Intergovernmental Oceanographic Commission
Workshop Reports No. 287

Workshop on Sea Level Data Archaeology

Paris, France
10–12 March 2020

UNESCO

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In partnership with:

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

GLOSS Global Sea Level Observing System

IHO International Hydrographic Organization

IUGG

IAPSO International Association for the Physical Sciences of the Oceans

UNESCO 2020

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1. WELCOME BY IOC EXECUTIVE SECRETARY AND REPORTING ARRANGEMENTS

Dr Vladimir Ryabinin, Executive Secretary of the Intergovernmental Oceanographic Commission (IOC), opened the Workshop on Sea Level Data Archaeology at 09:15 on Tuesday 10 March 2020. He welcomed the participants of the workshop to the IOC and thanked them for their attendance and dedication to Oceanography during this challenging time.

Dr Ryabinin highlighted the aims of the UN Decade for Ocean Sciences (2021–2030) (IOC/BRO/2018/2) and stressed that observations are essential for management of the ocean. He emphasized the importance of data archaeology and the contributions workshop like this makes towards the Decade objectives as well as the WCRP Grand Challenge project on Regional Sea-level Change and Coastal Impacts (https://www.wcrp-climate.org/gc-sea-level).

Philip Woodworth acted as rapporteur for session 1 of the workshop, Yann Ferret was rapporteur for session 2, Frédéric Pons was the rapporteur for session 3 and Laurent Testut acted as rapporteur for session 4. Elizabeth Bradshaw helped in this process and summarized the main outcomes of this workshop.

All presentations are available from: http://www.ioc-unesco.org/workshop-sea-level-data-archaeology.

2. DAY 1 SESSION 1 HISTORICAL SEA LEVEL DATA AND DATA AT RISK

Elizabeth Bradshaw presented the opening keynote talk, giving a brief history of GLOSS data archaeology efforts. She justified why sea level data rescue is important. The requirement for more baseline data was highlighted, as well as the importance of sea level data rescue in the context of international ocean observation programmes. Funding is a limiting resource but data rescue is multidisciplinary and we should look to find funding on a large scale.

At the end of the presentation a poll was conducted among the workshop participants, asking them about previous data rescue projects they had been involved in. The results are synthesised below, and the complete answers are listed in the Annex III.

- What went well? – We identified data we were not aware of, recovered data and found a helpful community.
- What challenges did you face? – It was difficult to find metadata, particularly datum connections. Digitising is time consuming. Resources and funding.
- What would you do differently next time? – Scan/capture the data (for redundancy and to prevent further data loss), prioritise the most important sites (evaluate quality control beforehand, pick best/longest record), work with others.

Kathleen McInnes presented the experience of data rescue activities in Australia, where several potential long records have been identified in a data sparse region. The justification for the data rescue has been to improve the confidence in predictions of extreme events. There were challenges in retrieving records that had been relocated, but the project has been particularly successful in employing the use of volunteers, including students. Students gain the benefit of experiencing the wider work of CSIRO and are also credited for their work.

David Pugh presented his experience on recovering tidal data from around Ireland. David thanked the International Hydrographic Organization (IHO) for producing throughout its history benchmark lists that he had found very useful. He stressed the importance of searching for

multiple data sources and of historic levelling of benchmarks. The presentation looked at considering clusters of historic measurements and not just individual gauges. Modern measurements were made with temporary tide gauges that were levelled to the historic datum.

Laurent Testut gave a presentation on behalf of Richard Coleman who was unfortunately unable to attend the workshop, on data rescue from several sites in the Southern Hemisphere. The data recovery at Port Arthur, Macquarie Island and Hobart are of special importance as they extend series in a data sparse region. Again the importance of locating historic benchmarks was emphasised, including linking benchmarks across from islands. Records were also complemented with saltmarsh proxy data.

Philip Woodworth presented five examples of data archaeology. He stressed that it was important to know why people made the measurements at the time, how they did it (what instruments were used, type of tide gauge) and the importance of ancillary measurements including air pressure (especially for quality controlling very short records). He also stated that it was important to consider what to do with the data that is rescued, as data quality and metadata will affect the data's application. He stressed that data rescue is never as simple as imagined.

