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IOC/JCOMM/GLOSS/ODINAFRICA Training Workshop on Sea-Level Measurement and Interpretation

13–24 November 2006
Ostend, Belgium

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Abstract

This report provides a summary of the IOC/GLOSS/OdinAfrica Workshop on Sea-Level Observation and Analysis which took place from 13-24 November 2006 in Ostend, Belgium. The main objective of the workshop was to train tide gauge operators from Africa and the Western Indian Ocean on sea level measurement hardware and software and aspects of sea level science. The report also provides an overview of methods and materials used in the region and provides a set of recommendations concerning sea level activities in the region.

***Note**: this report is published in electronic copy only and is available on UNESDOC, the documents database of UNESCO (http://unesdoc.unesco.org/ulis/)*

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1. INTRODUCTION

Training in sea level observation and data analysis for tide gauge operators has been an important component of the IOC's Global Sea Level Observing System (GLOSS). Since the GLOSS program was established in the mid 1980s courses have been held at the Proudman Oceanographic Laboratory (Liverpool, UK) approximately once per year until 1993. From then on courses have been convened at about the same frequency but at different locations around the world. While the courses have continued to evolve the core elements have remained the same (i.e. sea level observations, benchmark levelling, quality control, tidal prediction etc.) and underlining the requirements for long term high accuracy sea level measurements.

The Ocean Data and Information Network for Africa (ODINAFRICA) is a project under the IOC's International Ocean Data and Information Exchange (IODE) program which brings together marine institutions from twenty-five IOC Member States from Africa. The ODINAFRICA project was initiated in the late 1990s and is now in its third phase. The aim of the current phase of ODINAFRICA is to improve the management of coastal and marine resources and the environment in participating countries by: (i) enhancing data flows into the national oceanographic data and information centres in the participating countries, (ii) strengthening the capacity of these centres to analyse and interpret the data so as to develop products required for integrated management of the coastal areas of Africa, and (iii) increase the delivery of services to end users.

One of the work packages in the current phase of ODINAFRICA focuses on (i) upgrading African sea level stations in order to develop an African sea level observing network that is part of the GLOSS Core Network; and (ii) rescuing historical sea level data. The present joint ODINAFRICA-GLOSS training course is a contribution to these activities and in particular it is a preparation for the tide gauge operators who will be responsible for the planned sea level stations supported under ODINAFRICA. In light of the need for expanding the tide gauge support/maintenance community as well as the user community of sea level data, it is the hope that participants in this workshop will train colleagues of the different aspects of sea level observation, data analysis, and generation of sea level products for the benefit of local and global science.

2. LECTURES

The workshop program is provided in Annex I.

PowerPoint presentations from most of the lectures are available at http://www.pol.ac.uk/psmsl/powerpoint/

Opening and introduction to workshop [V. Vladymyrov, P. L. Woodworth and A. Aman]

The Workshop commenced the morning of Monday, 13 November 2006 and the participants were welcomed by Vladimir Vladymyrov, head of the IODE project office. In his presentation, he outlined the objectives of the IODE project office:

- Establish a creative environment facilitating the further development and maintenance of IODE projects, services and products with emphasis on improving the efficiency and effectiveness of the data and product/service stream between the stage of sampling and the user;

- Assist in strengthening the capacity of Member States to manage oceanographic data and information (with special attention to the developing countries) and to provide ocean data and information products and services required by users.

The workshop chairman Philip Woodworth introduced the course program (Annex I). In the opening session, Philip Woodworth gave an overview of the history of the sea level data collection of the Permanent Service for Mean Sea Level (PSMSL) and of the GLOSS network. He mentioned that there is a complementarity action between GLOSS and ODINAFRICA. This presentation was followed by an overview of ODINAFRICA by Angora Aman, regional coordinator for coastal observing system. He especially focused on the strategy of ODINAFRICA for tide gauge installations at a selected set of African sites.

Overview of IODE [V. Vladymyrov]

The IOC's International Oceanographic Data and Information Exchange Committee (IODE) was established in 1961 *to enhance marine research, exploitation and development by facilitating the exchange of oceanographic data and information between participating Member States and by meeting the needs of users for data and information products*. The IODE system forms a worldwide service oriented network consisting of National Oceanographic Data Centres and World Ocean Data Centres. During the past 40 years, IOC Member States have established over 60 national oceanographic data centres and the number keeps increasing. This network has been able to collect, quality control, and archive millions of ocean observations, and make these observations available.

The IODE Programme is trying to address the new challenges related to ocean data and information management. Whereas in the past IODE data centres focused mainly on delayed-mode, physical oceanography data, the IODE now gives attention to all ocean related data including physical, chemical, and biological oceanographic data, and to operational data streams in addition to delayed mode data.

In order to respond to these challenges, the IOC Project Office for IODE has been established in Ostend, Belgium. The Project Office is hosted and supported by the Flemish Government through the Flanders Marine Institute. The main objectives of the Project Office are:
(i) to provide a creative environment facilitating the further development and maintenance of IODE Projects, services and products; (ii) to assist in strengthening the capacity of Member States to manage oceanographic data and information (with special attention to the developing countries) and to provide ocean data and information products and services required by users.

The Project Office contains several conference rooms and is equipped with all necessary furniture, computer, audio and video equipment. During its first 1.5 years of existence the Project Office has organized 21 training workshops in which 255 trainees from 78 countries were trained.

Ocean Teacher Overview [M. Brown]

The objective of Ocean Teacher is to provide training tools for Oceanographic Data and Information Exchange. The tools are used during the IODE training courses but can be used for self training and continuous professional development. The Ocean Teacher is structured as follows:

- Digital Library (software, data examples and exercises)

  The software toolbox contains more than 30 free programs ready for installation with documentation. The Digital Library provides information on oceanographic data management, information on technology and scientific communication and oceanography today. 7500 resource documents, 44 000 illustrations and more than 17500 external links are available on this Library. The main site is: http://ioc.unesco.org/oceanteacher

- Course Manuals: it contains 5 available oceanographic courses and 7 courses on data management and a catalogue.

- OceanPortal: the web site http://www.oceanportal.org contains a catalogue for many resources on Ocean Teacher and 5000 indexes exist on data and information.

Overview of GLOSS, GOOS and CLIVAR [P.L. Woodworth]

Philip Woodworth provided an overview of the Global Sea Level Observing System (GLOSS) program formerly known as the Global Level of the Sea Surface. GLOSS was initiated in the 1980s with the aim of increasing the quantity and quality of month and annual MSL data to the Permanent Service for Mean Sea Level (PSMSL) for application to climate change, oceanographic and coastal sea level research. Philip Woodworth also described other international global observing programmes to which GLOSS contributes sea level data to i.e. the Global Ocean Observing System (GOOS) and the Global Climate Observing System.

Overview of ODINAFRICA [A. Aman]

The Ocean Data and Information Network for Africa (ODINAFRICA) brings together marine related institutions from twenty five Member States of the Intergovernmental Oceanographic Commission of UNESCO from Africa. The earlier phases of development of ODINAFRICA aimed at enabling member states from Africa to get access to data available in other data centres, develop skills for manipulation of data and preparation of data and information products, and develop infrastructure for archival, analysis and dissemination of the data and information products. The goal of the current phase of ODINAFRICA is to improve data flows into the national oceanographic data and information centres in the participating countries, develop data and information products required for integrated management of the coastal areas of Africa, and increase the delivery of services to end users.

