Report by the Permanent Service for Mean Sea Level (PSMSL) for the Period 1999-2003 to the XXIII General Assembly of the IUGG, Sapporo, June-July 2003

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1. Introduction

This report reviews briefly the work of the Permanent Service for Mean Sea Level (PSMSL) during 1999-2003. In this period, the PSMSL has data banked a large amount of sea level information, has taken a major role in the development of the Global Sea Level Observing System (GLOSS), and has contributed to important international working groups on climate change and geophysics.

The PSMSL is operated at the Proudman Oceanographic Laboratory (POL), Bidston Observatory under the auspices of the International Council for Science (ICSU), and is a member of the Federation of Astronomical and Geophysical Data Analysis Services (FAGS). The PSMSL reports to the International Association for the Physical Sciences of the Ocean Commission on Mean Sea Level and Tides (IAPSO/CMSLT) and has an Advisory Board consisting of scientists expert in each area of sea level research. Annual reports on the work of the PSMSL are circulated each year to the International Association of Geodesy (IAG), the Intergovernmental Oceanographic Commission (IOC), IAPSO, FAGS, and other relevant bodies and are available publicly via the web at:

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

This same web page also serves as a source of PSMSL data and ancillary information.

2. PSMSL Staff

Mr. Graham Alcock took early retirement in 2000. Graham was closely involved in PSMSL and GLOSS matters for over 20 years, being the main organiser of over 10 GLOSS training courses, having represented PSMSL and GLOSS at many international meetings, and having authored several important GLOSS reports. Dr. Philip Axe also left PSMSL and POL in 2000 to take up an appointment in Sweden and is now based at SMHI..

Of particular note during 2001 was the MBE (Member of the British Empire) awarded by the Queen to Mrs. Elaine Spencer in the 2001 New Year's Honours List. Elaine was PSMSL Technical Secretary between 1974 and 1999. The development of the PSMSL data set formed part of the citation for the award.

Two new scientists joined the PSMSL in 2002 following increased funding received from the UK Natural Environment Research Council. The first was Dr. Svetlana Jevrejeva from Tallinn in Estonia, who has published a number of papers on climate variability including studies of sea ice changes in the Baltic related to the North Atlantic Oscillation. The second was Dr. Simon Holgate from Liverpool University who has a background in sea-level related geology, geography and palaeo-carbon flux studies. Svetlana and Simon will lead the PSMSL data collection in future, with some continued assistance from Mrs. Rose Player.

3. PSMSL Data Receipts for 1999-2003

On average, approximately 1500 station-years of data were entered into the PSMSL database during each year of the period. This compares well to rates obtained in previous years. Most data originated from Europe, North America and Japan, but all regions are represented in the receipts at some level. Important data gaps in South America, Africa and parts of Asia are receiving special attention as part of the JCOMM GLOSS programme (see below). Figure 1 indicates the locations from which data were received during 1999-2003. Comparison to

the corresponding figure produced in the PSMSL report for the IUGG in 1999 shows slightly fewer stations this time in Africa and South America and considerably more in the Arctic.

The main method for distribution of PSMSL data is now unquestionably the internet, almost all other methods now having been abandoned. However, regular CDs and now DVDs are produced as backups and for people in some countries without good web access. A DVD was produced in 2002 with the PSMSL data set as part of the final conference of the World Ocean Circulation Experiment (WOCE), containing all tide gauge data collected during the programme.

4. GLOSS Activities

The Global Sea Level Observing System (GLOSS) is a project of the Joint Commission for Oceanography and Marine Meteorology (JCOMM) of the Intergovernmental Oceanographic Commission (IOC) and World Meteorological Organisation (WMO). One of the main aims of GLOSS is to improve the quality and quantity of data supplied to the PSMSL. GLOSS has been one of the first components of the Global Ocean Observing System (GOOS). GLOSS network status as perceived by the PSMSL is reviewed each year and can be found at http://www.pol.ac.uk/psmsl/programmes/gloss.info.html while a review of progress within the programme has been prepared by the PSMSL as a 'GLOSS Adequacy Report' submission to the 2003 IOC Assembly. Meetings of the GLOSS Group of Experts, which is the management committee for the programme, have been held every two years alongside scientific and technical workshops.

GLOSS training courses have been held in many countries since the mid-1980s. Since 1999, courses have been held in Brazil (1999), Saudi Arabia (2000), Guatemala (2001), India (2003), Chile (2003) and Malaysia (2003). (The Guatemala and India courses were not official IOC-funded GLOSS courses but had significant GLOSS participation). The GLOSS training programme also includes web based materials, training manuals, newsletters and tidal software. As an example of training materials, the PSMSL with some support from GLOSS funded Dr. Glenn Milne of the University of Durham to produce maps of sea level change through the Holocene period, showing the changes in coastlines which resulted.

A joint project between the IOC International Oceanographic Data and Information Exchange (IODE) Committee, GLOSS and PSMSL to conduct a 'data archaeology' survey of historical sea level records, was begun by Dr. Lesley Rickards. This project has the aim of extending existing time series and gaining access to observations which are not in digital form.

