Intergovernmental Oceanographic Commission
Workshop Report No. 133

IOC/GLOSS
Training Workshop on
Sea Level Data Analysis

Proudman Oceanographic Laboratory
Bidston Observatory
Birkenhead, Merseyside
United Kingdom
16-27 June 1997

UNESCO

Intergovernmental Oceanographic Commission
Workshop Report No. 133

IOC/GLOSS
Training Workshop on
Sea Level Data Analysis

Proudman Oceanographic Laboratory
Bidston Observatory
Birkenhead, Merseyside
United Kingdom
16-27 June 1997

UNESCO

IOC Workshop Report No. 133
Paris, 25 September 1997
English only

TABLE OF CONTENTS

I. INTRODUCTION

Since 1983, the Intergovernmental Oceanographic Commission (IOC) has co-sponsored a series of training workshops on sea level measurements, data analysis and interpretation. The courses have been held at the rate of approximately one per year, and have been organised primarily by the national organisations which have hosted the workshops. From 1983-90, workshops were held each summer at the Proudman Oceanographic Laboratory (POL), UK, and concentrated on technical aspects of operating the then-standard type of float and stilling-well tide gauge. The main objective was to build up tide gauge expertise around the world in order to facilitate the development of the Global Sea Level Observing System (GLOSS).

Workshops have since been held in a number of other countries around the world and in different languages. Each course has contained different proportions of the technical, scientific or socio-economic aspects of sea level studies. Courses have been held in China (IOC Training Course Report No.6), France, Brazil (Report No.20) and, most recently, in India in 1995 (Report No.39) and Argentina in 1996 (Report No.43). In addition, GLOSS-related training has been included in other IOC courses on, for example, data management.

The India and Argentina courses demonstrated how the priorities for training in sea level research have evolved during the last decade. At the Indian course, held at the Geodetic and Research Branch of the Survey of India at Dehra Dun, the emphasis was on training in the techniques of sea level data analysis (i.e. in software packages rather than tide gauge hardware) and in the coverage of sufficient scientific background in order to provide an overall context for the analyses. The workshop also took the opportunity to attempt the construction of collaborative regional GLOSS projects. At the Argentina meeting, hosted by the Servicio de Hidrografia Naval in Buenos Aires, the emphasis was on scientific analysis with a number of national experts on tidal matters, in addition to several invited international specialists in the fields of tides, satellite altimetry, oceanography and hydrography.

Two main factors were considered in the planning of the 1997 GLOSS training course at POL. The first was that it was highly desirable to undertake another workshop with the mix of software analysis and scientific background as had been held at Dehra Dun. The second was that a request had been received from the Commission Internationale pour l'Exploration de la Mer Méditerranée (CIESM) for training dedicated to the special needs of the Mediterranean and Black Seas, in order to contribute to the development of the IOC/CIESM regional GLOSS programme called MedGLOSS. An invitation was accepted from Dr.B.S.McCartney, Director POL, to host the workshop with Graham Alcock acting as local organiser.

II. COURSE PROGRAMME

The course programme (see agenda in Annex I) comprised four main elements:

(i) Lectures by specialists on scientific aspects of sea level studies. These included presentations on monitoring sea level by *in situ* and remote sensing methods, oceanography (tides, surges, extremes), geodesy (levelling, GPS, absolute gravity), and climate change. Also included were lectures on the impacts on the coast of sea level change and on risk assessment. Several of the presentations gave special emphasis to the Mediterranean and Black Seas.

(ii) Hardware presentations including demonstrations of tide gauge equipment (described most effectively during a visit to the Holyhead tide gauge and test facility in North Wales), an absolute gravity meter, and Global Positioning System (GPS) receivers (by colleagues from Nottingham University).

(iii) Hands On Training Sessions (HOTS). These included extended hands-on PC-based sessions of tide gauge data analysis using the POL Tidal Analysis Software Kit (TASK) software. Descriptions were also given of other software packages available, including those from the University of Hawaii and from Flinders University. The tide gauge data employed in these analyses were derived either from POL-operated sites or, more desirably, from the trainees' own gauges.

In addition, a presentation was provided by Dr.Dov Rosen on the ISRAMAR tidal data acquisition software, available to participants in MedGLOSS.