The network has assisted the Member States to establish and operate National Oceanographic Data and Information centres, and in particular: to get access to data available in other data centres, develop skills for manipulation of data and preparation of data and information products, and develop infrastructure for archival, analysis and dissemination of the data and information products. Each of the participating institutions has developed a suite of data and information products that have been quality controlled, merged and availed through project website (www.odinafrica.org). These include: Directories of marine and freshwater professionals; Catalogues of marine related data sets; Marine Species data bases, library catalogues, catalogue of marine related publications from/about Africa.

The three thematic work packages being implemented in the current phase of ODINAFRICA are: (i) Coastal Ocean Observing System, focusing on upgrading and expanding African network of sea level stations, provision of near real-time observations of ocean variables, and building adequate capacity for analysis and management of sea-state variables, (ii) Data and Information Management, focusing on further development and strengthening of National Oceanographic Data Centres (NODC) to manage data streams from the coastal ocean observing network, and Integrating biogeographic and hydrological data steams into NODC systems, and (iii) Product Development and end user communication and information delivery, focusing on identification of end users of marine/coastal data/information products and their requirements, identification and development of set of core products to be prepared by each NODC, development of the African Marine Atlases, improvement of atmospheric and oceanic monitoring databases, promotion and dissemination of outputs of the project, and assessment of the impacts of products on the end-user. The Intergovernmental Oceanographic Commission (IOC) of UNESCO in collaboration with the Flanders government has initiated the development of the Ocean Data and Information Network for Africa (ODINAFRICA-III) project. The goal of ODINAFRICA-III is to prepare databases, and data and information products, for integrated management of the coastal environments and its resources.

Types of tide gauges [P. L. Woodworth]

Philip Woodworth gave an overview of the four most common tide gauge measuring technologies:

a) A stilling well and float systems. The filtering of the waves is done through the mechanical design of the well. This technology is used in a large part of the global network.
b) Pressure systems: in this technology, the sub-surface pressure is monitored and converted to height based on knowledge of water density and local acceleration due to gravity. The different variants are: Single Transducer systems. Multiple Pressure Transducer Systems (‘B Gauges’), Bubbler Pressure Gauges. The pressure transducer systems are often used for tsunami monitoring.
c) Acoustic systems: in this system the transit time of a sonic pulse is used to compute distance to the sea surface.
d) Radar systems: they are similar to acoustic transmission, but using radar frequencies. This system is relatively cheap and can be easily installed. It is necessary to calibrate the system at regular intervals. Although this technology is relatively new, radar gauges are being purchased and installed by number of agencies as replacements for the older instruments or for completely new networks (example of ODINAFRICA).

Regional oceanography and climate (West Africa) [A. Aman]

Rainfall over West Africa is notoriously unreliable, especially in the northern part. Two sequences of a few extremely dry years were part of a longer drought that lasted continuously from the end of the 60’s to the mid 90’s. This drought event is one manifestation of the climate variability of West Africa, spanning a large range of time scales from intraseasonal to decadal. There is a need for a better understanding of this variability and for improved seasonal forecasting skills. This variability is under the control of a dominant atmospheric feature: the West African Monsoon (WAM).

Surface conditions also play an important role in the dynamics of the continental water cycle, mostly due to vegetation. At decadal and interannual time scales, the Sea Surface Temperature (SST) anomalies in the tropical Atlantic, and the evolution of vegetation cover and land use have to be considered first because they modify the land sea contrasts and the sensible and latent vertical heat fluxes. Seasonal rainfall amounts over West Africa depend strongly on SST anomalies, not only in the tropical Atlantic, but on a global scale.

Beyond the regional motivations explained above, one has also to consider the role of West Africa in a global context. This role received little attention. However, West Africa is one of the major heat sources of the earth climate.

In spite of these considerations, this area is poorly instrumented and needs to be better equipped with monitoring stations to obtain a more precise understanding of the climate variability. For several years, the African Monsoon Multidisciplinary Analyses (AMMA) program (with its ocean component EGEE) and PIRATA (Pilot Research moored Array in the Tropical Atlantic) have been developed in order to improve our knowledge on the variability on the sea surface temperature and on the mixing processes which are observed in the Gulf of Guinea. Atmospheric (wind, relative humidity, air temperature, precipitation, incident radiation) and oceanic (temperature from surface to subsurface, salinity and pressure) parameters are measured. The measurement of these parameters with those provided by the tide gauges and the satellite altimeters will improve the numerical models used and hopefully leading to a better understanding of the West African climate.

Characteristics of sea level records [P. Woodworth]

In this course the focus is on sea level observations measured relative to a tide gauge benchmark on land. The values of sea level (or sea surface height) are either spot-measurement at regular time intervals or averages (called integrations) over the time intervals of 5, 6, or 15 minutes. For the tsunami work, time intervals of a minute or less are usually needed.

The sea level records show the ocean tide, seiches, signals due to storm surges and climate change depending on timescales. From a year of good tide gauge data, it is possible to determine the tidal characteristics at any location and Tables of Predicted Tide Levels for local use. Tidal and non-tidal components of the sea level record can be separated easily using Harmonic Tidal Analysis of a tide gauge data set.

Tide gauge operations in Belgium [J. Verstraeten]

Johan Verstraeten gave an introduction to sea level measurements in Belgium which covers long term sea level measurements which are part of coastal, river, canal and international networks. The lecturer used the example of Ostende tide gauge to describe the procedures of maintenance of a coastal tide gauge: every week, the registration paper is changed and an external check of the level and time take place. The stilling well maintenance occurs twice per year. There is also a levelling survey connecting with nearby benchmarks every year while a GPS levelling to check the stability between tide gauges occurs one per 2 years. A yearly absolute gravity campaign completes this work. The tidal data are used for: paper registrations, ‘talking tide gauge’, data transmitted online data, bathymetric surveys, storm surge monitoring and warnings, tidal analysis, tide tables publications etc.

The second part of the presentation described the offshore sea level measurements. The measurements concern tidal heights and tidal currents measured respectively by a pressure tide gauge and an ADCP.

For more information on Belgian sea level observations and products please see:

- http://www.vlaamsehydrografie.be
  - Tidal data and hydrometeorological data
  - Tide tables
- http://www.lin.vlaanderen.be/awz/waterstanden/hydra/
  - Tidal data from rivers, water levels and flow on canals
- http://www.ngi.be
  - Benchmarks
  - Monitoring of the permanent GPS network

- http://www.flepos.be
  - Permanent GPS network
- http://homepage.oma.be/mvc/
  - Absolute gravity

Altimetry in the Gulf of Guinea [A. Aman]

Sea level observations from the TOPEX/POSEIDON (T/P) radar altimeter and tide gauges records are used to perform an intercomparison at the Sao Tome, Pointe Noire and San Pedro sites. A Gaussian low-filter is applied to both data sets which suppresses high frequency fluctuations on periods of much less than 2 months. The results obtained show the capability of the altimeter data to reproduce the sea level time series with an rms difference of 3.4 cm at Pointe Noire and San Pedro and 2.3 cm at Sao Tome. The correlation coefficients are 0.93, 0.86 and 0.92 respectively at Pointe Noire, San Pedro and Sao Tomé. This result is consistent with other intercomparisons carried out in the Pacific Ocean. It confirms the capability of the T/P altimetry in detecting sea level changes, within about 2 cm rms accuracy. It confirms also the necessity to maintain a tide gauge network in the Gulf of Guinea that could be used to calibrate signals derived from satellite altimetry.

