

UNESCO

Intergovernmental Oceanographic Commission (IOC)

Global Sea Level Observing System (GLOSS)

Ocean Data and Information Network for Africa (OdinAfrica)

MOROCCO Sea Level Network

Technical Visit Report

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1. SUMMARY

The objective of this technical survey was to (i) learn more about the status and history of existing tide gauge stations in Morocco; and (ii) to consider possible sites for an IOC-GLOSS-OdinAfrica sponsored tide gauge; and (iii) provide information on GLOSS/OdinAfrica programmes within Morocco. Historically limited sea level data has been available from North West Africa for GLOSS and related oceanographic science research activities along the Atlantic or Mediterranean.

With concerns over climate change, global warming and sea level rise issues in the scientific literature and public media it is important to promote the establishment of high quality sea level observations and access to data as part of GLOSS and OdinAfrica. Near real time tide gauge (TG) systems can be used to calibrate satellite altimetry, ocean circulation models and help to access local/regional rates of sea level rise. The data is essential for port hydrographic charting, safe ship navigation and production of annual tide tables for shipping. With concerns over earthquakes/tsunami in the region - near real time tide gauge systems can form an integral part of a tsunami warning system for the region.

Morocco has developed an extensive tide gauge network since 2003 with Radar/Microwave sensor tide gauge systems and digital data loggers. The Direction des Ports et du Domaine Public Maritime (DPDPM) now have 10 of these new radar TG systems at Dakhla, Laayoune, Tan Tan, Agadir, Kenitra, Mohammedia, Jorf Lasfar (Al Jadida), Tangier, Nador and at Safi. The Agence Nationale de la Conservation Fonciere du Cadastre et de la Cartographie (ANCFCC) have 2 acoustic tide gauges at Casablanca and Al Hoceima.

2. ITINERARY

Visit Agadir Port -Tide gauges (old and new), DPDPM office/staff.
Visit Essaouira - possible site for a new tide gauge - meet with Port staff.
Meetings with CNDIO/INRH/ISTPM senior staff in Agadir.
Meeting DPDPM Ports Management senior staff at Rabat.
Visit Casablanca Port DPDPM old tide gauge and Mohammedia Port new tide gauge.
Meeting with ANCFCC senior staff at Rabat to discuss GLOSS/continuous GPS.
Meeting with Prof Orbi/INRH staff Casablanca.

Travel - UK-Agadir-Essaouira-Agadir-Casablanca-Rabat-Casablanca-Rabat-Casablanca-UK. All flights via Royal Air Maroc. Internal road travel kindly provided by CNDIO/INRH.

3. INSTITUTES/ORGANISATIONS VISITED

3.1. CELLULE NATIONALE DE DONNÉES ET D'INFORMATION OCÉANOGRAPHIQUES (CNDIO)

CNDIO is a research group between the University of Ibn Zohr, Faculty of Science, Agadir, the Institut Spécialisé de Technologie des Pêches Maritimes (ISTPM) and the Faculty of Science, University Mohammed V, Rabat.

Hassan El Ouizgani (National co-ordinator and data manager for ODINAFRICA) is among the persons to develop CNDIO to promote OdinAfrica with co-operation of data sharing and oceanographic activities between each organisation (see also <http://www.cndio-maroc.org>).

3.2. INSTITUT SPECIALISE DE TECHNOLOGIE DES PECHEES MARITIMES (ISTPM)

Specialised Institute of Ocean Fisheries Technology, Agadir. Ministry of Ocean Fisheries <http://etudiant.ma/istpm.htm>. This is a College/Institute involved in training fisheries officers with courses in navigation, marine biology, oceanography and fisheries technology with a residential college

next to INRH Office in Agadir. The ISTPM residential college is located next to INRH offices in Agadir overlooking the Port.

Lecturer Aziz Regragui from the ISTPM Fisheries Department, Laboratory of Oceanography and Marine Biology accompanied Hassan El Ouizgani and myself to Essaouira Port and Agadir Port.

3.3. INSTITUT NATIONAL DE RECHERCHE HALIEUTIQUE (INRH)

The Scientific Institute of Marine Fisheries (ISPM) was created in 1969 and it has been in charge of fisheries research. In 1996, the institute became known as the Institut National de Recherche Halieutique (INRH).

Research activities include: physical oceanography, marine ecosystems, aquaculture, monitoring biological and chemical pollution sources, fishery resources, coastal management, mapping of fishing areas. With commitments to EU Marine projects: MEDAR, MEDATLAS, SEA-SEARCH, SEADATANET, CARBO-OCEAN, NATFISH, EUROCEANS, ENCOR, SESAME, ECOOP, MYTILUS.

INRH is a Public Establishment part of the Department of Fisheries, Ministère de l'Agriculture, Développement Rural et des Pêches Maritimes.