(iv) Presentations by trainees on the operation of gauges in their own countries, together with discussion of special problems and possibilities, including the potential for regional collaboration.

III. ABSTRACTS OF TRAINEES

This section provides abstracts of the presentations by each of the trainees.

Djaffer Bennacer (Algeria)

The Algerian Navy Hydrographic Service is responsible for hydrographic surveys with one survey vessel, and for providing logistical support for military activities. The Laboratoire des Études Maritimes (LEM) is responsible for civilian marine activities.

The Hydrographic Service operates three gauges in Algeria at (going west to east) Oran, Algiers and Annaba. Data exist for the last five years but are classified within the Service; it is possible that the data may be accessible through the LEM. Of interest is a possible gauge at Arze Skikda, which is an important location for gas and oil exports.

Mariana Popova (Bulgaria)

Sea level measurements along the Bulgarian coast are performed by two organizations: the National Institute of Meteorology and Hydrology (Bulgarian Academy of Sciences) and the Main Geodetic and Cartographic Survey (Ministry of Regional Development and Construction).

The sea level observations in the network of NIMH are performed using standard poles. The observations are done once daily at 8 a.m. local time. The observations are done under contracts on a 'semi-voluntary' basis. The stations are situated in the following ports: Kavarna (starting from 1.IX.1949), Balchik (18.VI.1973), Varna (1.I.1919), Nessebar (1.I.1924), Burgas (1.I.1910), the fishery terminal in the Burgas port (4.VIII.1973), and the oil port, which is very close to the main Burgas port (1.VIII.1973). For navigational purposes several poles are installed along the Varna lakes. In the regional branch of NIMH in Varna, the marine department is in charge of the primary data control, maintenance and administration of the network and the annual geodetic levelling for every pole. The data from the observations are stored in the hydro-meteorological national data bank in Sofia.

The sea level network of the Main Geodetic and Cartographic Survey consists of 4 stations: Varna, Irakly, Burgas and Ahtopol. These stations are equipped with stilling-well tide gauges. Tide-gauges of type A.Ott were installed in the ports of Varna and Burgas in 1928. These instruments could record sea level variations up to 1.50 m. Due to strong local subsidence at the Varna and Burgas ports, the extreme levels reached during the strong surges after 1976 are not recorded. Since 1985, in Varna a new instrument of type SUM (Russian) has been installed. The same instruments are used in the stations of Irakly and Ahtopol that are operating since 1971. The daily mean levels are determined using standard planimeters. The data are stored and administrated from the headquarters of the Survey in Sofia.

A number of sea level analyses have been undertaken. The long-term trends in mean sea level variations for the Black Sea show that they have a cyclic character, but there is a tendency of a little rise during the last years. It is established that for the period 1935 till now, the rate of sea level rise is 1.31 mm/y. The seasonal sea level variations are very evident with a maximum in June and a minimum in October, and the amplitude is in average about 25 cm. There is a very close relationship between these changes and the run-off from rivers. In the sea level variations on synoptic time scales, the predominant role is attributed to the along-shore winds and the 'barometric factor'. From a practical point of view, the tides are not interesting for the Bulgarian coast, because of their small amplitude, up to only 10-15 cm. The regional seiches in the western Black sea with periods of 150-170, 100 and 75 minutes contribute to the sea level variations along the shore. The analyses of observations show that the registered seiches are caused by winds, air pressures and seismic

forces. The occurrence of extreme levels is in a very close relationship with the storm activity. In all publications the method of German for determination of the extreme levels is used.

Sea level forecasting is of special interest. In NIMH, numerical analyses and forecasts up to 48 hours for the sea surface winds, wind waves and sea levels in the west part of the Black Sea are issued. To forecast the sea state (wind waves), a deep water model VAGBUL is in use, operational since January 1994. This is a version of VAGMED model (Guillaume, 1988), adapted to the Black Sea area. A shallow water version has been developed later and is now under verification. This is called VAGBULH. For the forecasting of the sea level, there are two models for modelling the storm surges. They are both non-linear, two dimensional, advective ones, with a different grid mesh. The first is the model of NIMH, based on the scheme of the 'angled derivatives' of Flather and Heaps, developed in a rectangular grid. The second is the operational model of Meteo France, based on the scheme of Miller and Pierce (1988), developed on a polar grid. Also under adaptation to the local computational system in the Sofia forecasting centre is the operational oil drift model of Meteo France.

