT OF PORTUGAL

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1. Scope of Report

The Portuguese Hydrographic Institute (IHPT) is the Portuguese Navy's Laboratory of Ocean Sciences and is the main responsible for the installation and maintenance of tide gauge stations as well as acquisition, processing, archiving and dissemination of sea level data.

This Report describes Portugal's Tide Gauge Network, namely GLOSS stations, and gives some details about the technology employed, data availability and future projects.

2. National Tide Gauge Network

2.1. Map

At the moment, there are 23 operational tide gauge stations in Portugal. Figure 1 gives the location of these stations.

IHPT is responsible for most of the stations; however, Cascais and Lagos tide gauges belong to the Portuguese Geographic Institute (IGP) while Horta and Angra do Heroísmo gauges now belong to the Department of Oceanography and Fisheries (DOP) of the University of the Azores.

Although some of these gauges belong to other Institutions, IHPT continues to analyse and process sea level data from these stations in order to generate predictions that will be published in the Official Portuguese Tide Tables.

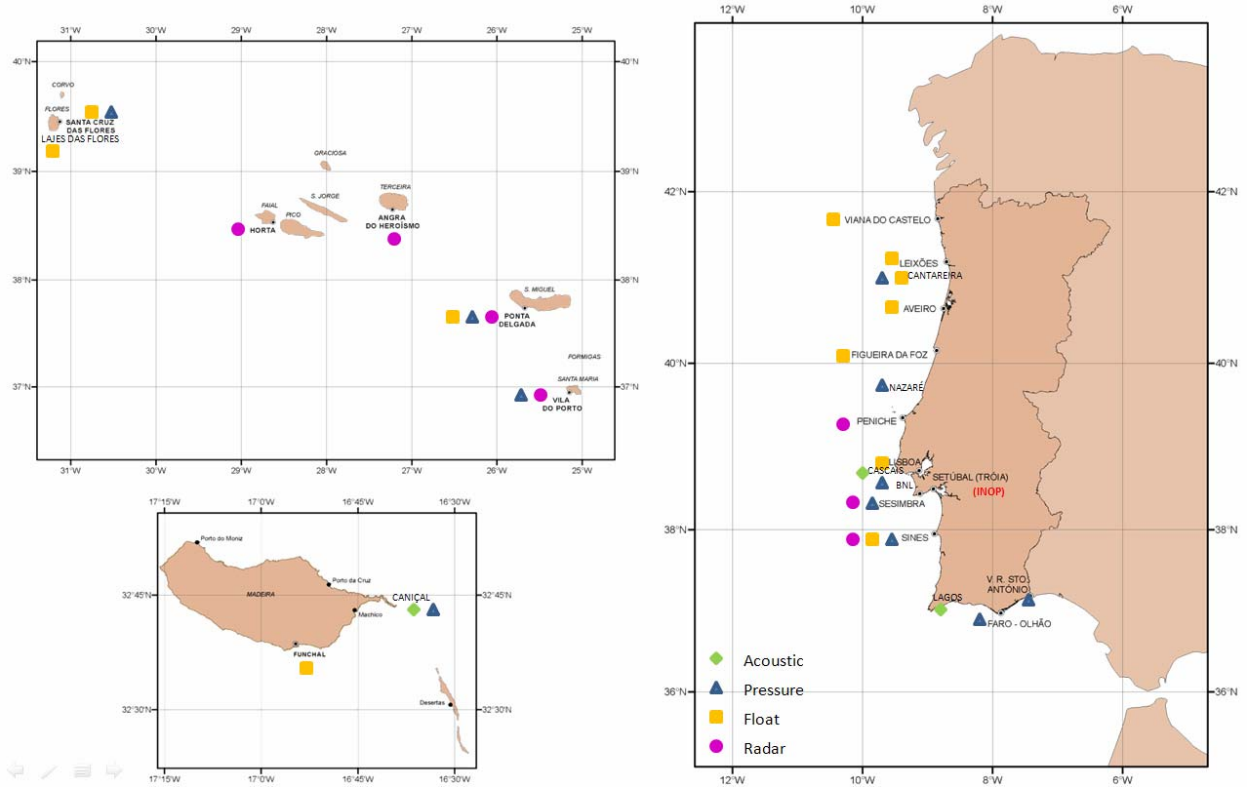

Figure 1 – National tide gauge network (symbols identify tide gauge technology)