INRH Head office is at Casablanca and regional centres are at Dakhla, Laayoune, Agadir, Tanger and Nador; specialised centres are at Agadir and M'Diq and have a network of eight environmental monitoring stations (RSSL). With two research vessels AL Amir Moulay Abdellah and Charif Al Idrissi <http://www.inrh.org.ma/>.

Dr Karim Hilmi (OdiAfrica 3 Project/WPII Co-ordinator) and Prof Orbi are the INRH staff concerned with Physical Oceanography assisting fisheries activities and research.

3.4. AGENCE NATIONALE DE LA CONSERVATION FONCIERE DU CADASTRE ET DE LA CARTOGRAPHIE (ANCFCC)

ANCFCC is the National Agency involved with topographical mapping surveys, photogrammetry, cartography, GPS and high order geodetic control surveys for Morocco, with the head office in Rabat. Equipment includes Leica GPS, Mors HT200 tide gauges and Centrix CG5 Gravimeter with full map production facilities (see also www.ancfcc.gov.ma).

3.5. DIRECTION DES PORTS ET DU DOMAINE PUBLIC MARITIME (DPDPM)

DPDPM is a Public Department of the Ministère de l'Équipement et du Transport concerned with management of all Morocco Ports, navigation, dredging with a department concerned with hydrographic surveys and oceanography. DPDPM head office is based at Rabat (see also www.mtpnet.gov.ma).

4. HISTORY OF MOROCCO SEA LEVEL MEASUREMENTS

Limited information was available on historical sea level measurements. The DPDPM has operated float type tide gauges (TG) at various Ports primarily for port construction and hydrographic surveys. A float type TG has operated at Agadir (Southern Harbour) up to 2006, the installation date is uncertain. This old TG was maintained by the present Agadir Marégraphe technician from 1982 to 2006 but this is no longer in service and was replaced in 2006 by the new Warsh/Martech Aurore 200 Radar TG in the newer Western Harbour.

The Marine Royale (Navy) have operated a network of tide gauges for hydrographic charting. No information was available on this network or systems used.

ANCFCC have operated Mors HT200 tide gauges at Casablanca and Al Hoceima for the past year.

5. EXISTING TIDE GAUGES IN MOROCCO

Direction des Ports et du Domaine Public Maritime (DPDPM) informed that they have installed and presently maintains 10 new operational radar/microwave tide gauges located at:

Morocco Mediterranean Sea	Tangier and Nador
Morocco Atlantic Coast	Agadir, Kenitra, Mohammedia, Jorf Lasfar (Al Jadida), Safi, Tan Tan
Western Sahara ¹	Dakhla ¹ , Laayoune ¹

For maps of the region please see the maps produced by the United Nations Cartographic Section <http://www.un.org/Depts/Cartographic/english/htmain.htm> .

The above mentioned 10 tide gauges are from Warsh Electronics (Casablanca), who custom developed these systems for DPDPM, and the first gauges of this batch were installed in 2003. Martec/Serpe-IESM of France provided the AURORE 200 data logger. A GPS patch antenna is used for time calibrations with a Vega Radar/Microwave sensor and guided wave antenna (VegaPuls 65). The system has potential Meteosat/GSM capability for data transmission - but presently only a replaceable data cartridge is utilised. (The BM18/19 data collection transmitter for geostationary satellites (METEOSAT – GOES – GMS) manufactured by ELTA (http://www.elta.fr/uk_doc/BM18.PDF) can be used in connection with the Aurore 200 datalogger).

The DPDPM radar sensor tide gauges are presently fitted with Vegapuls 65 sensors and microwave guide antennas operating in the C or K band frequencies. The 65 model has an accuracy of +/-10mm with a 24-degree beam width. The guide wave antennas attached to the VegaPuls radar sensors come in various types/materials to suit the application and environment (www.vega.com). The benefits of Radar technology is that it overcomes the problems of accuracy with temperature/humidity variations when using acoustic transducers.

Data is recorded every 10 minutes. All tide gauge data is processed in Rabat, with data sent as an attachment to an email on a monthly or 3 monthly period from all ports.

Note that the DPDPM - ANCFCC tide gauges do not have additional pressure transducers as per new GLOSS/OdinAfrica tide gauges.

SHOM and Creoccean (a marine science consultancy from La Rochelle, France) provided initial guidance on systems and locations to the Ports Directive. Creoccean have an office in Morocco.

DPDPM are seeking advice from SHOM about tide gauge calibrations and establishing new benchmarks next to the new tide gauges. SHOM have provided DPDPM with tidal analysis software.

¹ The boundaries, names shown and the designations used do not imply official endorsement or acceptance by the United Nations.

