The Global Sea Level Observing System

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The IALA Navguide (2002) now contains a section (Section 6.6) with advice on sea level measurements and draws attention to recommendations on sea level measurements from the Global Sea Level Observing System (GLOSS).

In this article we provide an overview of GLOSS and suggest some areas in which IALA may help further towards the implementation of GLOSS.

The need for sea level measurements

Short-term sea level measurements, often with real-time data transmission, are needed for: (i) the provision of operational sea level data to ships entering or leaving harbour; (ii) the delivery of data to storm surge and tsunami warning systems; and (iii) the management of sluices and barrages. In addition, the same data can be used in delayed mode for: (i) the determination of tidal constituents for application to tidal prediction and for establishment of chart datum; (ii) the computation of 'extreme levels' (the probabilities of exceeding given levels in terms of 'return period') for input to coastal engineering design including work on sea defences and port development; (iii) the wide range of scientific studies including those of long-term changes of Mean Sea Level and the statistics of extremes for insurance purposes.

Sea level data have also many applications in the rapidly developing field of 'operational oceanography'. Sea level data provided in near real time are used by oceanographers, together with data from satellites, within global/regional/local ocean numerical models in order to predict 'ocean weather' in analogous fashion to the use of air pressure and wind data within operational weather forecasts. These modelling products may in a few years become standard operational tools with, for example, currents made available to vessel traffic services centres and as navigational overlays on electronic chart systems. (See also information on the Global Ocean Observing System (GOOS) later in the Annex).

Long-term changes in global sea level due to climate change is also the focus for much research because of the potential impacts on the environmental, economic and social infrastructure at the coast. In that context the many sea level records gathered by national navigational, hydrographic and port authorities are now of great importance to sea level change studies.

It is hence evident that there are many potential users of data from a tide gauge. In that context we ask for the help of the IALA members with responsibility for operating national sea level observation networks in ensuring that, whenever

Système global d'observation du niveau de la mer

(Global Sea Level Observing System)

Cet article met en lumière la nécessité de mesurer le niveau de la mer, pour aider les navires lorsqu'ils doivent entrer au port ou le quitter, pour fournir les données à utiliser lors des tempêtes, pour gérer les écluses et barrages, pour la prédiction des marées, l'établissement des cartes marines, ainsi que les calcul des niveaux extrêmes utilisés par le génie civil pour la conception des défenses contre la mer et des ports. En outre, ces informations peuvent servir aux études scientifiques utilisant le concept de "niveau moyen de mer" et aux statistiques sur les extrêmes, utilisés cette fois en assurance.

Les données sur le niveau de la mer peuvent aussi trouver une application dans le domaine de l'océanographie opérationnelle.

Dans les années 1980 la Commission Océanographique Internationale (COI) de l'UNESCO a lancé un programme dénommé "système global d'observation du niveau de la mer" (GLOSS). Son but était de mettre en place un réseau mondial d'indicateurs de marée plus professionnel avec, autant que possible, des normes communes élevées pour les matériels et la transmission des données et, par conséquent, des normes communes élevées pour la production des résultats.

Les membres de l'AISM ont été invités à contribuer à l'amélioration du réseau central GLOSS par la rénovation des indicateurs de marée, la fourniture de données en général et de données sur l'historique des niveaux de la mer. ■

gauges are installed, consideration is given to the multiple usage of the data. That may mean that hardware installed might be a bit more expensive than what was considered initially. However, the same data should then be exploitable by a wider range of users, which should lead to cost savings and efficiency gains overall.

The GLOSS Programme

In the 1980s, the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) initiated a programme called the Global Sea Level Observing System (GLOSS). While many countries had donated (and continue to donate) their sea level data on a regular basis to the global sea level data bank (called the Permanent Service for Mean Sea Level, PSMSL), GLOSS was established to develop the worldwide network of tide gauges on a more professional basis with, as far as possible, common high standards for hardware and data transmission, and, consequently, common high standards for the resulting data sets.

This development was analogous to the construction many years ago of coordinated global networks for meteorology with data shared between all participating national agencies. Such collaboration has for instance led to improved forecasting both on a global and regional scale.