Ivica Vilibic (Croatia)

Sea level measurements along the eastern Adriatic coast started in the nineteenth century, first at Trieste in the Rijeka area. During the Austrian Empire, more than 30 tide gauges were working in the Adriatic. In 1929, the tide gauges at Split and Bakar started and are still operational today. After World War II, there were installed 27 permanent and portable tide gauge stations with chart record, from which 7 are working nowadays (Rovinj, Bakar, Zadar, Split-Harbour, Split-Marjan, Sucuraj and Dubrovnik). All original records are stored, except for Bakar and Split-Marjan, in the State Hydrographic Institute, Split. One of the major problems is that digitization in the Institute was used only after 1986. Therefore, most of the charts are in original form still and not in the digital form. Thus, one of the important further jobs to do is to make a digital database including all these records in it. Furthermore, all the present tide gauges are chart recording (German firm A.OTT) and the digitization has been performed in the Institute. Therefore, the next step has to be an installation of new equipment for in-situ digital recording and on-line connection, preferably from the same manufacturer (OTT-MESSTECHNICK). This could be done through some project e.g. MedGLOSS or any further project which will include the Croatian tide gauge network in it (such as SELF or others).

Ahmed Abdel-Monlem Radwan (Egypt)

Coastal erosion is a major problem in Egypt, erosion rates of order 1 m/yr being observed in some areas. Several gauges exist on the Egyptian Mediterranean coast e.g. at Damietta. In addition, the Suez Canal Authority has a long history (40 years or more) or recording e.g. at Port Said. However, the most important site is Alexandria with recording since approximately 1885 and still operational. The gauge is operated by the harbour authority, but data are analysed regularly by the National Institute of Oceanography and Fisheries which holds data in various forms for 1927-1996.

Karim Hilmi (Morocco)

The Royal Moroccan Navy is responsible for hydrographic measurements. Since 1986 they have had a 'basic tide gauge' with 'stylet' recording on a chart. Since 1989 they have had an ENDECO pressure tide gauge. Data are confidential. The Office d'Exploitation des Ports (ODEP) also carries out some surveys, although information on deployments seems difficult to obtain.

The Institut National de Recherche Halieutique has Aanderaa tide gauges and current meters which are used for field surveys and experiments of a few days or weeks. The Institute would be willing to operate more permanent gauges (e.g. for GLOSS) and action will be taken in this regard after the Workshop. The main oceanographic interest on the Atlantic coast of Morocco is upwelling, to which a permanent coastal gauge (e.g. at Tan Tan) should be able to make a major contribution. It would also form a strategic national reference for sea level measurements, to which other, temporary measurements at the coast could be compared. A permanent gauge on the Mediterranean coast would also be of interest.

The TASK package has been used for analysis at several sites and results compared to those from the Foreman package.

Viorel Malciu (Romania)

The Romanian Marine Research Institute undertakes a wide range of Black Sea measurements including cruises for water sampling, current measurements, meteorological observations etc. It has interests in shore and near-shore geomorphology and river run-off. It has laboratory technical development groups. The Institute uses mechanical sea level gauges located at different points on the coast. The main gauge is at Constantza. Scientific interests include the need for common datums for surveying; Danube and other river runoff which is a major forcing of sea level variability; water mass dynamics; seasonal changes; and ecosystems. There is great interest in potential collaboration with neighbouring countries by means of Black/MedGLOSS.

Mehmet Ali Gürdal (Turkey)

Researches on sea level in Turkey were initiated in 1922. Seven tide gauges stations have been progressively installed, by the General Command of Mapping (GCM) and the State General Directorate of Meteorological Affairs, at Turkish coasts since 1935 to 1981, primarily to measure the tide relative to fixed bench marks, and hence to provide a reference for the Turkish National Vertical Control Network. After 1984, a reorganization for which four new tide gauge stations were installed was commenced by the GCM. Charts related to all tide gauge stations were begun to be digitized once again using new digitizing instruments to avoid errors resulting from manually digitizing. At the first step, charts from four tide gauge stations for the year 1985-1996 were redigitized. So far, only data from the Antalya Tide Gauge Station at the Mediterranean Sea for the years 1985- 1995 have been analyzed using a new tidal analysis software developed by the TOGA Sea Level Data Processing Center. A rising sea level trend of about 3.72 mm/year was calculated in a trend analysis research using the Antalya Tide Gauge Station data for the years 1985-1995. Digitizing and tidal analysis procedure will be also applied for charts to three tide gauge stations which have been operating since 1984, and to seven tide gauge stations operated between 1935 and 1981. Meanwhile, GCM decided to enhance the present network of four tide gauge stations, and to replace the old instrumentation by new and more accurate systems which also include meteorological sensors, and which provide the possibility to send, via modems, all measured meteorological and oceanographic data from tide gauge stations to the data centre at GCM in Ankara.