The second part of this presentation focused on the upwelling signal itself and its space distribution along the northern and southern coasts of the Gulf of Guinea. The altimetry data reproduce clearly the seasonal signal in the Gulf of Guinea. The upwelling signal propagates westward along the Côte d'Ivoire, Ghana and Benin coasts. The mechanisms of the equatorial and coastal upwellings in the Gulf of Guinea have not been analyzed in detail but they are of a great interest for climate and local fisheries for the neighbouring countries.

East African Regional Oceanography [S. Mahongo]

For the purpose of this presentation, the East African region was defined to encompass the East African mainland states of Somalia, Kenya, Tanzania and Mozambique, as well as the island states of Seychelles, Comoros, Madagascar Reunion and the Republic of Maldives. The continental shelves were described to be narrow and highly variable. Sea surface temperatures in the region vary between 20-30^{o}C, with a clear distinction between cold winter and hot summer seasons. The monsoons (and other wind systems) and their effect on oceanography and climate were reviewed. Factors affecting rainfall were also discussed, but it was stressed that the ITCZ is not a zone of rainfall; rather, it is a zone of instability within which a number of factors can lead to a triggering of the rainfall mechanism. The effects of tropical cyclones and other global systems on rainfall such as ENSO were also reviewed. Using data from UHSLC, tides in the region were found to be semidiurnal with a spring tidal range of 2-4 m on the mainland states coast and the western coast of Madagascar. Elsewhere, the tides were about 1m or less and mixed, mainly semidiurnal. A description was also made on the major currents in the region, and how they are affected by the monsoon winds. They include the South Equatorial Current (SEC), Equatorial Counter Current, Mozambique Current, Madagascar Current, East African Coastal Current (EACC) and the Somali Current. During the SE Monsoon, the fast flowing Somali current leads to upwelling along the north-west Somali coast, inducing high productivity as the turbulent activity brings nutrient-rich cold sub-surface waters with temperatures below 20^{o}C to the surface. Most other parts of the region experience down-welling and the surface waters are generally nutrient-poor resulting in low biological productivity. The EACC for instance, feeds the continental shelves of Kenya and Tanzania with nutrient-poor mid-ocean water.

Impacts of sea level change [S. Mahongo]

Prior to impacts, it was felt necessary to describe the causal factors of global sea level change. To illustrate the impact of global climate change, few examples were given such as the recession of glaciers on Mount Kilimanjaro and Rwenzori Mountains in Africa, which may totally disappear in the very near future. A history of sea level change during the last 140,000 years was also reviewed. Over the past 1000 years, sea level could have changed by +/- several 10s cm on time scales of centuries, climbing to 1.7 mm/yr averaged over the last 50 years (Church & White, 2006). This significant rate of rise in sea level is attributed to global warming caused by industrialization during the second half of the 19th century. The average rate of global sea rise from the short T/P records over the period 1993–98 is 2.4 mm/yr (Jevrejeva et al., 2006). Eight long records in Europe, America and one in Africa (Takoradi) were used to show the rate of change through regressions made using RLR data sets from PSMSL. Regression results were also shown on data from 21 stations in the Western Indian Ocean. Out of the 21 stations, sea level was found to decline in eight stations, the rest indicated a rise in sea level. It was emphasized however that the records were not long enough to give any conclusive evidence on sea level change in the region. Fairly long records of at least 50 years are needed because of the influence of natural variability in the climate system. Due to insufficient tide gauge data in Africa, an urgent need was felt to build capacity in satellite altimetry so that current trends in sea level can be monitored by both satellite and in situ tide gauge records. Physical impacts of sea level change were described to consist of primary impacts (Inundation and displacement of wetlands and lowlands; Increased vulnerability to coastal storm damage and flooding; Shoreline erosion; and Saltwater intrusion into estuaries and freshwater aquifers) and secondary impacts (Altered tidal ranges in rivers and bays; Changes in sedimentation patterns; Decreased light penetration to benthic organisms; and Increase in the heights of waves). The experience of East Africa on the impacts of sea level change was demonstrated through examples, and a review of the predicted future impacts in the region was also made. The three response strategies were described as being Retreat, Adaptation/Accommodation and Defence/Protection. For East African countries, adaptation was recommended as being the immediate priority to respond to sea-level change. Lack of knowledge of the detailed topography of the near shore is however the major setback on responding to future impacts of sea level change.

Introduction to TASK-2000 and to TIDE TASKS for WINDOWS software packages [D.S. Rosen]

The Tidal Analysis Software Kit 2000 (TASK-2000) is an updated version of the previously distributed TASK software. This software runs under DOS operating system and was developed by scientists at the Proudman Oceanographic Laboratory, United Kingdom.

The TIDE TASKS for WINDOWS software makes it possible to use the TASK-2000 software under WINDOWS operating systems and was developed by scientists at the Israel Oceanographic & Limnological Research, Israel.

The software packages ownerships and copyrights belong to the corresponding organizations.

The TIDE TASKS for WINDOWS software runs in versions of WINDOWS '98 or later (preferably XP) as a Microsoft EXCEL application spreadsheet, and requires prior installation of Microsoft Office 2000 or later (preferably Microsoft Office 2003), in order to use the EXCEL graphic tools. It enables to run automatically the two main programs of the TASK-2000 package, namely the tidal analysis program (TIRA2000) and the tide predictions program (MARIE2000). It also enables input of data in ASCII format or in TASK-2000 format, automatic tools for data checking, filtering, spike removal, analysis and prediction.

The lecturer introduced these software packages and described the procedures for their use and guided the trainees in using the software with their own data. The TASK-2000 software can be downloaded from the POL/PSMSL web address http://www.pol.ac.uk/psmsl/training/task2k.html and the TIDE TASKS for WINDOWS and the TASK-2000 software packages can be downloaded from the MedGLOSS web address: http://medgloss.ocean.org.il/ . The TIDE TASKS for WINDOWS manual is provided together with the software.

ODINAFRICA sea level data facility [P. Pissierssens]

This lecture described a new service developed jointly by the IODE Project Office and the Flanders Marine Institute (VLIZ) for the benefit of the ODINAFRICA sea level network and the Indian Ocean Tsunami Warning and Mitigation System (IOTWS). Presently the facility is aimed at sea level stations in Africa and the Indian Ocean that transmit data via the WMO's Global Telecommunication System (GTS).Through this service it is possible to:

- monitor the operational status of sea level stations in Africa and the Indian Ocean in real-time;
- send emails and/or sms messages to station operators indicating if there is a failure of their sea level station data transmission;
- plot sea level data (recent and historic);
- download raw non-quality controlled sea level data.

The facility is presently working in a beta test version and development of the service is ongoing.

For more information, please see the following web addresses:
www.sealevelstation.net .

South African experiences with radar tide gauges [R. Farre]

Ruth Farre provided a comprehensive overview of the experiences which the South African Hydrographic Office has gained with the OTT Kalesto radar tide gauges. Ms Farre described the South African tide gauge network, levelling procedures used, benchmark surveying and calibration, and gave examples of the use of the datalogger software.

Installation of GLOSS OTT radar tide gauges with DCP telemetry for ODINAFRICA and future development [P. Foden and J. Pugh]

The lecturers provided a detailed overview of the tide gauge equipment for the planned sea level stations supported under ODINAFRICA. The tide gauge site requirements in preparation of the installations were also provided and included

- A weather proof tide gauge hut for electronics
- 24 hour security
- Electricity and if possible telephone
- Tools for installation
- Design of a mounting arm for the radar gauge

- Mountings for the pressure sensors
- A pole for antenna mounting
- A simple stilling well for calibration checks
- Regular dipper and tide staff measurements

Peter Foden also described the configuration of the geostationary satellite transmitters used in the ODINAFRICA gauges, as well as future development systems based on Inmarsat's Broadband Global Area Network (BGAN).