Andy Matthews gave a brief overview of the activities of the Permanent Service for Mean Sea Level (PSMSL). Challenges include maintaining datum stability over long records and how to process multiple versions of the same station. The PSMSL has proposed a new category of station data called 'recovered data', and asked for community input on the requirements for accepting recovered data. It is important that a user can follow each step on the processing of a series and be able to go back to the original supplied dataset.

3. DAY 1 SESSION 2: METHODOLOGY FOR TRANSFER OF PAPER RECORDS TO DIGITAL DATA

Frédéric Pons presented the marigram digitising software, NUNIEAU. The software is based on MATLAB and is freely available. Manually digitising charts is a time consuming process and the software was developed during a project to digitise a large number of charts. Before digitising the chart, a user should ask themselves several questions in order to ensure that the output will be suitable for their requirements. What format are your data in? What product do you require? Do you have related metadata? Are the data to be used to study sea level rise or extreme events? Frédéric Pons welcomed suggestions to enhance the NUNIEAU software. Localised versions of the NUNIEAU exist in French, English and German. Other language versions can easily be developed as text fields are stored in an Excel file which contains translation information and this file can be updated and returned to Frédéric Pons.

In the discussion following the presentation, there was a suggestion that a NUNIEAU users' group be established to share experiences, suggest enhancements and to see who has digitised data.

Stefan Talke discussed his experiences with data rescue and suggested a number of lessons learned. The first lesson was to make a catalogue. Lots of different institutes and people have collected data but we should check that the data still exist. Lesson 2 was "Don't take no for an answer". There are more records to find and looking at other sources e.g. letters gives confidence to data quality and contained metadata. Lesson 3 was to use multiple types of data e.g. High and low water measurements, hourly averages and charts to quality control digitised data. Lesson 4 was to think like a historian and lesson 5 was to try to give a reason as to why the old records matter. Stefan Talke is investigating improved ways of digitising, including working with students on using machine learning to recognise handwriting.

The discussion following this presentation was on the difficulties of using an internet search in languages not spoken by a user. It was easier to find additional data and metadata sources on the internet in languages the user was familiar with, but more difficult when the user was unfamiliar with terms to search for.

Jürgen Holfort presented work on digitising data along the German coast, focusing on the site at Warnemünde. The work began at the institute in the 1980s as technicians had time available while operating a 24/7 warning service. Freely available digitisation software (Engauge) has been used more recently to digitise paper charts. Chart scanning was a relatively quick process when the charts were in a small format and a form-feed scanner could be used, but a more expensive contactless scanner had to be purchased to scan larger format more delicate charts. At the current rate of digitisation, it will take ~20-30 years to digitise all of the analogue records. Funding was an issue but all records have been imaged (if not digitised) so users can at least request data.

In the discussion following the presentation it was identified that there has been recent interest in meteotsunami records and Jürgen Holfort reported that they had seen 30 events that were over 30 cm high in one record, but that the network was not dense enough to track the passage of a meteotsunami.

4. DAY 2 SESSION 2 (CONT.): METHODOLOGY FOR TRANSFER OF PAPER RECORDS TO DIGITAL DATA

Rob Allan gave an introduction to the interlinked Atmospheric Circulation Reconstructions over the Earth (ACRE) and Copernicus Climate Change Service (C3S) Data Rescue Service (DRS) initiatives. He highlighted the importance of regional densification of programmes and hosting workshops in each region. Citizen science and data rescue had helped to improve the reanalysis as increasing amounts of data increased resolution and allowed better capture of dynamic patterns. The 20th Century Reanalysis version 3 is now available (go.usa.gov/XTd).

Sylvie Jourdain (Météo-France, France) presented the data rescue activities of Météo-France, who have extensive climate archives. It is part of Météo-France's mission to make access possible to data and so it is considered that data rescue activities are part of this mission. This mission objective gives good weight to requests for funding. Météo-France is responsible for preserving, organising and cataloguing the national climate archives. Sylvie advised that it was essential to give people good guidelines for keying in information.