Location	Responsible Authority	System Type	Sensor	Operational	Installed
Dakhla²	DPDPM	Warsh. Martech Aurore 200 logger.	VegaPuls Radar 65	No	Not yet
Laayoune²	DPDPM	Warsh. Martech Aurore 200 logger with solar panel.	VegaPuls Radar 65	Yes	Since 2003
Tan Tan	DPDPM	Warsh. Martech Aurore 200 logger.	VegaPuls Radar 65	Yes	2006
Agadir Port	DPDPM	Warsh. Martech Aurore 200 logger.	VegaPuls Radar 65	Yes	2006
		Info not available	Float/Stilling Well	No - up to 2006	Info not available
Jorf Lasfar (El Jadida)	DPDPM	Warsh. Martech Aurore 200 logger.	VegaPuls Radar 65	Yes	Since 2004
Casablanca Port	ANCFCC	Mors HT200	Acoustic	Yes	2006
	Meteorological Institute	Info not available	Info not available	Info not available	Info not available
	Marine Royal	Info not available	Info not available	Info not available	Info not available
	DPDPM	Info not available Stilling well/solar panel	Info not available	No	Info not available
Mohammedia Port	DPDPM	Warsh. Martech Aurore 200 logger.	VegaPuls Radar 65	Yes	2006
Kenitra	DPDPM	Warsh. Martech Aurore 200 logger.	VegaPuls Radar 65	Yes	Since 2004
Tanger	DPDPM	Warsh. Martech Aurore 200 logger.	VegaPuls Radar 65	Yes	Since 2005
Al Hoceima	ANCFCC	Mors HT200	Acoustic	Yes	2006
Safi	DPDPM	Warsh. Martech Aurore 200 logger.	VegaPuls Radar 65	No	Since 2004
Nador Melilla/Nador Port	DPDPM	Warsh. Martech Aurore 200 logger.	VegaPuls Radar 65	Yes	Since 2005

Table 1. Summary of tide gauges operated in Morocco and Western Sahara (updated April 2007). Note: DPDPM older tide gauge systems at Safi and Casablanca are no longer working. Dakhla harbour/tide gauge is on the inner side of a 40km cape/spit similar to Nouadhibou (Mauritania). Nador tide gauge is located at Nador/Melilla Seaport and not inside the Nador Lagoon.

Note: Warsh Electronics (Casablanca) Tide gauge; Marégraphe Côtier Numérique

² See footnote 1

5.1. CASABLANCA PORT TIDE GAUGE

Mr Mohammed Belachkar, Chef de la Division Hydrographie Bathymétrie et Océanographie from DPDPM head Office along with Karim Hilmi (INRH) assisted with the visit to the old tide gauge at Casablanca.. This old DPDPM tide gauge is no longer operational and the cabinet was locked so no information on the system type was available. This had a small solar panel with a stilling well. The support frame and stilling wells (2) are badly corroded. The location is ideal for a new tide gauge with good security, 9 metre water depth and alongside the Port control tower which is manned 24 hours a day. Electrical power is available and a secure room for the system. The radar tower mast can be used to support a Meteosat antenna.

A real time local tide level display unit would be essential for Port control shipping movements as DPDPM mentioned large ships can only enter/leave Port at High Water and therefore needed a new tide gauge for this reason. No benchmarks were identified. They presently rely on tide predictions for shipping movements which is not ideal.

Prof. Orbi at INRH Casablanca indicated that it is likely that 3 tide gauge systems already exist in Casablanca with ANCFCC, Marine Royale and the Meteorological Institute. It was not possible to visit these two organisations except for the old DPDPM tide gauge at the Port Control Tower. As of this writing subsequent follow up from IOC with Marine Royale and the Meteorological Institute have not been able to confirm whether these institutions also operate tide gauges at Casablanca.

5.2. AGADIR PORT TIDE GAUGE

The DPDPM tide gauge is located in the newer north western port at the petrol/fuel ship terminal overlooked by a security/fire control building. This site has restricted access. The TG system is a Warsh Radar Gauge with a Martec Aurore 200 data logger and a Vegapuls 65 Radar sensor installed in 2006. Data is sent every month to DPDPM Rabat for processing by email attachment.

Mohammed Rhanmaoui the DPDPM maregraphe technician is responsible for the tide gauge and the port navigation systems, he previously operated the old tide gauge (float type) on the military pier in the old eastern Port from 1981-2006. It is uncertain when the old tide gauge was installed but may be as far back as 1940 when this eastern port at Agadir was constructed.

5.3. MOHAMMEDIA PORT TIDE GAUGE

The DPDPM Warsh Aurore 200 Radar tide gauge is located on the inner southern side of the Port at a sheltered jetty. The DPDPM Tide Gauge technicians Mr Layachi Badreddine and Mr Rkiouak Abderrahim based at DPDPM head office in Rabat accompanied us to the site along with Karim Hilmi (INRH). The data cartridge is changed every 3 months along with sea level calibrations provided the sea is calm.