2.2. List of Tide Gauge Sites and Specifications

A list of tide gauge sites with some details about gauge technology and sampling interval can be found in Appendix. All stations are operational apart from Setúbal/Tróia that was temporarily deactivated due to harbour constructions.

Gradually, an effort is being made to upgrade main stations:

- Horta and Angra do Heroísmo (Azores) have now a radar gauge installed by DOP.
- At Cantareira, in Douro River, a pressure transducer was installed and GSM connections were established.
- In order to integrate Peniche tidal station in the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas (NEAMTWS), a radar gauge was recently installed with a sampling interval of 1 minute; real time access to the station is now being developed and a pressure sensor for redundancy will be also installed soon, similarly to the system installed in Sesimbra, Sines and Vila do Porto (Azores).
- Lagos station is also being integrated in the NEAMTWS, so the data sampling interval was upgraded from 6 minutes to 5 seconds; for sea level analysis the sampling interval was upgraded to 3 minutes.
- The station at the mouth of Guadiana River, Vila Real de Santo António, was recently reactivated with the installation of a pressure transducer with GSM connection.

2.3. GLOSS Stations

Concerning GLOSS stations, an acoustic gauge was installed in Caniçal (Madeira) in December 2007. Still no level connection with the tide gauge in Funchal has been done because the beginning of the leveling works is behind schedule.

IHPT is now submitting data to GLOSS from two close sites in Funchal: besides analog records from the old site, we are now sending data from a float digital gauge. Figure 2 shows the location of these two tide gauges. The table in Appendix gives the respective coordinates.

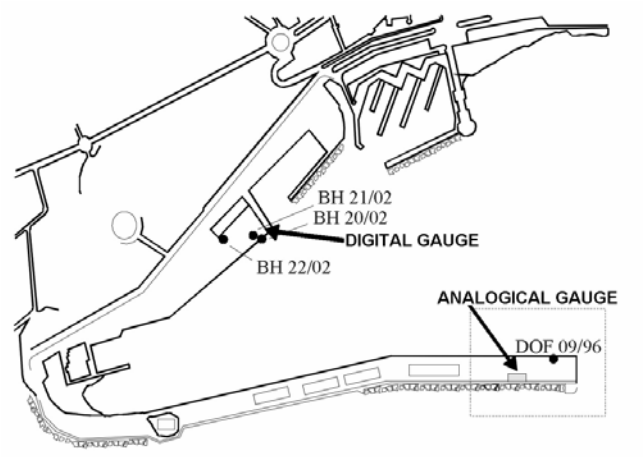

Figure 2 – Location of the digital and analog gauges in Funchal harbour.

In the beginning of 2008 a radar gauge, with a pressure sensor and a shaft encoder (float gauge) were installed in Ponta Delgada (Azores) by the University of Hawaii Sea Level Centre (UHSLC). Data is available at the UHSLC website. The radar and the pressure sensors have a sampling interval of 1 minute while the encoder has a 5 minute sampling interval.

The acoustic gauge that was to be installed in Lajes das Flores (Azores) is not operational any longer and now IHPT is considering other possibilities for upgrading this station. At the moment IHPT has a float gauge with a 6 minute sampling interval. These data is not ready for release because leveling works are to be done yet.

Due to the many gaps found in the analog records from Santa Cruz das Flores (Azores), a pressure sensor was installed in this station to assure good data quality. This station is very exposed to the sea and suffers high degradation. As soon as the leveling connections from this station to Lajes das Flores are done, IHPT intends to deactivate Santa Cruz das Flores station.