5. European Projects

A European Union (EU) funded sea level study called SELF-2 for the Mediterranean was completed during the period with PSMSL and POL participation, with concentration at POL on mean sea level changes, storm surge modelling, absolute gravity and tidal loading. The EU EOSS project aimed to enhance sea level (tide gauges) and land level (GPS) monitoring, and associated data exchange in Europe, primarily by sets of bilateral (i.e. no new cost) agreements. That project ended in September 2001 with an international conference in Dubrovnik, Croatia, and was followed by Calls for Participation in a new European Sea Level Service (ESEAS) which it is hoped will continue and extend the work of EOSS, and put the provision of sea and land level information from Europe on a sounder basis.

In 2000, Dr. Woodworth attended the first Coordination Meeting of the MedGLOSS programme at Haifa, Israel organised by Dr. Dov Rosen. MedGLOSS is a joint programme of the International Commission for the Scientific Exploration of the Mediterranean Sea (CIESM) and IOC and aims to install and coordinate a network of gauges for the Mediterranean and Black Seas.

6. Altimetry and Gravity Field Activities

Participation has continued in European and US altimeter working groups during the period. Dr. Woodworth is a Principal Investigator for the TOPEX/POSEIDON and JASON-1 missions and of particular interest to the PSMSL is the symbiosis between altimetry and tide gauge measurements with gauges being used extensively by the project to calibrate the altimeter data set. During 2001, Dr. Xiaojun Dong from the Shanghai Astronomical Observatory joined the sea level group at POL through a Fellowship from the Royal Society, with the object of researching the best methods for ongoing altimeter calibration using tide gauge data. This resulted in one paper being accepted for publication in Marine Geodesy with other work in progress.

Drs. Woodworth and Hughes of POL have during the period been members of the Mission Advisory Group (MAG) of the European Space Agency (ESA) Gravity Field and Steady State Ocean Circulation Experiment (GOCE) mission which is planned for launch in 2006. This is a major development for ocean circulation and sea level studies in the next decade. Drs. Hughes and Woodworth are also involved in the use of data from the US-German Gravity Recovery And Climate Experiment (GRACE).

7. Geodetic Fixing of Tide Gauge Benchmarks

In 1997, an important meeting on tide gauge benchmark fixing was held at the Jet Propulsion Laboratory, prior to the fifth meeting of the GLOSS Experts (GE5). This meeting was organised jointly by the IGS Central Bureau, the PSMSL and IOC/GLOSS and resulted in an excellent workshop report on the use of GPS at gauge sites for measuring long term changes in vertical land movements and for altimeter calibration. In 1999 and 2001, follow-up meetings were held in Toulouse, France and Honululu, USA alongside GE6 and GE7 respectively. In September 2002, a study week was organised on vertical crustal motion and sea level change and on the use of GPS at tide gauges in Toulouse. The week included the development of the TIGA project at GFZ, Germany which aims to better understand the uncertainties in the use of GPS in this role further, and was held under the auspices of the IGS/PSMSL/IAPSO/IAG/GLOSS CGPS@TG working group which had been formed at the 1997 JPL meeting. As part of CGPS@TG work, regular surveys have been conducted on behalf of the PSMSL, EUREF and other organisations on the availability of permanent GPS stations near to tide gauges by Dr. Guy Woppelmann of the University of La Rochelle.

8. Publications

The PSMSL has a responsibility to not only collect and redistribute sea level information, but also to analyse data and publish scientific results. The main papers published each year are listed in PSMSL Annual reports. However, three important ones may be mentioned here. The Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC) was published during 2001 with Chapter 11 on sea level changes led by Dr. J. Church (Australia) and Dr. J. Gregory (UK) and with Dr. Woodworth as a Lead Author. In 2002 a major paper was published by Dr. Woodworth and others on the use of tide gauges during WOCE. Finally, a review paper of the work of the PSMSL was published in the Journal of Coastal Research in 2003.

9. GLOUP

The PSMSL is responsible to the IAPSO Commission on Mean Sea Level and Tides for the maintenance of the data base of pelagic (bottom pressure recorder) information. This data base, called GLOUP (Global Undersea Pressures), was maintained during the period by Dr. Chris Hughes and can be inspected at:

http://www.pol.ac.uk/psmslh/gloup/gloup.html

10. PSMSL Forum

Mr. Philip Knight of POL has written a newsgroup type software called the 'PSMSL Forum' which allows discussion via emails of matters of importance to the PSMSL, such as developments in tide gauge technology or sea level research. The software is presently being tested by volunteers and the utility of such a forum will be assessed during 2003.

11. Publicity

The opportunity has been taken whenever possible to publicise the work of the PSMSL in newspapers and on radio and TV. Presentations were given in the period in all three media in several countries and details can be found in the PSMSL Annual Reports.

12. Relocation of POL to Liverpool University

Plans have advanced for POL's relocation from Bidston Observatory to a new building on the campus of Liverpool University in September 2003. This will include the relocation of the PSMSL. Our new postal address and phone and fax numbers will be advertised on the PSMSL web pages as soon as possible but our email and web addresses will be unchanged. We expect that any disruption to the work of the PSMSL will be temporary.

Summary

It can be seen that 1999-2003 has been a further active period with regard to important workshops and conferences, and a busy one with regard to data acquisition and analysis. Particular thanks as usual go to PSMSL staff, and also to the staff of the Proudman Oceanographic Laboratory who provide the extended Service.

P.L.Woodworth (June 2003)

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Figure 1: New PSMSL Data 1999–2003