The lecturers also organized separate sessions for detailed discussions with participants from Cameroon, Mauritania, Djibouti and Ghana to discuss preparations for ODINAFRICA tide gauge installations at these locations.

Satellite altimetry [Ernst Schrama]

During both lectures various aspects of the remote sensing technique “satellite altimetry” whereby microwave radar is observing height profiles of the actual sea level directly beneath the spacecraft. These measurements are collected at a rate of 1 per second while the satellite flies at 8 km/second, and they refer waveform samples collected within a footprint of roughly 4 to 8 km in diameter depending on the state of the sea surface. For a user the retrieved information consists of sea level anomalies, significant wave height and radar backscatter. Furthermore the satellites usually carry a microwave radiometer for mapping the relative humidity which in turn is required for correcting the radar range measurement. During the lectures it was explained that the ground track coverage was optimized for most altimeters, and in particular for the TOPEX/Poseidon and Jason altimetry missions that have mapped the oceans since August 1992. Examples of sea level maps retrieved from these systems can be found on the internet, a good starting place is for instance http://sealevel.jpl.nasa.gov. During the first part of the lectures the technique was explained, more focussing on activities required for the operation of the altimeter system, in the second part of the lecture some science results were shown, ranging from the observation of mesoscale variability, ocean tides, sea level rise, the Earth’s gravity field, the 1997-1998 El Nino and the devastating tsunami of 26-12-2004 that has hit many countries around the Indian ocean. During the lectures various examples were shown emphasizing the need of a well maintained global network of tide gauge stations to calibrate the altimeter system. Common consensus is that satellite altimetry helps to map the consequences of climate change which is believed to affect the global sea level since the oceans play an important role in the exchanging heat.

Geodesy at tide gauge, where the tide gauge operator meets the surveyor [Tilo Schöne]

During the workshop two talks were given on the topic of geodetic fixing of tide gauges in respect to a global datum and on basic principles of levelling. GLOSS standards require 5 benchmarks at each site which must relevelled at least annually by traditional levelling. The BMs can be connected to the national height system (this is not essential) and monitored with GPS. Even if tide gauge benchmarks are connected to the national height system, the vertical land motions mean that they must be relevelled frequently. GPS can tie the BMs to the International Terrestrial Reference Frame.

The first part of the first lecture has covered basic aspects about the benefit of GPS and other space geodetic techniques. A dual frequency GPS receiver should be operated continuously and the data and meta-data should be provided with short latency to international data centers and the IGS. Basic recommendations have been given how to setup a GPS station near tide gauges.

The second part of the first lecture covered aspects of the use of absolute gravity measurements at tide gauge sites. While space geodetic techniques are affected by small inconsistencies in the Terrestrial Reference Frame, absolute gravity provides and independent estimate of the vertical land motion. Examples of 3 UK absolute gravity sites at or near tide gauge sites have been presented showing the high quality of this technique.

The second lecture continued on the geodetic fixing and covered the aspects of levelling at tide gauge sites. Equipment and methods for levelling have been discussed. The lecture closed with a practical exercise using automated and digital levels and a small levelling loop was surveyed by the participants.

Recommendations for GPS and levelling can be found in the lecture material.

3. COUNTRY REPORT PRESENTATIONS

Two sessions were allocated for trainees to present the status of tidal observation and analysis in their respective countries. The trainees had prior to the course provided reports on sea level activities in their home countries. The reports are available at http://www.gloss-sealevel.org/publications/national_reports.html. Some highlights from the presentations are provided in this section. Additional details can be found in the submitted reports.

GHANA - There are two stations for sea level measurement in Ghana. The first was installed at the Takoradi Harbour around 1928 to determine tidal predictions for ships entering and leaving the harbour. It also provided data for other hydrographical works along the coast of the region. The tide gauge was operational until 1998 when it completely broke down. The equipment employed was a mechanical float type. Between 1998 and 2004 only visual staff readings were kept. In 2004 the Indian Government through its National Institute of Oceanography (NIO) installed a new gauge at the Takoradi Harbour and a meteorological station. With the help of two scientists from NIO, the Takoradi Gauge became fully operational in July 2004. The station successfully recorded the arrival of signals from the 24 December 2004 Indian Ocean tsunami.

Primary data from the GLOSS station is recorded and processed in Takoradi. This data is made up of (a) absolute pressure recordings (b) visual staff recordings (c) water density recordings and (d) meteorological data received from the Meteorological District Office in Takoradi. The data is sent on a monthly basis to the Headquarters of The Survey of Ghana by post and E-mail and also to the NIO by E-mail.

An ODINAFRICA funded tide gauge will be installed at Takoradi in December 2006.

NIGERIA - Sea level monitoring activities in Nigeria started as far back as in the early 20th century. The primary objective of sea level monitoring activities at that time was for safe navigation into the ports of Lagos, Port Harcourt and Calabar. The list of gauge sites in Nigeria cannot be ascertained because several oil companies maintain tide gauges either at their offshore platforms or at their estuary terminal. However, some stations are known: Lagos I, Lagos II, Koko, Forcados, Port Harcourt, Bonny and Calabar. NIOMR (Nigerian Institute for Oceanography and Marine Research) using its own internally generated funds purchased a Kalesto tide gauge for collecting meteorological data. The platform and housing for the tide gauge has been constructed while installation of the equipment is in progress.

MOZAMBIQUE - The National Institute for Hydrography and Navigation (INAHINA) is responsible for the installation, and maintenance of the national tide gauge network, as well as, for the acquisition, processing, archiving and dissemination of the sea level data. The network of sea level stations in Mozambique consists of thirteen stations from which, only three (Maputo, Nacala and Pemba) are nowadays operational. The Maputo and Nacala stations are equipped with floating gauges of model OTT R20. In 2005 radar gauges (OTT Kalesto) were installed at the two GLOSS stations in Pemba and Inhambane in collaboration with INAHINA, SANHO and POL. INAHINA expects to hire local tide gauge operators who will be tasked with basic maintenance of the equipment as well as weekly tide staff readings for data quality control. INAHINA has acquired two Kalesto radar sensors, which are intended to be installed in Maputo and Beira Harbors in the next couple of months.

KENYA - Status of the sea level network: There are two GLOSS stations in Kenya – Mombassa and Lamu. Both stations were upgraded in 2006 by the University of Hawaii Sea Level Center as part of the Indian Ocean Tsunami Warning System. Each station consists of radar water level sensor, pressure sensors and a satellite data transmitter (DCP). The local operator is the Kenya Marine and Fisheries Research Institute.

The Kenya Meteorological Department has acquired three new tide gauges. These will be installed at Shimoni, Malindi and Manda Bay in Lamu. The proposed gauges are part of the National Multi-hazard Early Warning System that is being established at KMD.

The KMFRI performs the following analysis of data in its possession:

- Time series analysis of various data sets
- Harmonic and spectral analysis of hourly height data for Mombassa and Lamu
- Tide predictions for Mombassa and Lamu.

CAMEROON - For some years, Cameroon has been trying to develop a sea observing network. The three operating stations established in Wouri River help vessels to berth. The South West or the South coast tide is calculated according to the tide provided by the port of Douala: i.e. the tide at Limbe (Victoria) is 1h20 before the tide Douala and at Kribi almost 1h30 after. ODINAFRICA is planning to install a tide gauge at Port Sonara near Limbe in 2007.