Cascais tidal station was upgraded in the beginning of 2009, by decreasing the sampling interval from 6 to 3 minutes (ftp access). For integration in the NEAMTWS, the data logger of this station also supplies 5 second raw data.

2.4. GPS Technology

GPS technology is not yet disseminated through the Portuguese Tide Gauge Network. However, at Leixões tidal station a GPS receiver has recently been installed by the University of Porto. Ponta Delgada, Horta and Angra do Heroísmo (Azores) tidal stations also have a GPS installed. At Cascais and Lagos, IGP has two GPS permanent stations, which belong to the European network EPN from EUREF. Here receivers and Leica GNSS antennas are installed. The GPS permanent station of Cascais is 275 m apart from the acoustic gauge. Lagos GPS station is 138 m apart from the tidal station.

2.5. Data availability

Cascais float gauge, which was installed in 1882, is the oldest in operation in Portugal. IGP has analog records since that time. Concerning the other 3 GLOSS stations, IHPT has data since the following years: 1962 for Funchal (Madeira), 1976 for Santa Cruz das Flores (Azores) and 1978 for Ponta Delgada (Azores).

Sea level data from the Portuguese GLOSS stations are available at the GLOSS and PSMSL websites. Since the stations of Ponta Delgada and Cascais have real time connections, the data from these stations are also available in near real time on the internet. Data from Ponta Delgada can be found at the UHSLC, at the Sea Level Station Monitoring Facility (VLIZ) and at the Sea Level along the European Atlantic Coast Line (SLEAC) websites. Data from Cascais is available at the VLIZ and SLEAC websites. IGP has also an ftp page where data from Cascais can be downloaded with a sampling interval of 3 minutes.

3. Sources of Further Information

Data from the Portuguese GLOSS stations can be found at the following websites, which give also a short description of the tide gauge stations:

http://www.vliz.be/gauges/map.php (Cascais and Ponta Delgada)
http://ilikai.soest.hawaii.edu/RSL1/index.html (Ponta Delgada)
http://ilikai.soest.hawaii.edu/uhslc/datai.html (all Portuguese GLOSS stations)
http://www.gloss-sealevel.org/station_handbook/ (all Portuguese GLOSS stations)
http://www.sleac.org/ (Cascais and Ponta Delgada)

Monthly and annual mean sea levels can be found at the PSMSL website:
http://www.pol.ac.uk/psmsl/psmsl-individual_stations.html

Tide predictions for the Portuguese Coast as well as some details about the tide in Portuguese territory can be found at the IHPT website: http://www.hidrografico.pt/

4. Future Projects

Due to the involvement on other international projects, IHPT is considering the release of sea level data from 4 other stations in Portugal. The data can be sent regularly to the Permanent Service for Mean Sea Level (PSMSL) or be available at the IHPT website.

Meanwhile, IHPT will continue to upgrade the Portuguese Tide Gauge Network through the installation of radar gauges and real time connections to the stations. Leixões, Nazaré and Lisboa are examples of stations that will soon be upgraded.

APPENDIX – List of Tide Gauge Stations in Portugal (April 2009)