Gwenaële Jan (and Chair of International Hydrographic Organisation Tides, Water Level and Currents Working Group) gave a presentation on the activities of the IHO TWCWG to highlight their experiences and areas of expertise. The WG is interested in recovering historical data to monitor developments in tides, currents and tidal analyses. The WG would like to use long-term datasets to compare tidal analysis methodologies and will come up with guidance or recommendations on harmonic analyses. The presentation showed how different approaches to data rescue work in different countries, focusing first on the recovery of records from the Republic of Korea, where books and papers were scanned and digitised. The WG raised the point on metadata assigning image full filename information to select the pertinent information from historical data. The WG would like to see some guidelines for data consistency: measures of uncertainty, detailed historical data in a collective bank / database for several gauges (not only tide) for research in climate, land vertical trend, water level trend, vertical reference etc. to inform the scientific community.

5. DAY 2 SESSION 3: AUXILIARY HISTORICAL ARCHIVES RELATED TO SEA LEVEL

Nathalie Giloy reported on a new French national Working Group (WG) "Historical Storms and Floodings" that has been working on a database of storm events. There will soon be a web-based page to access the data. The WG includes researchers, statisticians and historians from different entities (IRSN, Artelia, BRGM, Cerema, EDF, LIENSs, SHOM and Université Populaire du Littoral Charentais). It was mentioned that for statistical approaches "a bad value with high uncertainty is better than no value." and consequently the work on qualitative measurements can be valuable.

David Pugh (National Oceanography Centre, UK) gave a presentation discussing the work of Thomas G Bunt, who instigated a levelling exercise and sea level measurements in 1837 and 1838, to compare mean sea levels in the English and Bristol Channels. Again, David Pugh highlighted the importance of being able to locate historical benchmarks and datum information.

Frédéric Pons spoke about the development of a database, from historical archive data to study extreme marine events in the Thau watershed and the eastern part of the Sète agglomeration community. The data rescue used a historian-focussed approach and the database is challenging to maintain due to the number of links it contains. It was discussed how one can convert from the qualitative to the quantitative data. Frédéric Pons asked the workshop to think about how best it would be to store the data and metadata identified in such projects so that others could be made aware.

Emmanuelle Athimon discussed data rescue from a historian's perspective. She advised that we try to define guidelines to assess archives/documents reliability and spoke about the importance of primary and secondary sources. In her talk she highlighted why it was important to analyse historical documents critically and not just take them at face value and consider the authenticity of a document. For each document, we should be trying to answer "what, where, when, who and why".

Ed Hawkins presented work done by Citizen Scientists to recover historical weather observations. Ed Hawkins reported that it was important to tell people why the observations had been done and by whom, to help them feel involved and that it was important to tell the story of the data. ~3000 volunteers had rescued 3.8 million observations in a year, but the work needed to speed up! There are 1 billion observations still to be digitised. 20% of the volunteers did 80% of the work. Weather rescue projects have been set up in the UK, Canada and New Zealand.

6. DAY 2 SESSION 4: APPLICATIONS AND KNOWLEDGE PRODUCTS FROM RECOVERED DATA

Ivan Haigh reported on a data rescue project that focused on the Thames estuary, where various different data types (charts, high and low water measurements) were used to re-evaluate the changing flood risk. The Thames barrier and other schemes protect 1.3 million people and £275 billion property and the study was considering adaptive defences. Students had helped with the data rescue activity by keying in high and low waters.

Déborah Idier described how BRGM had built a database of storm events based on archives, newspapers, maps and photographs. The database could be incorporated into models, to validate the model assumptions. Using the historical data, they were able to characterise past events over 100 years and identify significant flood events.

Marta Marcos discussed recent data rescue activities in Spain, which were partly prompted by the forthcoming retirement of a colleague. There was the impetus to carry out the project before

the local knowledge was lost. Analogue data were identified for several sites, but Alicante and Santander were chosen as the longest and most complete records. A large amount of effort was invested in investigating and correcting the datum but there were still some issues. The data from Alicante was buddy checked with the record from Marseille, and Santander with Brest.

Peter Hogarth presented his work on developing an average Mean Sea Level curve for the British Isles, incorporating recovered data. Data sources included the archives of the Admiralty United Kingdom Hydrographic Office (UKHO), PSMSL documentation, Ordnance Survey publications and miscellaneous other documents. Peter Hogarth again emphasised the importance of datum information, as well as assembling a site history for each location, detailing instrument and sensor changes, site visits, surveys etc. which would help to explain any datum shifts/jumps in the data series. The presentation also discussed the use of grouping sites into regional clusters.