ANGOLA - There is no operational tide gauge along the Angolan coastline. The Benguela Large Marine Ecosystem (BCLME) program plans to install two tide gauges at Luanda and Namibe.

COTE D'IVOIRE - Five float tide gauges are operational in Côte d'Ivoire. Four are installed in the Abidjan port but only the station known as "Wharf" is used for the sea level forecasting. The other stations are used for civil engineering studies. The fifth station is installed at San Pedro port. For historical and financial reasons, the prediction of the tide off the Ivorian coastline is always produced by SHOM based on tide measurements recorded from "Wharf" station. The San Pedro port authority uses the same predictions for ship navigation. Tide gauge records from Abidjan and San Pedro stations exist in digital form with many gaps. The comparison of these data with those derived from altimetric system points out the necessity to upgrade and to develop a tide gauge network along the Ivorian coastline as they could be used for satellite calibration. A study conducted by Dje Kouame Daniel from the Abidjan Port Authority is in hand in order to install a new tide gauge sensor there.

MAURITANIA - The port authority of Nouakchott has a tide gauge established at the western end of the quay (latitude: 17° 59' 20.95 N, longitude: 16° 01' 56.20 W). This tide gauge (OTT R 16) is equipped with a digital recorder (Thalimedes). The recording is written on millimetre paper support. Each sheet corresponds to a seven days period. An ODINAFRICA funded gauge will be installed in November 2006.

TANZANIA - The network of sea level stations in the United Republic of Tanzania is comprised of two operational stations, located in Dar es Salaam and Zanzibar ports. The Dar es Salaam port station consists of a mechanical float gauge whilst the Zanzibar port station has GLOSS status No. 297 and data transmission is by satellite. In the past there were four tide gauges installed at Tanga, Mtwara (GLOSS Station No. 9), Mkoani in Pemba and Latham Island. At present they are not operational. The Zanzibar tide gauge station is under the management of the Zanzibar Department of Surveys and Urban Planning. The Dar es Salaam tide gauge station is maintained by Tanzania Ports Authority. The Zanzibar tide gauge is installed at the main quay at the port of Zanzibar and provides sea level data in digital format. At this station, formerly the satellite transmission was at one hour intervals. In July 2006, the UHSLC upgraded the station to 15 minute satellite transmission intervals. The sea level data processing for this station is carried out by the UHSLC. The Dar es Salaam tide gauge is located at the Ferry Terminal, in front of the Marine Police offices. Recording of sea level data is by analogue charts, at 10 minute intervals. The main products produced from sea level data are the predictions of heights and times of low and high water for each day of the year. Tidal information is of paramount importance in ports operation. The tide predictions for Zanzibar are produced by the UHSLC. Also the UKHO and POL produce tide predictions for Zanzibar as well for Dar es Salaam port. The tide for this country is semi diurnal type. It will be very useful to have multi-parameter gauge stations, equipped with additional sensors for measuring meteorological and oceanographic parameters. Also the stations should have facility to use GPS techniques for vertical reference.

DJIBOUTI - The Institut de Physique du Globe de Paris of Université de Paris VII installed an OTT R20 float gauge at the harbour in Djibouti in 1995. The gauge is maintained by the observatory team of Arta which is located 35 km far from the port of Djibouti. Data is retrieved every two weeks in graphic form and is digitized by IPG and copies sent to Djibouti Centre for Studies and Research. The current tide gauge has detected the Indian Ocean Tsunami in December 2004. An ODINAFRICA funded gauge will be installed in February 2007.

4. HANDS-ON-TRAINING SESSIONS (HOTS)

There were four hands-on-training sessions conducted throughout the workshop. Three were on the practical usage of the TASK-2000 software and one on levelling. Each participant was provided with a computer to allow individual practice with the TASK-2000 software. A first order levelling exercise was carried out on the quay outside the Project Office.

5. FIELD VISIT

The participants were invited to visit the Ostend tide gauge. The tide gauge set up was explained. The maintenance consists of changing the registration paper weekly and stilling well maintenance cleaning twice a year. The data is available on intranet and internet.

6. CONCLUSIONS AND RECOMMENDATIONS

Angora Aman presented recommendations made by all the trainees:

1) Rescue historical sea level data: an effort should be done by all the participants to digitize historical sea level data. ODINAFRICA should plan for a data digitizing facility for Africa. An important element of the GLOSS program concerns data rescue and historic tide gauge data in non-computer form which represents a great value for the sea level community in a range of application. Many port and hydrographic agencies possess large numbers of historic tide gauge data which are in danger of decay. Angora Aman (as coordinator for the ODINAFRICA WP2) should send a questionnaire to collect information concerning the historical data holdings. ODINAFRICA, IOC, GLOSS should ask directors of the different ports to release the historical sea level records.
2) Course participants should collect sea level information (metadata) for their stations and the information should be included on the ODINAFRICA Web page (Angora Aman to coordinate this). A proposition to include GLOSS Africa Web page into ODINAFRICA Web page was evoked.
3) Course participants should get involved in the tide gauge operations and he/she should be responsible for the tide gauges.
4) The course participants requested and stressed the need for free access to sea level data acquired by the equipment installed by ODINAFRICA.
5) The course participants recommended that laptop computer should be provided for the tide gauge operator in connection with the upgrade of a tide gauge.
6) Lack of maintenance of tide gauge equipment represents a great danger for the planned gauge upgrades supported under ODINAFRICA. ODINAFRICA should continue to provide training for local technicians and ODINAFRICA should make an effort to provide spares for the maintenance during and after the end of the project.
7) Tide gauge operators and course participants are strongly encouraged to develop collaboration with other national institutions including university departments to enable broad usage of the tide gauge observations in research and student projects.

7. CLOSURE

The Sea level training course was officially closed by Wouter Rommens on behalf of the IODE Project office. Angora Aman, the coordinator for coastal observing system speaking on behalf of ODINAFRICA thanked the IODE Project office and thanked the participants for their enthusiasm and interest. Certificates (ANNEX IV) were distributed to participants by Wouter Rommens and the workshop was closed at 17:00 on Wednesday 22 November 2006.

8. ACKNOWLEDGMENTS

Support for this training workshop was provided by IOC through funding from the Government of Flanders, the Ministry of Foreign Affairs of Finland and the Natural Environment Research Council (NERC, UK). The TASK 2000 software was kindly provided by the Proudman Oceanographic Laboratory and the TIDE TASKS for WINDOWS software was kindly provided by the Israel Oceanographic and Limnological Research. Thanks are also due to the staff at the IODE Project Office and all the lecturers.