5.4. TAN TAN

Tan Tan is a designated GLOSS Core Network station (see references for more information on the GLOSS core Network) and is at the same latitude as the Islas Canarias and on the Atlantic coast. We were unable to visit Tan Tan during this visit as with a distance of 351 km from Agadir this would have required an extra 2/3 days. DPDPM have a small port here and a new operational Warsh radar tide gauge installed in 2006. As long as DPDPM can maintain the radar tide gauge with local technicians and regular calibrations are carried out then Tan Tan could still be part of the GLOSS Core Network and provide useful data concerning the Canary Current System and upwelling important for Morocco's fisheries oceanography.

6. BENCH MARKS AND CALIBRATIONS

The DPDPM Radar TG at Agadir has a tide gauge bench mark (TGBM) approximately 10 meters away from the TG and is a small steel bolt in a vertical jetty wall surface. No periodic calibrations have been carried out at Agadir since installation of the gauge in 2006.

At Mohammedia the DPDPM Radar TG has a TGBM just next to the base of the TG. This is used for 3 monthly calibrations when the data cartridge is changed.

DPDPM are aware of the importance of regular calibrations and benchmarks and are taking advice from SHOM to install at least 3 benchmarks at each TG and provide regular calibrations. At present there are no stilling wells provided for sea level calibrations at the new DPDPM TG locations.

No information was available on the ANCFCC benchmarks or calibrations.

7. EXISTING DATA AVAILABILITY

Sea level data from Morocco has only been provided to GLOSS/PSMSL for 3 years (1957-1959) from Casablanca and 1 year from Sidi Ifni (1963).

All DPDPM data is now archived and processed at DPDPM head office in Rabat.

No information is available on data from the Marine Royale (Navy) or the Meteorological Institute regarding any tide gauges they may operate.

ANCFCC have data from Al Hoceima and Casablanca Mors-HT200 tide gauges for at least one year.

8. AN ODINAFRICA/GLOSS SPONSORED TIDE GAUGE IN MOROCCO

8.1. CASABLANCA

DPDPM proposed the option of installing a new GLOSS/OdinAfrica tide gauge at Casablanca Port, replacing the old (now non-operational) tide gauge at the Port Control Tower. This site is ideal with 9m water depth, good security, sheltered harbour, electrical power and a secure room for the system cabinet/logger. The port-control tower would need a local real time display unit for ship movements, as these are high water dependent for some of the larger vessels. DPDPM staff from Rabat could easily maintain a new TG here along with the existing DPDPM Radar TG at Mohammedia Port (28 km from Casablanca).

8.2. BOUJDOUR

Boujdour was proposed as a possible location by INRH for a new tide gauge to help study the Canary Current System and the permanent upwelling regions on the Atlantic coast. INRH could provide logistical support and a technician from INRH offices in Laayoune and Dakhla, 196 km and 304km, respectively from Boujdour. However regular weekly calibrations may be difficult to arrange.

Ref: www.mtpnet.gov.ma/Vpm/Maroc%20Maritime/ports/PortsAtlantiques/Boujdour/Plan.htm.

Boujdour is a small fisheries harbour with limited port infrastructure or security, no jetty structure with only a rubble breakwater, so it would be difficult to install a TG. However to provide initial sea level data to assist with research into the upwelling and Canary Current System the data from the new DPDPM TG systems now at Dakhla, Laayoune, Tan Tan and Agadir should be suitable.

8.3. ESSAOUIRA

Seasonal upwelling around the Agadir/Essaouira region is another application suitable for a high accuracy/near real time tide gauge. Essaouira was initially proposed by DPDPM/INRH for a new tide gauge, however the small harbour is open to the public and tourists so security will be an issue.

A potential location was found on the east - outer side of the sheltered eastern small jetty at the harbour entrance. This location is however affected by 0.5m (maximum) waves in the windy summer months with the North/North-West winds and swells. At this location on the eastern jetty, water depth is an issue with only 0.8m (approx) at spring low tide, so not ideal for a stilling well with pressure transducers. A location on the immediate opposite side of this jetty may have been more suitable but unfortunately the rocks exposed at low tide will affect a radar sensor tide gauge signal and also prevent a pressure sensor/stilling well system. The main western jetty/breakwater protects the harbour entrance from the unusual strong summer season winds and waves. Numerous moored fishing vessels make it impossible to use a radar sensor tide gauge inside the harbour.

Essaouira is more suitable for a dual-pressure sensor system, enclosed within a strong stilling well and secure cabinet inside the main harbour basin. A location will need to be found without being affected by the numerous moored fishing vessels. Further photographs/measurements are needed at either side of the base of the jetty walls at 'spring low tide' and within the inner harbour basin to assist with any proposed installation.

8.4. OPTIONS PROPOSED

DPDPM proposed the alternative option of providing Casablanca as a suitable location for a new GLOSS/OdinAfrica tide gauge and moving the old DPDPM tide gauge from Casablanca to Essaouira if it is still operable.