Three periodical GPS measurements in the years 1991-1995-1997, and the first period absolute gravity measurements in 1996 (a second period is planned for 1999) were successfully carried out on the tide gauge bench marks, with the aims of geodetic fixing of tide gauge bench marks in three dimensional terrestrial reference frame, and monitoring of crustal deformations.

Studies, developments and programs for future on sea level research in Turkey were significantly accelerated in recent years. An extended report 'Sea Level Researches in Turkey' is available, either from the author (M.A.Gürdal) or from the Permanent Service for Mean Sea Level (PSMSL).

Vladimir Udovik (Ukraine)

Sea levels on the Black Sea shoreline of the Ukraine have been measured since the late 19th century. A network of sea level stations was modified periodically. Data series for most of the stations were interrupted during the First and Second World Wars. For the majority of stations, data have been collected over periods as long as 70 years, and for separate stations more than 100 years.

At the present time there are 12 stations of the State Committee on Hydrometeorology of the Ukraine (SCHU) and one sea level monitoring station of the Experimental Department of the Marine Hydrophysical Institute of the National Academy of Sciences of the Ukraine (ED MHI NASU).

All level gauge sites have a Visual Level Staff (VLS). Seven stations of SCHU (Belgorod-Dnestrovsky, Ilichevsk, Odessa, Ochakov, Sevastopol, Feodosia and Yalta) also have a Float Operated Level Gauge (FOLG) with recording on charts, and the station of ED MHI NASU at Simeiz-Katcively has an automatic gauge with continuous registration on paper.

Other types of sea level gauges, such as pressure gauges and strain gauges, and recording media used in the sea level projects are designed and produced by the Designing and Construction Department of MHI NASU (DCD MHI NASU). A new sea level station with a pressure gauge and a strength cable gauge will be opened by MHI NASU on Zmeiny Island in September 1997.

Since 1961, Level Gauge Datum (LGD) is the same for all stations, and is equal to -5000 mm below the Zero Mark of the Krondshtadt VLS. Bench marks of all stations are levelled with First (0.5 mm) or Second (1.0 mm) Order Levelling within the State Geodetic Network.

According to the Instructions for Hydrometeorological Stations (IHS), the level gauge data have been obtained from Odessa, Sevastopol and Yalta and are used for investigations of low frequency level changes and trends, with Sevastopol as the main Black Sea station.

Standard 6-hourly sea level data are collected by the Marine Department of the Ukrainian Research Hydrometeorological Institute (MD URHI). Hourly and other temporally sampled data series have been prepared for different time periods as part of special projects of MD URHI and MHI NASU, or in collaborations, and are available. The longest record collected is from Sevastopol (1875-1997). The correlation of mean sea levels calculated from this series with values from other stations is 0.99. All the data collected before 1961 have been readjusted to the LGD (-5000 mm) and corrected for vertical tectonic motions (0.07-0.11 cm/year at Crimean stations and 0.51 cm/year downwards at Odessa).

MHI NASU and MD URHI are the main sea level research centres in the Ukraine. The departments of the institutes also produce computer software, carry out special field observations, and undertake sea level studies for industrial managers and construction specialists.

IV. CONCLUSIONS OF THE TRAINEES ON THE WORKSHOP

The final day of the workshop included a 'wrap up session' in which trainees were invited to comment on aspects of the two weeks. Responses included:

(i) Lectures and HOTS had been very good. It would be preferable for participants in a future course to have lectures and presentations available on disk or CD.

(ii) There is a need for strengthening of regional (e.g. within Black Sea area) and inter-regional (Black-Mediterranean) cooperation through, for example, active participation of all interested countries in projects such as MedGLOSS, EuroGLOSS, SELF, COPERNICUS etc. There is an ongoing need to evaluate requirements including methods for cooperation, logistics etc.