Walter Grismeyer discussed the data rescue activities along the Argentinean coast. The longest historical series is from the Port of Buenos Aires (1905 onwards). Data exists in the archives of the Naval Hydrographic Service in paper format or other obsolete media. Alongside the tide gauge measurements, the archives also contain site diagrams and datum information. The archives also contain many important short records from refuges in Antarctica beginning in 1929. More recent data rescue work has been focused on recovering data from the San Matías and San José gulfs.

7. DAY 3 SESSION 4 (CONT.): APPLICATIONS AND KNOWLEDGE PRODUCTS FROM RECOVERED DATA

Hui Wang and Wenshan Li gave a presentation about the factors that could affect the quality of data being collected. They highlighted again why it was important to build up a comprehensive site history for a location, to help identify issues with data, such as changes of instruments, sites being relocated and the change of the gauge zero level and why it was a good idea to compare data with neighbouring stations if possible. A knowledge of local and regional phenomena (land subsidence, earthquakes, ocean circulation) was also required to help understand anomalies in the data.

8. POSTER SESSION

Seven posters were delivered and open-discussions took place during break times.

Fabio Raicich presented the potential sources of historical sea-level measurements in Italy where modern observations started in the mid-19th century. He pointed out that many tide gauge data and metadata have never been published and survive in several archives (the Geographic Military Institute for the 1872–1922 period, the former ‘Magistrato alle Acque’ in Venice, local archive centres …).

Torbjørn Taskjelle gave an overview of the historical tidal records in Norway. Many historical sea level measurements have already been recovered, but some work on digitisation remains. The Oslo sea level time series could be extended for almost 30 years. By digitising the analog marigrams and/or the tabulated hourly values, time series from other locations along the Norwegian coast could also be extended, or have gaps filled. Torbjørn Taskjelle indicated this work of data rescue is challenging because of the funding issues, it is a time consuming process and it is sometimes hard to make the time series coherent (tie to benchmarks).

Issa Sakho presented a study on the estimation of Sea Level Rise in West Africa. Trends are estimated from Tide gauge observations performed in Senegal (Dakar, 1993–2018), Mauritania (Nouakchott, 2008–2014) and Cape Verde (Palmeira, 2001–2018). On the studied

periods, all the tide gauge stations showed significant positive trends. Signal processing methods were also carried out in order to decompose these time series into several components (non-linear trend, seasonality and noise components). The authors stressed that the recovery of older tidal measurements could be very useful to confirm or refute their results over a long term period.

Yann Ferret gave an overview of the Inventory of Sea level data to rescue from SHOM archives and from other French institutions. He briefly presented the work of Data Rescue performed at SHOM (Sea level time series reconstruction) but the poster was mainly focussed on the Sea Level Documents inventory. These old tide measurements are essentially related to French ports but also to some locations around the world. The cataloguing initially started with the content of SHOM archives, but the ultimate aim is to include old measurements from others institutions in order to get a general overview of the available sea level data in France. The up-to-date inventory can be downloaded from http://refmar.shom.fr/dataRescue.

Oleg Nikitin gave an overview of the sea level observations performed in Russia: several hundred stations located on the coast and islands of 13 seas surrounding Russia (spanning time intervals ranging from many decades to more than 100 years at some stations). Hourly or daily sea level data are in digital form since 1977, the records before are still stored only in analog form in regional agencies. Historical monthly mean sea level have been digitised in the framework of some short-term archaeological projects, in the State Oceanographic Institute, and organised in a database which is partially accessible online.

Richard Crouthamel and Elizabeth Griffin wondered about the next steps of Data Rescue. He stressed that research deriving from legacy data can be life-saving by offering vital information towards solving humanitarian problems (rainfall and droughts; flash floods and mud slides; Preventing the spread of disease). In order to make it possible, digitised historical data and metadata has to be easily accessible, the use of these historical has to be promoted and guided and teaching must be delivered to local communities on how to forecast, and prepare for, major events. In order to get there, Richard Crouthamel advised on 1) the creation of an International Panel for Historical Scientific Data with prominent organizations as sponsors; 2) including worldwide memberships, governments, etc.; 3) the necessity of identifying trusted long-term repositories for digitised data and 4) sharing experience, knowledge, programmes.