Additional/alternative options could also be to provide Meteosat packages for a number of DPDPM TG systems which may be suitable for Tsunami research/warning system. Warsh Electronics (www.warshelectronics.com) in Casablanca who developed and installed the DPDPM TG systems could assist with Meteosat upgrades in collaboration with Martech/Serpe-IESM the manufacturers of the Aurore 200 data logger <http://en.martec.fr/>.

9. ANCFCC CONTINUOUS GPS STATIONS/TIDE GAUGES

ANCFCC have started to develop research activities in continuous GPS (CGPS) for vertical land movements (VLM) with a network of Leica GPS stations at Guelmim, Agadir, Casablanca, Rabat, Tanger and Al Hoceima. With ANCFCC Mors HT200 acoustic tide gauges at Al Hoceima and Casablanca.

The CGPS station at Al Hoceima is 4km from the ANCFCC tide gauge and at Agadir the CGPS station is 10km from the DPDPM tide gauge. However the location of ANCFCC CGPS stations is on top of buildings for security and would be impossible to spirit level to tide gauge benchmarks.

Vertical height separation between TG and CGPS can be achieved by differential GPS (DGPS). But ideally the CGPS station needs to be alongside the TG or within 1km for ease of regular high order geodetic spirit levelling and at ground level.

10. CONCLUSIONS/RECOMMENDATIONS

DPDPM and ANCFCC might consider participating more actively in the GLOSS programme. GLOSS organises regularly training courses for tide gauge technicians and provides additional technical training material through its web-site.

DPDPM has suggested Casablanca as a possible location for a GLOSS/OdinAfrica sponsored tide gauge. Although the ANCFCC may have a TG system at the same location, it is likely that this gauge would not provide the required accuracy for sea level scientific research (i.e. long term sea level science studies).

Essaouira may be impractical for an open air radar tide gauge system due to lack of security and numerous moored fishing vessels. More information is needed including photographs of exposed rocks and information of depth of water at spring low tides. A pressure sensor/stilling well system could be used inside Essaouira main harbour basin if DPDPM can provide a suitable secure jetty wall away from moored boats and fisheries activities. The stilling well would need to be galvanised steel to avoid damage by moored vessels. Alternatively utilise a Warsh VegaPuls radar tide gauge with the radar sensor enclosed inside a steel stilling well.

Boujdour is not suitable for a GLOSS/OdinAfrica tide gauge system with limited DPDPM port facilities and logistics problems with such a remote site.

An option could also be to improve the accuracy of the DPDPM Radar tide gauges with an upgrade to the newer VegaPuls 61 B-Version radar sensor guided microwave antenna. This has a 10-degree beam width with an accuracy of +/-3mm as compared to the Vegapuls 65, which has a 24-degree beam width and +/-10 mm accuracy.

Upgrading one or two DPDPM sea level stations at the Mediterranean and Atlantic coast with real time transmission capability (i.e. a satellite transmitter for use international geostationary meteorological satellites under the World Meteorological Organisation (WMO)) could also be considered. Such an upgrade would allow existing stations both in the Mediterranean and along the Atlantic coast to be part of the North Eastern Atlantic, Mediterranean and connected seas Tsunami Warning System (NEAMTWS). As a start an international North-East Atlantic sea level network is presently under establishment (see www.sleac.org and Fig 1). The BM18/19 data collection transmitter for geostationary satellites (METEOSAT – GOES – GMS) manufactured by ELTA (http://www.elta.fr/uk_doc/BM18.PDF) has been used in connection with the Aurore 200 datalogger.

DPDPM is encouraged to establish tide gauge benchmarks and regular calibrations for its tide gauge network. (IOC/GLOSS may be able to assist with training). Maintaining benchmarks and calibrations will help to build a reliable national sea level monitoring network that can provide high accuracy data for multiple use spanning from port operation, storm surge monitoring, tsunami monitoring, coastal zone management over to research.

ANCFCC is developing research into vertical land movements (VLM) with continuous GPS near tide gauges. Co-location of tide gauges with Continuous GPS stations is of interest to the GLOSS programme. There is a group (TIGA) associated with the GLOSS programme that address this issue and ANCFCC might want to consider linking up with this network.

DPDPM proposed the option of providing Casablanca as a suitable location for a new GLOSS/OdinAfrica tide gauge and moving the old DPDPM tide gauge from Casablanca to Essaouira if it is still operable. With equipment costs significantly lower than installation costs and time involved - it may be more cost effective to obtain a new tide gauge system than utilise old equipment.

The status of Tan Tan sea level station as part of the GLOSS Core Network should be re-examined. An alternative DPDPM tide gauge with easier accessibility may be more optimal. However Tan Tan has a DPDPM radar tide gauge installed in 2006.