ANNEX I

COURSE SCHEDULE

Date/Day	Time	Programme/Activities	Lecturer
Mon 13 November	0900 – 0930	Welcome / official opening of the Training Course.	V. Vladymyrov
	0930 – 1000	Why this agenda?	P.L. Woodworth
	1000 – 1100	Overview of GLOSS	P.L. Woodworth
	1130 – 1230	Overview of ODINAFRICA	A. Aman
	1230 – 1300	Country reports presentation	
	1400 – 1600		
	1615 – 1715	Types of tide gauges	P. L. Woodworth
Tue 14 November	0900 - 0930	Country reports presentation	
	0930 – 1030	Infrastructure requirements for ODINAFRICA installations. Characteristics of sea level records	P.L. Woodworth
	1030 – 1130	Introduction to TASK-2000 software (HOTS)	D. S. Rosen
	1200 – 1300	HOTS	D. S. Rosen
	1400 – 1715		
Wed 15 November	0900 – 0930	Project to establish a System of Industry Metocean data for the Offshore and Research Communities (SIMORC)	V. Vladymyrov
	0930 – 1000	Ocean Data Management Training with Ocean Teacher	M. Brown
	1000 – 1100	Installation and setting up of GLOSS OTT radar tide gauge with DCP telemetry for ODINAFRICA and future developments	P. Foden
	1130 – 1300	OTT Kalesto radar gauge	Ms. R. Farre
	1400 – 1500		
	1500 – 1715	Detailed discussions with individuals of planned ODINAFRICA installations and anticipated problems. HOTS	P. Foden P. Woodworth R. Farre A. Aman D. S. Rosen
Thu 16 November	0900 – 1000	- Suggested method for datum determination for the radar gauge provided for ODINAFRICA and GLOSS Africa. - Detailed discussions with individuals of planned ODINAFRICA installations and anticipated problems	P. Woodworth P. Foden F. Simon R. Farre

	1000 – 1230	HOTS	
	1400 – 1500	- Regional oceanography and climate (West Africa) - Detailed discussions with individuals of planned ODINAFRICA installations and anticipated problems	A. Aman P. Foden F. Simon R. Farre
	1530 – 1645	Measuring long term sea level change	P. Woodworth
	1645 – 1700	Review of detailed discussions with individuals of planned ODINAFRICA installations and anticipated problems	P. Foden
Fri 17 November	0830 – 0930	Visit to Ostend tide gauge	J. Verstraeten
	0945 – 1030 1040 – 1100	Tide gauge operation in Belgium	J. Verstraeten
	1200 – 1300	Review of the first week	A. Aman
Sat 18 November	Free day		
Sun 19 November	Free day		

Week 2

Date/Day	**Time**	**Program/Activities**	
Mon 20 November	0900 – 1000	Tide gauge and altimetry measurements in the Gulf of Guinea	A. Aman
	1000 – 1100	East African Regional Oceanography	S. Mahongo
	1130 – 1300	Impacts of sea level change	S. Mahongo
	1400 – 1715	TASK-2000 software training	
Tue 21 November	0900 – 1015	Geodesy at tide gauge Where the tide gauge operator meets the surveyor	T. Schoene
	1020 – 1100	How to: some basic principles for levelling	T. Schoene
	1130 – 1300	HOTS on Levelling	T.Schoene
	1400 – 1530 1545 – 1715	Satellite altimetry	E. Schrama
Wed 22 November	0900 – 1000	International sea level data banks (PSMSL, UHSLC….)	P.L. Woodworth
	1000 – 1100	Operational uses of sea level data- how to engage others and sustain the African network	T. Aarup
	1100 – 1130	BGAN demonstration	J. Pugh
	1145 – 1220	Levelling practice	T. Shoene
	1220 – 1300	ODINAFRICA: Sea level data facility demonstration	P. Pissierssens
	1400 – 1600	Review, conclusion and recommendations of the training course	

ANNEX II

COURSE MATERIAL

Training Workshop on Sea Level Measurement and Interpretation
Ostend, Belgium
13–24 November 2006

List of course materials used during the course.

- R. Stewart (2006). Introduction to Physical Oceanography (can be downloaded from http://oceanworld.tamu.edu/home/course_book.htm) – pages 293-312
- WOODWORTH, P.L. (ed.) 1998. Global Sea Level Observing System (GLOSS) Implementation Plan 1997. IOC, Technical Series, No. 50, 91pp. Available at: http://unesdoc.unesco.org/images/0011/001126/112650eo.pdf
- IOC Manual 14 on Sea Level Measurement and Interpretation:
  Volume I: Basic Procedures http://www.pol.ac.uk/psmsl/manuals/ioc_14i.pdf
  Volume II: Emerging Technologies http://www.pol.ac.uk/psmsl/manuals/ioc_14ii.pdf
  Volume III: Reappraisals and Recommendations as of the year 2000
  http://unesdoc.unesco.org/images/0012/001251/125129e.pdf
  Volume IV: An update to 2006
  http://www.pol.ac.uk/psmsl/manuals/manual_14_final_21_09_06.pdf

- POL/PSMSL Tidal Analysis Software Kit 2000
  http://www.pol.ac.uk/psmsl/training/task2k.html

  Manual for the tidal software is available at:
  http://www.pol.ac.uk/psmsl/training/task2k.rtf

- IOLR TIDE TASKS for WINDOWS software and its manual
  http://medgloss.ocean.org.il/download_software/registration.asp

- P. Woodworth (2006) Kalesto calibration doc in English (http://www.iode.org/projectoffice/docshow.php?doc=127) or in French (http://www.iode.org/projectoffice/docshow.php?doc=128)

- P. Foden (2006) Kalesto installation instructions

- D. Pugh (2004): Changing Sea Levels – Effects of Tides, Weather and Climate (will be provided)
- D. Smith, S.B. Raper, S. Zerbini, A. Sanches-Arcilla (2000): Sea level change and coastal processes – Implications for Europe (hard copies)

- ODINAFRICA information (http://www.odinafrica.net/)

ANNEX III

LIST OF PARTICIPANTS

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ANNEX IV

DIPLOMA

THE INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION OF UNESCO

THE IOC INTERNATIONAL OCEANOGRAPHIC DATA AND INFORMATION EXCHANGE PROGRAMME

THE GLOBAL SEA LEVEL OBSERVING SYSTEM

United Nations Educational, Scientific and Cultural Organization

Herewith certify that

Sinibaldo CANHANGA
Mozambique
attended and successfully completed the

GLOSS/ODINAFRICA
Training Workshop on Sea Level Measurement and Interpretation

organized by the UNESCO-IOC, GLOSS and the IOC Project office for IODE

Ostend, Belgium
13 - 24 November 2006

SIGNED

Thorkild AARUP
UNESCO-IOC

Philip WOODWORTH
PSMSL

SIGNED

Peter PISSIERSSENS
IODE Programme Coordinator
UNESCO-IOC

SIGNED

Vladimir VLADYMYROV
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UNESCO-IOC
Ostend, Belgium

ANNEX V

ACRONYMS

AMMA	African Monsoon Multidisciplinary Analyses
BCLME	Benguela Current Large Marine Ecosystem
CLIVAR	Climate Variability
EGEE	AMMA Ocean Component for the Gulf of Guinea
GLOSS	Global Sea Level Observing System
GOOS	Global Ocean Observing System
GTS	Global Telecommunication System
HOTS	Hands On Training Sessions
INAHINA	Instituto Nacional de Hydrographica e Navegação (Mozambique)
IOTWS	Indian Ocean Tsunami Warning and Mitigation System
IOC	Intergovernmental Oceanographic Commission
IODE	International Oceanographic Data and Information Exchange
KMFRI	Kenya Marine & Fisheries Research Institute
KMD	Kenya Meteorological Department
NERC	Natural Environment Research Council (UK)
NIORM	Nigerian Institute for Oceanography and Marine Research
NIO	National Institute of Oceanography (India)
NODC	National Oceanographic Data Centres
ODINAFRICA	Ocean Data and Information Network for Africa
PIRATA	Pilot Research Moored Array in the Tropical Atlantic
POL	Proudman Oceanographic Laboratory (UK)
PSMSL	Permanent Service for Mean Sea Level
SANHO	South Africa Navy hydrographic Office
SEC	South Equatorial Current
SHOM	Service Hydrographique et Océanographique de la Marine (France)
TASK	Tidal Analysis Software Kit
UHSLC	University of Hawaii Sea Level Centre (USA)
VLIZ	Flanders Marine Institute
WAM	West Africa Monsoon