(iii) There is a perceived need for inter-levelling of the tide gauge benchmarks between countries, using GPS etc., in order to establish common datums, especially for Black Sea countries. This work should be performed by the proper specialists within the appropriate international frameworks.

(iv) Future courses would benefit from a detailed questionnaire survey of trainees' comments. (Comment added by organisers: such a questionnaire has been circulated to attendees of previous courses after periods following each course, in order to establish how successful the courses had been in retrospect).

(v) There is a lack of funds in some countries for journals and general library access, which is a problem which should be addressed by IOC/UNESCO.

(vi) Accommodation had been good.

V. WORKSHOP CERTIFICATE

Each trainee was presented with a workshop certificate on behalf of IOC and POL, signed by Graham Alcock as Local Organiser and Philip Woodworth as Chairman of the IOC Group of Experts on GLOSS (Annex V).

VI. ACKNOWLEDGEMENTS

Thanks are due to a number of POL staff for their help with the course. In particular, Colin Bell organised computer equipment for the HOTS sessions. Phil Cookson made all arrangements for transport. Bob and Elaine Spencer provided an excellent social evening. The trainees themselves are thanked for their patience with having to work around other scientific meetings at POL during the workshop.

ANNEX I

**IOC/GLOSS TRAINING WORKSHOP
AT POL 16-27 JUNE 1997**

Transport will be provided hotel to POL around 8.30 each morning and POL to hotel around 5.30. Format (1) 9.30-11.00 (2) 11.30 - 1 pm (3) 2-3.30 (4) 3.45-5 pm

WEEK 1:

Monday 16 June 1997

(1) Formal welcome [Alcock]. Any registration details (including check of telephone, fax and email addresses) and tour of lab. (two parties). Meet individuals including Dr.Brian McCartney (Director, POL) at coffee.

(2) Introduction to 'sea level' within basic geodesy (ellipsoid, geoid, sea level variations) [Woodworth]

Review of PSMSL, WSLC etc. databanks. Review of tide gauge data available from the Mediterranean, Africa etc. [Woodworth/Rickards]

Ice-breaker lunch.

(3/4) International programmes - GLOSS, GOOS, CLIVAR etc. [Dr.Albert Tolkatchev, Intergovernmental Oceanographic Commission]

The GLOSS Handbook CD-ROM product. A similar product for MedGLOSS? [Tolkatchev, Rickards]

Start of 20-minute introductions by attendees of work in each country, and detailed statements of individual requirements. [Spencer/Alcock]

Evening: Introductory course dinner.

Tuesday 17 June 1997

(1) Tidal analysis (theory of) and extremes and MSL (Part 1) [Vassie] (*)

(2) Sea level and climate change [Pugh] (*)

(3) Measuring and predicting (IPCC) global sea level changes [Woodworth] (*)

(4) Continue 20-minute introductions by attendees of work in each country, and detailed statements of individual requirements. [Spencer/Alcock]

(*) Recommended reading: see references to books by Pugh, Emery and Aubrey and Open University listed below.

Wednesday 18 June 1997

(1) Remaining 20-minute introductions by attendees [Alcock].

(2) Introduction to tidal analysis packages e.g. TASK (mailed to attendees beforehand) [Woodworth]. HOTS demonstrators to attend also [Woodworth, Vassie, Blackman]. (Hereafter there will be 4 PC's available for private HOTS study)

GLOSS standards on requirements for local levelling (based on Carter report and IOC Manuals) [Woodworth]

(3) The UK tide gauge network and its mixture of gauge-types [Smith]. Description of float gauges and their problems [Vassie] (n.b. most attendees will have float gauges). 'Walk through' of the 2 IOC Manuals, especially with regard to float gauges, prior to visit to Holyhead on Thursday [Smith/Vassie]

(4) Overview of other (i.e. non-sea level) oceanographic projects at POL [Alcock] (Hereafter please feel free to have private discussions off-line with any POL staff. Alcock or Woodworth can make necessary introductions.)

Thursday 19 June 1997

Visit to Holyhead [Smith] - to include VdC test in stilling well (in principle needs a whole tidal cycle, not so relevant for Mediterranean or Black Sea) as explained in Manual. Holyhead contains a float gauge, bubbler pressure and an 'ACCLAIM B gauge'. It is about a 2 hour drive from POL.