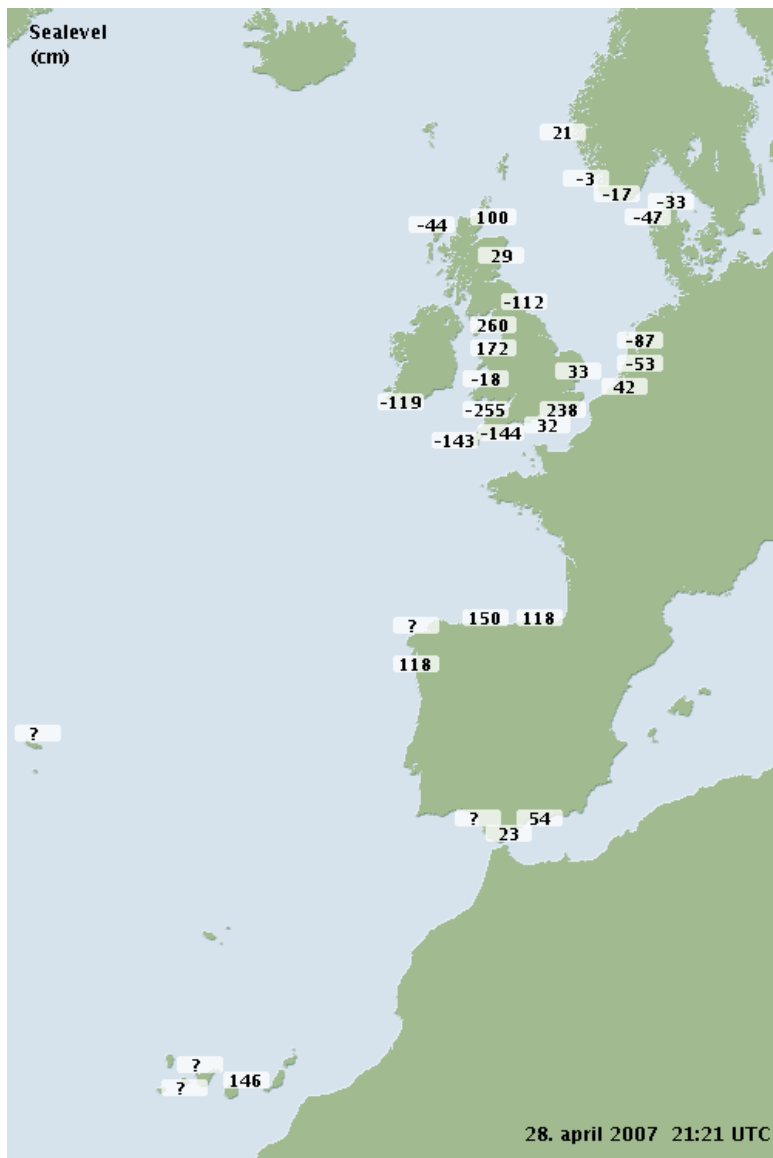


FIGURE 1. STATIONS PRESENTLY IN THE SEA LEVELS ALONG THE EUROPEAN ATLANTIC COASTLINE (SLEAC) PROJECT (SEE REFERENCE LIST FOR FUTURE INFORMATION)

11. SUGGESTED ACTIONS FOR GLOSS

1. Further information on the history of tide gauges and access to TG data will need additional follow up by GLOSS with DPDPM and ANCFCC at Rabat.

2. Contact the manufacturers of the Warsh radar tide gauge and Mors HT200 acoustic tide gauge to assess suitability of sending data by Meteosat along with full system specifications and accuracies. Contact DPDPM and Vega to assess the suitability of upgrading the DPDPM/Warsh tide gauge VegaPuls Radar sensors and wave guided antennas to a higher accuracy configuration.

Follow up the potential in installing VegaPuls radar sensors inside steel stilling wells, which may provide a solution at locations such as Essaouira or elsewhere in Africa.

3. Investigate the option of translating IOC GLOSS Technical Manuals into French.

4. Review the status of Tan Tan as part of the GLOSS Core Network.

APPENDICES

1. ODINAFRICA/GLOSS CONTACTS IN MOROCCO

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2. REFERENCES

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www.ciesm.org/online/monographs/villefranche05.pdf

Institut National de Recherche Halieutique (INRH) <http://www.inrh.org.ma/>

Direction des Ports et du Domaine Public Maritime (DPDPM)
(Ministère de l'Équipement et du Transport) www.mtpnet.gov.ma

Morocco Ports Details/Plans/Photographs
<http://www.mtpnet.gov.ma/vpm/Maroc%20Maritime/LienPorts.htm>

Agence Nationale de la Conservation Foncière du Cadastre et de la Cartographie (ANCFCC)
<http://www.ancfcc.gov.ma>

Cellule nationale de données et d'information océanographiques (CNDIO) <http://www.cndio-maroc.org>

University of Ibn Zohr, Faculty of Science, Agadir
www.univ-ibnzohr.ac.ma
www.fsa.ac.ma

Institut Spécialisé de Technologie des Pêches Maritimes (ISTPM)
<http://etudiant.ma/istpm.htm>
www.mpm.gov.ma/marin/etablissement/agadir.htm