IOC Training Course Reports

No.	Title	Language
1.	IOC Indian Ocean Region Training Course in Petroleum Monitoring Perth, 18 February-1 March 1980	English
2.	IOC Regional Training Course for Marine Science, Technicians Cape Ferguson, Queensland, 1-28 June 1980	English
3.	ROPME-IOC-UNEP Training Workshop on Oceanographic Sampling Analysis, Data handling and Care of Equipment, Doha, Qatar, 3-15 December 1983	English
4.	Stage COI d'initiation à la gestion et au traitement de l'information scientifique et technique pour l'océanologie, Brest, France, 28 novembre - 9 décembre 1983	French
5.	Curso mixto COI-OMM de formación sobre el Sistema Global Integrado de Servicios Oceánicos (SGISO), Buenos Aires, Argentina, 15-26 de octubre de 1984	Spanish
6.	UNESCO-IOC-NBO Training Course on Tidal Observations and Data Processing Tianjin, China, 27 August - 22 September 1984	English
7.	Stage COI sur la connaissance et la gestion de la zone côtière et du proche plateau continental Talence, France, 18 septembre - 4 octobre 1984	French
8.	IOC Regional Training Course on Marine Living Resources in the Western Indian Ocean Mombasa, Kenya, 27 August - 22 September 1984	English
9	IOC-UNESCO Summer School on Oceanographic Data, Collection and Management Erdemli, Icel, Turkey, 21 September - 3 October 1987	English
10.	IOC-UNESCO Regional Training Workshop on Ocean Engineering and its Interface with Ocean Sciences in the Indian Ocean Region Madras, India, 17 March - 5 April 1986	English
11.	IOC-UNESCO Training Course on the Use of Microcomputers for Oceanographic Data Management Bangkok, Thailand, 16 January - 3 February 1989	English
12.	IOC Advanced Training Course on Continental Shelf Structures Sediments and Mineral Resources Quezon City, Philippines, 2-13 October 1989	English
13.	IOC/IODE Training Course on GF3 Data Formatting System Obninsk, USSR, 14-24 May 1990	English
14.	IOC Training Course on Microcomputers and Management of Marine Data in Oceanographic Data Centres of Spanish-speaking Countries, Bogotá, Colombia, 21-30 October 1991	English & Spanish
15.	IOC Advanced Training Course on Nearshore Sedimentation and the Evolution of Coastal Environments, Kuala Lumpur, Malaysia, 17-29 February 1992	English
16.	First IOC Training Course on the Applications of Satellite Remote Sensing to Marine Studies Caracas, Venezuela, 24-28 September 1990	English
17.	IOC-KMFRI-RECOSCIX (WIO) Regional Training Course on Microcomputer-based Marine Library Information Management, Mombasa, Kenya, 10-21 August 1992	English
18.	ROPME-IOC Regional Training Course on Management of Marine Data and Information on Microcomputers for the ROPME Region, Kuwait, 18-28 October 1992	English
19.	IOC-SOA Training Workshop on Environmental Effects on Benthic Communities Xiamen, China, 19-23 October 1992	English

No.	Title	Language
20.	IOC Training Course for the Global Sea Level Observing System (GLOSS) directed to the African and South American Portuguese and Spanish-Speaking Countries São Paulo, Brazil, 1-19 February 1993	English
21.	IOC-SSTC-SOA Training Course on Marine Information Management and ASFA Tianjin, China, 19-30 October 1992	English
22.	First IOC/IOCARIBE-UNEP Training Course on Monitoring and Control of Shoreline Changes in the Caribbean Region, Port-of-Spain, Trinidad and Tobago, 21-30 July 1993	English & Spanish
23.	IOC/WESTPAC Training Course on Numerical Modelling of the Coastal Ocean Circulation Matsuyama, Japan, 27 September - 1 October 1993	English
24.	IOC-JODC Training Course on Oceanographic Data Management Tokyo, Japan, 28 September - 9 October 1992	English
25.	IOC-JODC Training Course on Oceanographic Data Management Tokyo, Japan, 27 September - 8 October 1993	English
26.	IOC Training Course on Ocean Flux Monitoring in the Indian Ocean. Organized with the support of the Government of Germany Mombasa, Kenya, 15-27 November 1993	English
27.	IOC-UNEP-SPREP Training Course on Coral Reef Monitoring and Assessment Rarotonga, Cook Islands, 23 February - 13 March 1994	English
28.	IOC-JODC Training Course on Oceanographic Data Management Tokyo, Japan, 26 September - 7 October 1994	English
29.	IOC-UNEP-WHO-FAO Training Course on Qualitative and Quantitative Determination of Algal Toxins Jena, Germany, 18-28 October 1994	English
30.	IOC Training Course on Oceanographic Data Management for Black Sea Countries Obninsk, Russian Federation, 1-12 August 1994	English
31.	COI-CEADO Curso Regional de Capacitación en Gestión de Datos e Información Oceanográficos Buenos Aires, Argentina, 17-28 de octubre de 1994	Spanish
32.	IOC-UNEP-FAO Training Course on Nutrient Analysis and Water Quality Monitoring Zanzibar, Tanzania, 21-26 November 1994	English
33.	IOC-IOMAC Advanced Training Course on Marine Geology and Geophysics off Pakistan. Pakistan, 12-26 November 1994	English
34.	Training Course on Management of Marine Data and Information for the Mediterranean Region Valletta, Malta, 10-21 April 1995	English
35.	IOC-UNEP-WHO-FAO Training Course on Toxin Chemistry and Toxicology related to Harmful Algal Blooms Trieste, Italy, 3-12 September 1995	English
36.	MAST-IOC Advanced Phytoplankton Course on Taxonomy and Systematics Naples, Italy, 24 September - 14 October 1995	English
37.	IOC-JODC Training Course on Oceanographic Data Management Tokyo, Japan, 16-27 October 1995	English
38.	IOC/IODE Training Course on Marine Geological and Geophysical Data Management Gelendzhik, Russian Federation, 13-29 September 1995	English
39.	IOC/GLOSS-GOOS Training Workshop on Sea-Level Data Analysis, Geodetic & Research Branch Survey of India, Dehra Dun, India, 21 November- 1 December 1995	English