Inge van den Beld presented the work of reconstruction of the historical sea level time series of Saint-Jean-de-Luz / SOCOA (French Basque Coast), currently performed at SHOM. The recovery of these old paper documents allowed the reconstruction of systematic sea level observations: hourly values from handwritten ledgers for the 1875-1920 period, and from marigrams for more recent periods. The freely available digitisation software NUNIEAU has been used to digitise marigrams. Inge van den Beld detailed the image processing method applied to these old documents in order to make them operable.

9. WORKSHOP SUMMARY

The underlying challenges linking the presentations were:

- Funding projects – limits to resources (time and cost);
- Finding data – importance of datum and levelling metadata, previously known records going missing;
- Capturing original data – importance of scanning original data sheets to prevent further data loss;
- Capturing ancillary data (e.g. air pressure, meteorological data) if included with sea level records;

- Digitising—still time consuming, but improvements are being made and several participants are interested in exploring volunteer help arrangements (e.g. citizen science); and
- Emphasizing that data archaeology is not just rescuing historical analogue data, but also about recovering more recent born-digital data and metadata to improve and extend measurement series.

A full set of recommendations is provided in the following section.

RECOMMENDATIONS

The workshop made a number of recommendations pertaining to both organisational and technical nature.

Organisational recommendations and action items

The workshop recommends that the GLOSS Group of Experts establish a Data Rescue Working Group (DRWG) to promote and progress the recommendations and action items. (Until the working group can be formally established, interested (workshop) participants and their institutions may want to advance the activities based on interim organisational arrangements.)

- Reactivation of the GLOSS data archaeology web pages.
- Develop a catalogue of recovered data and a catalogue for potential data repositories, archives and scanned files still to be digitised. (Where available this should also include ancillary data like air pressure or meteorological observations).
- Develop definitions/guidelines for the various types of observational and metadata that can be recovered e.g. marigrams, high and low water measurements, hourly observations, and compile advice for the rescue of each data type.
- Investigate the development of persistent URLs e.g. DOIs for the delivery of data, identification of instruments and sensors, identification of sites etc.
- Compile inventory of data rescue tools (incl. software) and facilitate sharing of best practices.
- Liaise with international efforts such as the Research Data Alliance Data Conservation Interest Group (https://www.rd-alliance.org/groups/data-conservation-ig), the International Data Rescue (I-DARE) (https://www.idare-portal.org/) and the Atmospheric Circulation Reconstructions over the Earth (ACRE) (https://www.met-acre.net/).
- Explore and develop guidelines in collaboration with historians on the use of archives and what terms or keywords to search that may facilitate unveiling of historic sea level observations.
- Assemble and develop a multi-lingual vocabulary of common archive terms to search for.
- Explore opportunities with relevant communities and networks (eg. IHO/TWCWG, IOC/GLOSS GE, WMO, technology companies…) for capacity development that can support data rescue activities and initiatives.

Technical guidelines and recommendations

- The workshop recommends that during the development phase of a data rescue project that careful consideration be given to the purpose and subsequent usage of the data. Scan/capture any data first for redundancy and/or to prevent further data loss and then prioritise the most important sites. Evaluate the data quality beforehand, pick best/longest record, decide if it is better to focus on data sparse regions rather than already well covered areas and work with others.

- The workshop stresses the importance of preservation of original records (usually paper) through appropriate archive arrangements and to avoid dispensing records when they have been data rescued.

- The workshop identified some basic requirements for the quality control of rescued data and recommends that a "raw" version of a dataset as well as a quality controlled version for processing be stored together alongside lineage metadata that describes and documents any processing the dataset has undergone.

- The workshop invites researchers that have developed projects involving students and volunteers consider to share any useful experiences.

- The workshop stresses the importance of building on existing networks and knowledge (e.g. For rescue of meteorological data – see for instance *Guidelines on Best Practices for Climate Data Rescue*, WMO No 1182:
- https://library.wmo.int/doc_num.php?explnum_id=3318)

- The workshop suggests that scientists and researchers consider adding a Task/Work Package on data rescue when they submit funding proposals related to scientific exploitation of long-term sea level data, in order to contribute to the international data rescue effort.