Ministry des Pêches Maritimes www.mpm.gov.ma

Sea Levels along the European Atlantic Coastline www.sleac.org

UNESCO IOC GLOSS www.gloss-sealevel.org

Vertical land movement at tide gauges <http://www.pol.ac.uk/psmsl/landmove.html>

OdinAfrica www.odinafrica.org

Mediterranean Science Commission www.ciesm.org

ELTA data collection transmitter for geostationary satellites (http://www.elta.fr/uk_doc/BM18.PDF)

Martec Fr Group
www.serpe-iesm.com/
<http://en.martec.fr/>

Martec Aurore 200 data logger
http://en.martec.fr/page/p-211/art_id-687/

Warsh Electronics Casablanca
www.warshelectronics.com
warsh@menara.ma

Vega (VegaPuls Guided Microwave/Radar Sensors)
www.vega.com

www.vega.fr

www.vegacontrols.co.uk

Individual Morocco Station Data from POL PSMSL data holdings (2007)

www.pol.ac.uk/psmsl

Station name = CASABLANCA PSMSL country/station code = 350/021 GLOSS code (if a GLOSS station) = Location = 33 36 N 07 36 W Number of years of data = 3 Spanning 1957 to 1959 Authority Comments: auth.code 19

Station name = SIDI IFNI PSMSL country/station code = 350/051 GLOSS code (if a GLOSS station) = Location = 29 22 N 10 12 W Number of years of data = 1 Spanning 1963 to 1963 Authority Comments: auth.code 66

3. MEASUREMENTS OF WATER DEPTH AT TIDE GAUGE SITES WITH BENCHMARK LOCATIONS

1. **Agadir** - Radar Tide Gauge

Water depth 6m @ 12.30 LT /GMT on 5/2/07

Jetty surface level to sea bed 10m.

BM is a small steel bolt approximately 10m NE from TG in top of vertical sea wall facing SE.

2. **Essaouira**

Possible tide gauge site - middle of outer side of eastern short jetty at harbour entrance.

Jetty surface to sea bed 5.5m. Water depth 2m, at 12.30pm LT/GMT 6/2/7 (2.5 hrs after low tide)

Tide level on 6/2/7 at Agadir LW at 10.00hrs =1.09 and at 12.30=1.78, difference of 0.69m.

And Spring low on 19/3/07 at 0755hrs = 0.58m at Agadir.

Indicates water depth at this location on Essaouria jetty approx only 1.31m at LW on 6/2/07.

At Spring low tide (19/3/07) depth at Essaouri jetty as only 0.80m.

BM (Iron pipe) located on northeast side support wall of Northern Arch entrance to Skala de la Ville.

3. **Casablanca**

Old DPDPM Tide Gauge at the Port Control Tower.

BM - no information

Water depth 9.5m, sea bed to jetty surface level 14m @ 11.15am 9/2/7

Cable run from existing TG to Port control tower control room 40m. Height to control tower roof 4m from roof of building.

4. **Mohammedia** - Radar Tide Gauge

BM - top surface of steel right angle bar at edge of jetty surface immediately alongside NW side of tide gauge.

4. SURVEY PHOTOGRAPHS

Rabat DPDPM



Figure1, Meeting at DPDPM Head Office in Rabat

Direction des Ports et du Domaine Public Maritime

Layachi Badreddine (DPDPM Marégraphe Technician), Dr Karim Hilmi (INRH), Mr Belachkar (Chef de la Division Hydrographie Bathymétrie et Océanographie, DPDPM), Ali Adouch (Director, DPDPM)

Agadir Port



Figure 2, Mr Ajbli (DPDPM Port Technical Director), Mohamed Rhanmaoui (DPDPM Marégraphe Technician), Dr.Hassan El Ouizgani (CDNIO), Aziz Regragui (ISTPM) alongside Agadir DPDPM Radar tide gauge.



Figure 3, Direction des Ports et du Domaine Public Maritime DPDPM Warsh/Martech Radar Tide Gauge-Agadir.



Figure 4, Dr.Hassan El Ouizgani pointing to the Agadir Tide Gauge BenchMark (TGBM) nearby.

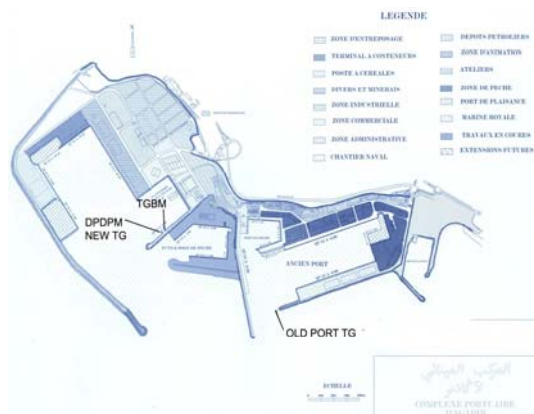


Figure 5, Port Plan of Agadir - DPDPM Radar Tide Gauge as indicated in newer North-Western Port with the TGBM alongside. Location of old float type tide gauge indicated in older eastern Port.