Friday 20 June 1997

(1) Tidal analysis (theory of) and extremes and MSL (Part 2) [Smithson]

(2) Tide gauge instrumentation other than float gauges (see Manuals), including measuring proxy-'sea levels' in the deep ocean with bottom pressures and inverted echo sounders [Smithson]

(3) Satellite altimetry - applications to geophysics, tidal studies and measuring changes in the ocean circulation [Woodworth]

(4) Deep ocean 'sea level' instrumentation [Bob Spencer]

WEEK 2:

Monday 23 June 1997: HOTS Day

(1/2) Party 1 HOTS [Demonstrators: Woodworth, Vassie] / Party 2 Practical exercises in geodetic levelling around the POL site [Smith]

2 pm POL seminar by Dr.Mickey Tsimplis, Southampton Oceanography Centre. Sea level variability in the Eastern Mediterranean Sea: trends, extremes, tides and correlation with meteorology, from the point of view of an observationalist.

(3/4) Party 2 HOTS [Demonstrators: Woodworth, Vassie] / Party 1 Levelling

Tuesday 24 June 1997: Mediterranean Day

(1) Sea level changes and coastal impacts [Dr.Andrew Plater, Dept. of Geography, University of Liverpool]

(2) Modelling tides and surges in the Mediterranean. Review of the SELF project. [Proctor]

(3) MedGLOSS project [Dr.Dov Rosen, Israel Oceanographic and Limnological Research Ltd.]

(4) The ocean circulation of the Mediterranean [Rosen]

Wednesday 25 June 1997: Special Day on Measuring Vertical Land Movements

(1) Space geodetic techniques and applications to measuring vertical land movements. European geodetic networks (EuroGLOSS, EOSS etc.) Review of conclusions of JPL IGS/PSMSL GPS Workshop etc. [Baker]

(2) Absolute gravity (theory) and demonstration of POL's FG5 meter [Edge]

(3) Demonstration of GPS receiver installation at a tide gauge (on POL roof) [Dr.Richard Bingley, Nottingham University Institute of Engineering Surveying and Space Geodesy]

(4) Remaining questions/problems [Baker]

Thursday 26 June 1997: Final HOTS Sessions etc.

(1) Party 1 HOTS [Demonstrators: Vassie, Blackman]/ Party 2 POL instrumentation of interest or personal discussions with POL scientists or private study

(2) Party 2 HOTS [Demonstrators: Vassie, Blackman]/ Party 1 POL instrumentation etc.

(3/4) Private HOTS or private discussions or free time for shopping etc.

Friday 27 June 1997

(1) Wind-up review by administrators of PSMSL/WSLC data banks [Rickards/ Spencer] to make sure we have correct addresses for future collaboration.

General debrief of course. Comments/criticisms. Draft workshop report for IOC. [Alcock]

ANNEX II

LIST OF PARTICIPANTS

A. TRAINEES

ALGERIA

Djaffer BENNACER
Service Hydrographique
Commandement des Forces Navales
BP: 78 Bordj el-Behri
Boumerdes
Fax : +213 2 57 82 06

BULGARIA

Mrs.Mariana POPOVA
c/o Dr.Maria Popova
National Institute of Meteorology and Hydrology
Tzarigradsko Chaussee 66
Sofia 1789
Email: mariana.popova@meteo.bg

CROATIA

Mr.Ivica VILIBIC
State Hydrographic Institute
Zrinsko Frankopanska 161
2100 Split
Tel: +385 21 361840
Fax: +385 21 47 045
Email: dhi-oco@dhi.tel.hr

EGYPT

Mr.Ahmed Abdel-Monlem RADWAN
National Institute of Oceanography & Fisheries
Physical Oceanography Lab.
Alexandria Branch
Kayet Bay, El Anfoushi
Alexandria
tel: +203 4807140, 4807138
fax: +203 4801174
email: tsm@idsc.gov.eg

MOROCCO

Mr.Karim HILMI
Institut National de Recherche Halieutique
2 rue de Tiznit
Casablanca 01
Tel: +212 2 26 81 92
Fax: +212 2 26 69 67
Email: inrh@mail.cbi.net.ma
(attn. Karim Hilmi)