Station Name	Coordinates (WGS84)	Responsible Institution	Gauge Technology	Current Sample (min)	Type of Transmisson	Network
Viana do Castelo	41º41,10'N 8º50,38'W	IHPT	Float	6 (OTT Thales); Continuous analog record digitised at 60 minute intervals (OTT R20)	GSM	
Leixões	41º11,20'N 8º42,27'W	IHPT	Float	6 (OTT Thales); Continuous analog record digitised at 60 minute intervals (OTT MXX)	GSM	
Cantareira (Douro River)	41º08,78'N 8º40,01'W	IHPT	Float Pressure (Druck)	6 (pressure); Continuous analog record digitised at 60 minute intervals (OTT MXX)	GSM	
Aveiro	40º38,60'N 8º44,97'W	IHPT	Float	6 (OTT Thales); Continuous analog record digitised at 60 minute intervals (OTT R20)	GSM	
Figueira da Foz	40º08,90'N 8º51,37'W	IHPT	Float	6 (OTT Thales); Continuous analog record digitised at 60 minute intervals (OTT R20)	GSM	
Nazaré	39º35,08'N 9º04,43'W	IHPT	Pressure (Valeport)	6	Laptop – Direct Link	
Peniche	39º21,22'N 9º22,47'W	IHPT	Radar (Krohne)	1	GSM	
Cascais	38º41,60'N 9º25,10'W	IGP	Acoustic (Aquatrak) Float	3 min (for tidal purposes) or 5 seconds (for NEAMTWS)	Internet	GLOSS NEAMTWS
Lisboa	38º42,63'N 9º09,66'W	IHPT	Float	6 (OTT Thales); Continuous analog record digitised at 60 minute intervals (OTT R20)	GSM	
Alfeite – Lisbon Naval Base (BNL)	38º40,30'N 9º08,97'W	IHPT	Pressure (Valeport)	6	Laptop – Direct Link	
Sesimbra	38º26,29'N 9º06,77'W	IHPT	Radar (Krohne) Pressure (Druck)	1 min (for tidal purposes) or 15 seconds (for NEAMTWS)	GSM	
Setúbal/Tróia	38º29,69'N 8º54,17'W	IHPT		Not Operational		
Sines	37º56,89'N 8º53,27'W	IHPT	Float Radar (Krohne) Pressure (Druck)	1 min (for tidal purposes) or 15 seconds (for NEAMTWS); 6 (OTT Thales); Continuous analog record digitised at 60 minute intervals (OTT R20)	GSM	NEAMTWS
Lagos	37º05,93'N 8º40,10'W	IGP	Acoustic (Aquatrak)	3 min (for tidal purposes) or 5 seconds (for NEAMTWS)	Internet	NEAMTWS
Barra de Faro/Olhão	36º58,69'N 7º51,97'W	IHPT	Pressure (Valeport)	6	Laptop – Direct Link	
Vila Real de Santo António	37º11,39'N 7º24,77'W	IHPT	Pressure (Druck)	1	GSM	

APPENDIX (continued) – List of Tide Gauge Stations in Portugal (April 2009)

Station Name	Coordinates (WGS84)	Responsible Institution	Gauge Technology	Current Sample (min)	Type of Transmisson	Network
Funchal	Analog: 32º38,51'N 16º54,43'W Digital: 32º38,64'N 16º54,78'W	IHPT	Float	6 (OTT Thales); Continuous analog record digitised at 60 minute intervals (OTT MXX)	GSM	GLOSS
Caniçal	32º44,17'N 16º44,06'W	IHPT	Acoustic (Aquatrak) Pressure (Druck)	1	GSM	
Sta. Cruz das Flores	39º27,29'N 31º07,48'W	IHPT	Pressure (Valeport) Float	6 (Pressure); Continuous analog record digitised at 60 minute intervals (OTT MXX)	Laptop – Direct Link	GLOSS
Lajes das Flores	39º22,70'N 31º10,12'W	IHPT	Float	6 (OTT Thales); Continuous analog record digitised at 60 minute intervals (OTT R20)	GSM	
Horta	38º32,04'N 28º37,31'W	DOP	Radar (Vega)	4	GPRS	
Angra do Heroísmo	38º39,03'N 27º13,31'W	DOP	Radar (Vega)	4	GPRS	
Ponta Delgada	37º44,16'N 25º40,27'W	UHSLC / IHPT	Radar (Vega) Pressure (Druck) Float	1 (Radar, Pressure); 5 (Float)	GTS (UHSLC)	GLOSS NEAMTWS
Vila do Porto	36º56,75'N 25º08,87'W	IHPT	Radar (Krohne) Pressure (Druck)	1	GSM	

Acronyms:

IHPT – Portuguese Hydrographic Institute
IGP – Portuguese Geographic Institute
DOP – Department of Oceanography and Fisheries of the University of the Azores
UHSLC – University of Hawaii Sea Level Centre