The implementation of GLOSS follows its implementation plan (IP). The first GLOSS IP was published in 1990 and the second version was published in 1997.

To this end GLOSS consists of the following components: (i) coordination of a Core Network of 287 stations (see Figure 1); (ii) technical advice and training concerning sea level observations and data analysis; (iii) provision of tide gauges, GPS and geodetic equipment. Due to the limited resources the main focus of GLOSS is on (i) and (ii).

The current status of the GLOSS Core Network is that about 67% of the 287 stations are considered operational and deliver monthly and annual average sea level values in delayed mode to PSMSL. About 50% of the stations deliver hourly sea level values to the international sea level databanks.

About 100 stations in the GLOSS Core Network deliver near-real time values of sea-level to the GLOSS Fast Centre.

The operational level of the GLOSS Core Network has now reached a level of development which can to some extent be considered a plateau. There are important gaps in some regions, the most obvious being those for which access is difficult such as Antarctica. In addition, there are extensive parts of Africa, South America and Asia where help is required to complete the network. That is why we need the help of organisations such as IALA and its members responsible for sea level measurements, if the network is to develop further.

Requests to IALA members with responsibility for sea level measurements

There are several ways in which IALA members with responsibility for sea level measurements can contribute to the enhancement of the GLOSS Core Network and its sub-networks.

Upgrade and Renovation of Tide Gauges -

As mentioned above, sea level measurements in ports and harbours are often required by a wide range of users. The different applications imply different standards: real-time operations such as ship movements demand accuracies of around 0.1 m whereas long-term monitoring of sea level trends calls for accuracies of order 0.01 m or better. However, in practice there are advantages in making all observations to the highest standards so that the data are available for all applications. The difference in cost between a high quality sea level gauge and a lower quality one is small. Many agencies will in the coming years upgrade and renew their tide gauge networks. Therefore, we would urge these agencies to aim if possible for replacement by high quality gauges. Advice on types of tide gauge technology is available from the PSMSL Training web page mentioned in the Table. In some cases GLOSS may also be able to provide technical expert visits to help advise on improvements in sea level recording and development of national/regional tide gauge networks.

Data submission -

Each country will have 'GLOSS Contacts' who are people nominated by their Governments to keep in touch with the GLOSS programme (and especially with the GLOSS Technical Secretary at IOC), deliver status reports on their national sea level recording to IOC (see the GLOSS web-site for examples of status reports), and aid the flow of data to international data centres. Consequently, good communication should exist between the Contacts and the people responsible for the gauges in the ports.

Data submission to the international data banks such as the PSMSL has always been of great importance in delayed-mode. However, near real-time delivery of data for local and global operational purposes and for delivery to the GLOSS Fast Centre is becoming increasingly more important. Consequently, there are increasing demands on GLOSS Contacts to communicate effectively and in a timely way. The help of IALA members with responsibility for sea level measurements is requested to make national dialogues work as efficiently as possible, so that international communications between Contacts, IOC and data banks can in turn be improved further.

To that end GLOSS also offers training courses in sea level observations and data analysis for tide gauge operators. These courses are offered approximately once per year.

Historical Sea Level Data – Data Archaeology

GLOSS has a particular interest in the continuation of sea level recording at sites with very long historical records whether those sites are formally in the GLOSS Core Network or not. Historical tide gauge data are usually in the form of paper charts and tabulations, and their conversion to modern computer-accessible media is called 'data archaeology'. These data sets are of potential great value to the sea level community in a range of applications, of which the most obvious is the extension of existing sea level time series as far back as possible in order to understand more completely the timescales of sea level change. Information about the extent of historical records is currently being collected by the GLOSS programme, and hydrographic agencies are asked to inform GLOSS if they have archives of such information in their organisations. Information may be sent to the GLOSS Technical Secretary in IOC.