ROMANIA

Mr.Viorel MALCIU
Ministry of Waters, Forests &
Environmental Protection
Romanian Marine Research Institute
300 Mamaia Blvd.
8700 Constantza 3
Tel: +40 41 64 32 88
Fax: +40 41 83 12 74

TURKEY

Msc. Mehmet Ali GÜRDAL
Eng.Captain
Geodesy Department
General Command of Mapping
TR-06100 Dikimevi
Ankara
Tel: +90 312 3197740 ext 2267
Fax: +90 312 3201495
Email: harita-g@tr-net.net.tr

UKRAINE

Dr Vladimir F. UDOVIK
Hydrophysical Shelf Department (OHFS)
Marine Hydrophysical Institute Ukrainian
Academy of Science
2 Kapitanskaya Str.
Sevastopol 335000
Fax: 0692 444253
Email: ocean@mhi2.sebastopol.ua

B. LIVERPOOL UNIVERSITY STUDENTS

Alberto Naviera GARABATO
Lucy Mathers
Barry Morley
Smaeyl Hassan Zadeh
Oceanography Laboratories
Liverpool University
Liverpool L69 3BX
U.K.

C. INVITED EXPERTS

Dr.Richard BINGLEY
Institute of Engineering Surveying and Space Geodesy
University Park
Nottingham NG7 2RD
U.K.
Tel: +44 1159 513880
Fax: +44 1159 513880
Email: isxrb@evn1.nott.ac.uk

Dr.Andy PLATER
Geography Department
Liverpool University
Liverpool L69 3BX
U.K.
Email: gg07@liverpool.ac.uk

Dr.David PUGH
Southampton Oceanography Centre
Empress Dock
Southampton SO14 3ZH
U.K.
Tel: +44 1703 596611
Fax: +44 1703 596612
Email: d.pugh@soc.soton.ac.uk

Mr. Dov ROSEN
Israel Oceanographic &
Limnological Research
Tel Shikmona
P.O. Box 8030
Haifa 31080
Israel
Tel: +972 485 15202
Fax: +972 485 11911
Email: rosen@ocean.org.il

Dr.Albert TOLKATCHEV
Intergovernmental Oceanographic Commission
UNESCO
1 rue Miollis
Paris 75732 Cedex 15
France
Tel: +33 1 45 68 39 78
Fax: +33 1 45 68 58 12
Email: sctol@unesco.org

Dr.Mickey TSIMPLIS
Southampton Oceanography Centre
Empress Dock
Southampton SO14 3ZH
U.K.
Tel: +44 1703 595000
Fax: +44 1703 596666
Email: m.tsimplis@soc.soton.ac.uk

D. EXPERTS FROM POL

Philip WOODWORTH
Director, PSMSL
Proudman Oceanographic Laboratory
Bidston Observatory
Birkenhead, Merseyside L43 7RA
U.K.
Tel: +44 151 653 8633
Fax: +44 151 653 6269
Email: plw@pol.ac.uk

Graham ALCOCK
(Local Organiser of the Course) gaa@pol.ac.uk

Trevor BAKER
(Geodesy) tfb@pol.ac.uk

Colin BELL
(Computer Support) cb@pol.ac.uk

David BLACKMAN
(Tidal Data Analysis) dlb@pol.ac.uk

Robert EDGE
(Absolute Gravity) rje@pol.ac.uk

Roger PROCTOR
(SELF Mediterranean Studies) rp@pol.ac.uk

Lesley RICKARDS
(British Oceanographic Data Centre)
ljr@pol.ac.uk

David SMITH
(UK Tide Gauge Network) des@pol.ac.uk

Michael SMITHSON
(Tides, Surges, Extremes) msm@pol.ac.uk

Elaine SPENCER
(PSMSL Secretary) psmsl@pol.ac.uk

Robert SPENCER
(South Atlantic Tide Gauges and Bottom Pressures)
rsp@pol.ac.uk

Ian VASSIE
(Tides, Surges, Extremes) imv@pol.ac.uk

ANNEX III

MATERIALS DISTRIBUTED

The two IOC Manuals on operating tide gauges, the Carter (Surrey) report on geodetic fixing of tide gauge bench marks, and the TASK package floppy package were mailed to trainees approximately two months prior to the course. These documents were assumed to have been read before the course commenced, and the TASK package investigated on the trainees' own PCs using the test data provided. In addition, all trainees were asked to bring to the course a year of their own tide gauge data which could be analysed during the HOTS sessions.