No.	Title	Language
40.	IOC-DANIDA Training Course on the Taxonomy and Biology of Harmful Marine Microalgæ; University of Copenhagen, Denmark, 31 July-11 August 1995; IOC-SAREC-DANIDA Training Course on the Taxonomy and Biology of Harmful Marine Microalgæ; University of Mauritius, Republic of Mauritius, 5-14 February 1996; and Annual Report 1995, IOC Science and Communication Centre on Harmful Algæ, DANIDA, University of Copenhagen, Danish Fisheries Research Institute, Danish National Environmental Research Institute	English
41.	IOC-Germany Advanced Training Course on Bathymetric Charting in the Western Indian Ocean METEOR, 15-29 December 1995	English
42.	COI-SHOA-CICESE Curso Sobre Modelación Numérica de Tsunamis Valparaiso, Chile, 11 de Marzo - 11 de Mayo de 1996	Spanish
43.	Seminario/Taller de la COI/GLOSS-SHN sobre Observación y Análisis del Nivel del Mar para países de habla hispano-portuguesa de Latinoamérica Servicio de Hidrografía Naval (SHN), Buenos Aires, Argentina, 19-27 de noviembre de 1996	Spanish
44.	IOC-INCO-ROPME Training Course on Oceanographic Data and Information Management, Tehran, Iran, 19-30 October 1997	English
44.	IOC-ICSU-IAEA-EU Training Course on Marine Geological and Geophysical Data Management for the Countries of the Black and Caspian Seas Regions, Gelendzhik, Russian Federation, 8-19 September 1997	English
45.	IOC-ICSU-IAEA-EU Training Course on Marine Geological and Geophysical Data Management for the Countries of the Black and Caspian Seas Regions Gelendzhik, Russian Federation, 8-19 September 1997	English
46.	Training Course on Management of Marine Data and Information for the IOCINCWIO Region Mombasa, Kenya, 1-11 December 1997	English
47.	IOC/WESTPAC-SIDA-SAREC-SEAPOL Training Workshop on Operational Data and Information System for the Gulf of Thailand Bangkok, Thailand, 18-21 November 1997	English
48.	SZN-IOC Advanced Phytoplankton Course on Taxonomy and Systematics Vico Equense, Naples, Italy, 10-30 May 1998	English
49.	First IOC/WESTPAC Training Course on Monitoring of PSP Plankton and Shellfish Toxicity, Japan, July 1995 Second IOC/WESTPAC Training Course on Species Identification of Harmful Microalgæ, Japan, February 1997 Third IOC/WESTPAC Training Course on Species Identification of Harmful Microalgæ, Japan, August 1997	English
50.	IOC/IODE-NIO Training Course on Oceanographic Data and Information Management Goa, India, 17–27 October 1998	English
51.	IOC/GLOSS-GOOS Training Workshop on Sea-Level Data Analysis South Africa, 16–27 November 1998	English
52.	IOC-UNEP Germany Training Course on Qualitative and Quantitative Determination of Algal Toxins, Jena, Germany, 2-12 March 1999	English
53.	*Cancelled*	
54.	IOC/GLOSS-GOOS Training Workshop on Sea-Level Measurements, Tidal Analysis, GPS and Gravity Measurements, Satellite Altimetry and Numerical Modelling Sao Paulo, Brazil, 30 August-25 September 1999	English

No.	Title	Language
55.	IODE Training on Oceanographic Data and Information Management for the Spanish-Speaking Countries of Central and South America / Curso de Formación del Iode sobre la gestión de datos e información oceanográficos para los países de habla hispana de América Central y del Sur Rio Grande, Brazil, 20-29 September 1999	English/Spanish
56.	*Cancelled*	
57.	PERSGA/ALECSO-IOC/GLOSS-GOOS Training Workshop on Sea-level Data Analysis for the red Sea and Gulf of Aden Region Jeddah, Kingdom of Saudi Arabia, 15-19 April 2000	English
58.	Third IOC/WESTPAC Training Course on NEAR-GOOS Data Management Tokyo, Japan, 24 January-4 February 2000	English
59.	Fourth IOC/WESTPAC Training Course on NEAR-GOOS Data Management; Tokyo, Japan, 27 November–8 December 2000 ***(electronic copy only)***	English
60.	First IOC-Flanders ODINAFRICA Training Course on Marine Data Management, Casablanca, Morocco, 2–13 April 2001 ***(electronic copy only)***	English
61.	First ODINAFRICA Training Course on Marine Information Management, Cape Town, South Africa, 29 October–9 November 2001 ***(electronic copy only)***	English
62.	First ODINCARSA Training Course on Marine Data Management, Guayaquil, Ecuador, 20-31 May 2002 ***(electronic copy only)***	English
63.	Remedial Training Course in Marine Data Management for Côte d'Ivoire, Abidjan, Côte d'Ivoire, 21-29 March 2002 ***(electronic copy only)***	English
64.	Second ODINAFRICA-II Training Course in Marine Data Management, Tunis, Tunisia, 29 April–10 May 2002 ***(electronic copy only)***	English
65.	***under preparation***	
66.	First ODINCARSA Training Course in Marine Information Management, Mazatlan, Mexico, 29 September – 4 October 2002 ***(electronic copy only)***	English & Spanish
67.	IODE Training Course in Ocean Data Management for the Caspian and Black Sea Regions, Tehran, I.R. Iran, 20–30 October 2002 ***(electronic copy only)***	English
68.	Fifth IOC/WESTPAC Training Course on NEAR-GOOS Data Management, Tokyo, Japan, 5–16 November 2001 ***(electronic copy only)***	English
69.	ODINAFRICA II Remedial Training Course in Marine Data Management (Data Short Course), Accra, Ghana, 14–18 April 2003 ***(electronic copy only)***	English
70.	Sixth IOC/WESTPAC Training Course on NEAR-GOOS Data Management, Tokyo, Japan, 21 October–1 November 2002 ***(electronic copy only)***	English
71.	Taller de Entrenamiento en Observación y análisis del Nivel del Mar, Valparaíso, 7-17 de abril de 2003 ***(disponible solamente en formato electrónico)***	Spanish
72.	ODINAFRICA II Combined Madagascar Marine Atlas Workshop and Remedial Training Course in Marine Data Management for Comoros, Tulear, Madagascar, 30 June – 11 July 2003 ***(electronic copy only)***	English
73.	ODINAFRICA II Training Course in Marine Data Management for Mozambique, Maputo, Mozambique, 11–22 August 2003 ***(electronic copy only)***	English
74.	Final ODINAFRICA II Training Course in Marine Data Management, Brussels, Belgium, 1–5 September 2003 ***(electronic copy only)***	English
75.	Second ODINCARSA Training Course in Marine Data Management, Cartagena, Colombia, 13–17 October 2003 ***(electronic copy only)***	English
76.	***under preparation***	
77.	IOC/JCOMM Training Course for the Global Sea Level Observing System (GLOSS) on Sea Level Observation and Analysis, 9–20 February 2004, Kuala Lumpur, Malaysia ***(electronic copy only)***	English
78.	First ODINCINDIO Training Course in Ocean Data Management, 10–21 October 2005, Ostend, Belgium ***(electronic copy only)***	English

No.	Title	Language
79.	First ODINAFRICA-III Training Course in Marine Data Management, , 11–29 April 2005, Ostend, Belgium ***(electronic copy only)***	English
80.	HELCOM/BSRP/ICES and IOC/IODE Training Workshop: Baltic Sea Data Collection— Management, Analysis & Synthesis, 24–28 October 2005, Vilnius, Lithuania ***(electronic copy only)***	English
81.	First ODINCARSA-II Data Management Training Workshop, 7–18 November 2005, Ostend, Belgium ***(electronic copy only)***	English
82.	Second ODINCARSA Training Course in Marine Information Management, 9 November – 19 November 2005, Ostend, Belgium ***(electronic copy only)***	English
83.	Web service development training for ODINAFRICA, 5–9 December 2005, Ostend, Belgium ***(electronic copy only)***	English
84.	ODINAFRICA Training course on development of electronic repositories on marine related publications from Africa, 5–9 December 2005, Ostend, Belgium ***(electronic copy only)***	English
85.	Third ODINCARSA-I Marine Data Management Training Workshop, 21–26 November, 2005, Ostend, Belgium ***(electronic copy only)***	English
86.	IODE/GOOS/JCOMM Combined Modelling and Data Management Training Workshop ("Jamboree"), 5–10 September 2005, Ostend, Belgium ***(electronic copy only)***	English
87.	IOC/JCOMM Training Course for the Global Sea Level Observing System (GLOSS) on Sea Level Observation Analysis, 15–26 May 2006, Tokyo, Japan ***(electronic copy only)***	English
88.	IOC/JCOMM/GLOSS/ODINAFRICA Training Workshop on Sea-Level Measurement and Interpretation, 13–24 November 2006, Ostend, Belgium ***(electronic copy only)***	English