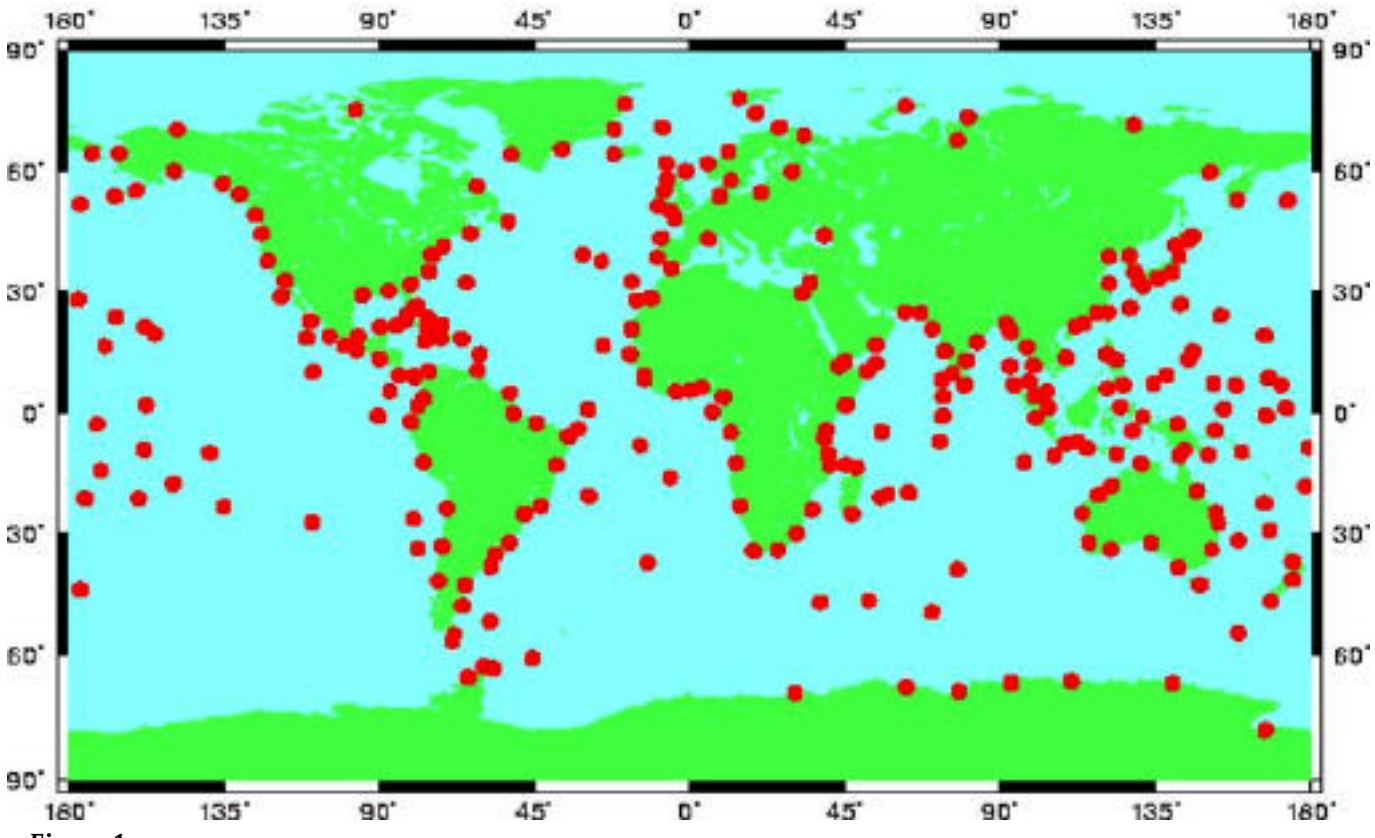

Figure 1

Annex:
Additional Information on GLOSS and Related Organisations

Intergovernmental Oceanographic Commission

The Intergovernmental Oceanographic Commission (IOC) of UNESCO was established in 1960 as a specialized mechanism of the United Nations system to coordinate ocean scientific research and ocean services worldwide. The work of IOC focuses on:

(i) development, promotion and facilitation of international oceanographic research programmes to improve understanding of critical global and regional ocean processes and their relationship to the sustainable development and stewardship of ocean resources;

(ii) planning, establishment and co-ordination of an operational global ocean observing system to provide the information needed for oceanic and atmospheric forecasting, for oceans and coastal zone management by coastal nations, and for global environmental change research;

(iii) provision of international leadership for education and training programmes and technical assistance essential for systematic observations of the global ocean and its coastal zone and related research; and

(iv) assurance that ocean data and information obtained through research, observation and monitoring are efficiently handled and made widely available. IOC collaborates with other relevant organization within and outside the UN system to pursue these objectives. The IOC is composed of its Member States (currently 129), an Assembly, an Executive Council and a Secretariat.