On arrival, trainees received the Draft GLOSS Implementation Plan 1997, EuroGLOSS proposal (Baker et al.) and MedGLOSS and GOOS general information. Listings of PSMSL, WOCE etc. data holdings were distributed, as well as information on TOPEX/POSEIDON data availability and conference information. The GLOSS Handbook (V3.0) CD-ROM was distributed, along with Dov Rosen's ISRAMAR data acquisition software package.

Copies of lecture notes used by Woodworth and Vassie at Liverpool University were circulated, in addition to copies of the IPCC Second Scientific Assessment Chapter 7, and the papers shown below:

Baker, T.F., Woodworth, P.L., Blewitt, G. Boucher, C. and Woppelmann, G. 1997. A European network for sea level and coastal land level monitoring. Journal of Marine Systems (in press).

Rosen, D.S. 1997. Launching of the pilot phase of the MedGLOSS network. Outcome of the first meeting of the joint IOC/UNESCO and CIESM group of experts on MedGLOSS. Edited by D.Rosen, Chairman, Joint Group of Experts on MEDGLOSS (20-21 January 1997).

Spencer, N.E. and Woodworth, P.L. 1991. Data holdings of the Permanent Service for Mean Sea Level (January 1991). Bidston, Birkenhead: Permanent Service for Mean Sea Level. 136pp.

Tsimplis, M.N. and Spencer, N.E. 1997. Collection and analysis of monthly mean sea level data in the Mediterranean and the Black Sea. Journal of Coastal Research, 13(2), 534-544.

Woodworth, P.L., 1991. The Permanent Service for Mean Sea Level and the Global Sea Level Observing System. Journal of Coastal Research, 7(3), 699-710.

Zerbini, S. et al. 1996. Sea level in the Mediterranean: a first step towards separating crustal movements and absolute sea-level variations. Global and Planetary Change, 14, 1-48.

ANNEX IV

SELECTED FURTHER REFERENCES

Mean Sea Level and Tides

Emery, K.O. and Aubrey, D.G. 1991. Sea level, land levels, and tide gauges. Springer-Verlag, New York. 237pp.

Open University. 1989. Waves, tides and shallow-water processes. Open University Oceanography Series, Volume 4. Oxford, Pergamon Press in association with the Open University. 187pp. (This is Volume 4 within the Open University Oceanography Series. All of them are worth reading)

Pugh, D.T. 1987. Tides, surges and mean sea-level: a handbook for engineers and scientists. Chichester, Wiley. 472pp.

Warrick, R.A., Le Provost, C., Meier, M.F., Oerlemans, J. and Woodworth, P.L. 1995. Lead authors of Chapter 7 (Changes in sea level) of Climate Change 1995. The science of climate change. Contribution of working group I to the second assessment report of the Intergovernmental Panel on Climate Change, eds. J.T.Houghton, L.G.Meira Filho, B.A.Callander, N.Harris, A.Kattenberg and K.Maskell. Cambridge: Cambridge University Press. 572pp.

Mediterranean Tides

Tsimplis, M.N., Proctor, R. and Flather, R.A. 1995. A two-dimensional tidal model for the Mediterranean Sea. Journal of Geophysical Research, 100(C8), 16223-16239.

Mediterranean Circulation

Deep-Sea Research, 44, 3-4, 1997 contains a number of papers on geochemical studies in the western Mediterranean.

Malanotte-Rizzoli, P. et al. 1996. Experiment in eastern Mediterranean probes origin of deep water masses. EOS, Transactions of the American Geophysical Union, 77, 32, 305-311.

Robinson, A.R. et al. 1991. The eastern Mediterranean general circulation: features, structure and variability. Dynamics of Atmospheres and Oceans, 15, 215-240.

Rosen, D.S. 1997. Physical aspects of the Mediterranean versus integrated sustainable coastal and marine development. Paper submitted to the International Forum on the Fragility of the Mediterranean Ecosystem: a Conflict of Uses and Resources, Vilanova I La Geltru, 12-13 March 1997.

ANNEX V

EXAMPLE OF CERTIFICATE PRESENTED TO TRAINEES

(End of document)