- The workshop recommends to include historians or draw from historical expertise when looking at qualitative data.

- The workshop recommends that sea level agencies include data rescue in their mission statement.

- The workshop highlights the importance of the publication Tidal Harmonic Constants (International Hydrographic Bureau Special Publication 26). For data archaeology, research the publication provides an inventory of ~ 1000 locations where tidal measurements have been made. The publication is made up of sheets for individual harbours containing information on average height (Z_0) and local datum. The workshop recommends that the publication be scanned in its entirety and made available for data archaeology research.

- The workshop invites the community to proposals for how the PSMSL should identify and make available recovered data.

- The workshop recommends that the Data Rescue Working Group collate and provide guidance for processing data from Mean Tide Level to Mean Sea Level.

- The workshop recommends that data rescuers try to discover the method used to determine the time when measurements were made and record this information (e.g. solar time).

- The workshop invites community to send updates and/or suggestions for enhancements of the NUNIEAU digitisation software package to Frédéric Pons.

- The workshop recommends that levels of confidence/uncertainty in recovered data be provided.

- The workshop recommends to explore the feasibility of a pilot project for the Zooniverse platform for citizen science research (https://www.zooniverse.org/). The elements for such an effort would require "a compelling story for the data collection", why the records were collected and the purpose of rescuing the data. It would also require a substantial

set of ledgers in need of digitising, as thousands of images are required to justify setting up a project.

- The workshop suggests production of a summary article for submission to e.g. Eos, Nature Scientific Data or similar.

ANNEX I

PROGRAMME

Tuesday, 10 March 2020

09:15 – 10:30
- Welcome from Vladimir Ryabinin, IOC Executive Secretary
- Opening and practical arrangements
  Thorkild Aarup, IOC Secretariat, Technical Secretary GLOSS

S1. Historical sea level data and data at risk
- Keynote: Why Rescue data
  Elizabeth BRADSHAW (BODC, UK)
  - Extending Australia's tide gauge records through data digitization
- Kathleen MCINNES (CSIRO, Australia)

10:30 – 11:00 *Coffee break*

11:00 – 12:15 **S1. Historical sea level data and data at risk**
- *Irish sea levels since 1840*
  David PUGH (NOC, UK)
- *Sea-level change from historical records to present times – case studies for Port Arthur (1839-1842 to 2002), Macquarie Island (1912-1913 to 2009) and Hobart (1889-)*
  Richard COLEMAN (UTAS, Australia), presented by Laurent Testut

Poster presentations
- Fabio Raicich (CNR, Italy)
- Torbjørn Taskjelle (Norwegian Mapping Authority Hydrographic Survey)
- Issa Sakho (Université Amadou Mahtar MBOW de Dakar, Sénégal)
- Yann Ferret (SHOM, France)
- Oleg Nikitin (State Oceanographic Institute, Russia)
- Richard Crouthamel (IEDRO, USA) & Elizabeth Griffin (DAO, Canada)
- Inge van den Beld (SHOM, France)

12:15 – 13:30 *Lunch break*

13:30 – 15:00 **S1. Historical sea level data and data at risk**
- *Some Experiences of Sea Level Data Archaeology*
  Phil WOODWORTH (NOC, UK)
- Including *recovered data in the Permanent Service for Mean Sea Level (PSMSL) global sea level dataset: opportunities and challenges*
  Andy MATTHEWS (PSMSL, UK)

S2. Methodology for transfer of paper records to digital data
- *Keynote Methodology to transfer data from marigrams (NUNIEAU software)*
  Frédéric PONS (Cerema, France)

15:00 – 15:30 *Coffee break*

15:30 – 17:00 **S2. Methodology for transfer of paper records to digital data**
- *NUNIEAU demo*
  Frédéric PONS (Cerema, France)

- *Water Level Data Rescue in the United States + Experiments in using software to digitise analog tide data*
  Stefan TALKE (Cal Poly, US) [video]
- *Digitalization of Station Warnemünde at the German Baltic coast*
  Jürgen HOLFORT (BSH, Germany)