More information on IOC is available at:
http://ioc.unesco.org.

Global Ocean Observing System (GOOS)

The vision guiding the development of GOOS is one of a world where the information needed by governments, industry, science and the public to deal with marine related issues, including environmental issues, sustainable development, and the effects of the ocean upon climate, is supported by a unified global network to systematically acquire, integrate and distribute oceanic observations, and to generate analyses, forecasts and other useful products.

The analogy for GOOS is the highly successful World Weather Watch (WWW) of the WMO, which underpins all weather forecasting. Typical GOOS products might include, for instance: forecasts of change in water level; positions and strengths of currents; occurrence of coastal flooding; extent of sea ice. Consequently, benefits might include improvements in, for example, forecasts (of wind, waves, sea-ice); warnings (of storms; high waves; surges); management (of ports and harbours, fisheries and aquaculture); optimising offshore design and operations; ship routeing.

GOOS currently includes a number of existing observing programs including GLOSS. In addition there are some specific time-bounded activities included in GOOS such as the Global Ocean Data Assimilation Experiment (GODAE), which will provide a significant step forward by integrating space-based remotely sensed data and field measurements of ocean properties (including sea level observations) into advanced numerical models run on supercomputers to describe and forecast ocean behaviour at a high level of detail, and to yield products useful for environmental managers and forecasters. A unique feature of GODAE is the Argo Profiling Float Programme, which will seed the world ocean with 3000 profiling floats to obtain upper ocean temperature and salinity profiles globally for the first time, as the necessary complement to the global data on the ocean surface that are collected by satellites. GODAE will run from 2003 to 2007. The deployment of Argo floats has already begun. If successful, GODAE will transition from an experiment to a fully operational and continuous programme, as one of the means of developing GOOS as an operational system. The experiment and its follow on are critical to obtaining the high level of detail needed to support the sustainable development of ocean and coastal seas resources.

More information on GOOS, GODAE and Argo is available at:
http://ioc.unesco.org/goos
www.bom.gov.au/bmrc/ocean/GODAE/
http://www.argo.ucsd.edu/

Global Sea Level Observing System (GLOSS)

GLOSS is a part of GOOS. For more information on GLOSS download a copy of its Implementation Plan via the above web page or contact Dr. Thorkild Aarup via the above email. The same web page also provides a link to various other related reports and data sets concerning GLOSS.

http://www.pol.ac.uk/psmsl/programmes/gloss.info.html
Email: t.aarup@unesco.org

Permanent Service for Mean Sea Level (PSMSL)

The PSMSL is the global data bank for long term sea level change information. Its data bank consists of approximately 50000 station-years of monthly and annual means of sea level. The PSMSL also functions as the long term GLOSS International Archiving Centre. The PSMSL also provides a range of information on its Training Web Page (Information, Reports, Manuals, Tidal analysis software etc.) accessed via the above address.

http://www.pol.ac.uk/psmsl/
Email: psmsl@pol.ac.uk

University of Hawaii Sea Level Center (UHSLC)

The UHSLC hosts the Joint Archive for Sea Level and maintains a Research Quality Data Set of hourly, daily and monthly values of sea level for several hundred stations primarily but not exclusively in the Pacific. The UHSLC is now the nominated GLOSS Fast Centre for the collection and transmission of near-real time data.

http://www.soest.hawaii.edu/UHSLC/
Email: markm@soest.hawaii.edu

Other Sea Level Programmes and Data Sets

See
www.pol.ac.uk/psmsl/programmes/