Essaouira



Figure 6, Essaouira Harbour Entrance and fishing fleet.



Figure 7, Abdelaziz Sahraoui (DPDPM) Essaouira Port Chief of Management, indicating location of BM.



Figure 8, Essaouira. Location of old Tide Gauge.

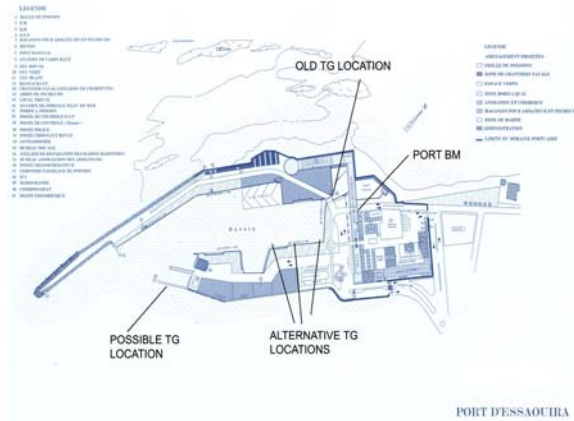


Figure 9, Essaouira Port Plan and locations.



Figure 10, Essaouira. Inner Port Basin and fishing boats. Potential location for a stilling well/pressure sensor TG with secure cabinet & stilling well. Note: problems of fishing boats/mooring lines.



Figure 11, Essaouira Harbour entrance eastern jetty with electrical power available at the navigation light. Potential location for a radar tide gauge.

Casablanca



Figure 12, Casablanca Port Control Tower and old Tide Gauge alongside



Figure 13, Old Port TG and rusting stilling wells

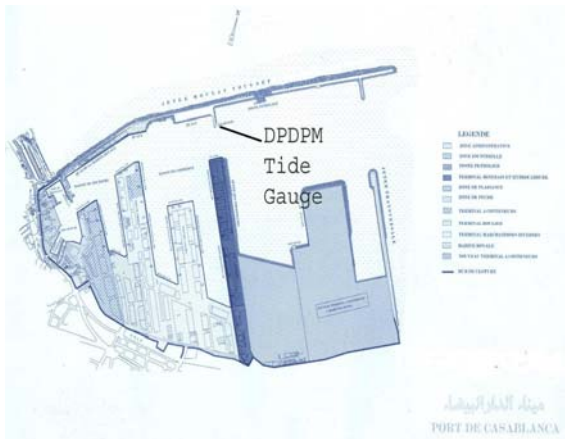


Figure 14, TG Location within Casablanca Port



Figure 15, Old Tide Gauge with solar panel (no longer operational), Casablanca.



Figure 16, INRH office in Casablanca with the Mosque Hassan II, Minaret Tower (200 metres high)



Figure 17, Dr Karim Hilmi and Prof. Abdellatif Orbi, Physical Oceanography Department, INRH, Casablanca. Satellite images of Dakhla and Nador on wall.

Mohammedia Port



Figure 18, DPDPM Marégraphie Technicians Rkiouak Abderrahim & Layachi Badreddine, Dr Karim Hilmi & Ahmed Rharfi (INRH).



Figure 19, DPDPM Marégraphie Technician Layachi Badreddine pointing to the TGBM. Radar/microwave guide antenna just visible at base of cabinet.



Figure 20, Mohammedia DPDPM Warsh/Martech Radar Tide Gauge. Data cartridge is the grey cylinder at the base of the Aurore 200 data logger.



Figure 21, VegaPuls Radar Sensor (yellow) and GPS Patch Antenna alongside at the open base of the galvanised steel cabinet. The microwave/radar antenna wave-guide extends (approx 35cm) below the VegaPuls sensor.



Figure 22, Mohammedia Port Radar Tide Gauge

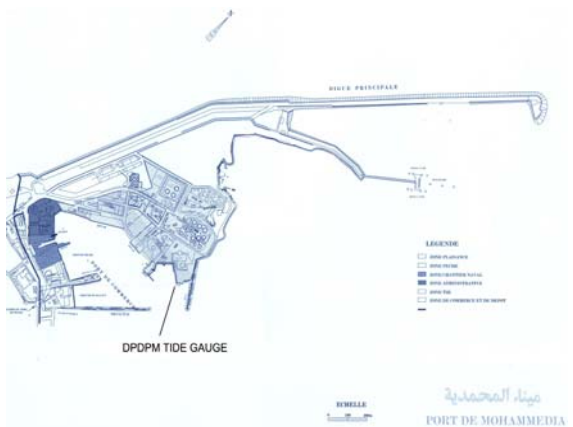


Figure 23, Port Plan of Mohammedia indicating location of the DPDPM tide gauge.