Open discussion

17:30 – 19:15 *Reception at UNESCO*

Wednesday, 11 March 2020

09:00 – 10:30

- *The international ACRE initiative: Lessons from major global historical data rescue activities in the climate sciences*
  Rob ALLAN (ACRE, C3S Data Rescue, MetOffice, UK) [video]
- *Experience of data rescue at Météo-France*
  Sylvie JOURDAIN (Météo-France) [video]
- *Overview of long term sea level observation and analysis in the IHO context. Usefulness of historical data on prospective studies at tide, water level, current IHO-working group*
  Gwenaelle JAN (Chair of TWCWG)

S3. Auxiliary historical archives related to sea level

- *Keynote Presentation of the French flooding database and experience sharing of work together with Sea level scientist and historians*
  Nathalie GILOY (IRSN, France)

10:30 – 11:00 *Coffee break*

11:00 – 12:15 **S3. Auxiliary historical archives related to sea level**

- *Historical and statistical analysis of extreme marine events for implementation of numerical surge models of the Thau territory, France*
  Frédéric PONS (Cerema, France)
- *In Praise of Bunt: The 1838 levelling to compare mean sea levels in the English and Bristol Channels*
  David PUGH (NOC, UK)
- *First methodological steps to define the reliability of historical documents and datasets used to study past storms, storm surges and surge levels*
  Emmanuelle ATHIMON (Historian, France)

12:15 – 13:30 *Lunch break*

13:30 – 15:00

- *Rescuing historical weather observations with citizen scientist volunteers*
  Ed HAWKINS (NCAS, UK) [video]

S4. Applications and knowledge products from recovered data

- Keynote *Sea level register for the Thames Estuary and how it has informed coast flood defense plans*
  Ivan HAIGH (NOC, UK)
- *A composite method for past events characterisation providing insights on past, present and future coastal flood hazards: Joining historical, statistical and modeling approaches*
  Déborah Idier (BRGM, France) [video]

15:00 – 15:30 *Coffee break*

15:30 – 17:00 **S4. Applications and knowledge products from recovered data**

- *Historical tide-gauge sea-level observations in Alicante and Santander (Spain) since the 19th century*
  Marta MARCOS (UIB, Spain)) [video]
- *Changes in Mean Sea Level around the British Isles over the past 200 years*
  Peter HOGARTH (NOC, UK)
- *Digitizing tide gauge records to extend recovered data along Argentinean coast*
  Walter GRISMEYER (Argentina Hydrographic Office) [video]

Open discussion

17:30 – 19:15 *Self-paid dinner at restaurant near UNESCO*

Thursday, 12 March 2020

09:00 – 10:30 **S4. Applications and knowledge products from recovered data**

- *Sea Level Data Rescue and Products in China*
  Hui WANG (NMDIS, China) [video]

Open discussion
Common challenges, needs, future actions

10:30 – 11:00 *Coffee break*

11:00 – 12:00 **Summary and recommendations**

Closing

ANNEX II

ABSTRACTS

Tuesday, 10 March 2020

Why rescue data?

Elizabeth Bradshaw
British Oceanographic Data Centre, National Oceanography Centre, Liverpool, UK

The United Nations Decade of Ocean Science for Sustainable Development will begin in 2021. It aims to develop scientific knowledge, build infrastructure and foster relationships for a sustainable and healthy ocean. Planning meetings have already identified priority issues[1] for programme development including:

- More data are needed to support accurate, real-time ocean hazard detection, forecast, warning and responses, including baseline data
- Gaining access to a large amount of existing data not currently shared
- Challenging biases. Current research has geographic biases (e.g., where data are collected, with gaps in the global south, for example)
- Incorporating citizen science data

Data rescue activities are one response to these issues.

The OceanObs19 conference also aimed to develop the direction for the next decade of Ocean Observations and one recommendation was there be a:

“Commitment to extend the historical SL record through data rescue, digitization and the accurate detailed integration of historic tide gauge data into international repositories to reduce spatial and temporal gaps and to validate process-understanding as well as process-based climate models, and to detect and attribute the influence of natural (intrinsic and externally forced) and human-induced drivers.”[2]

This workshop will help sea level researchers and the wider scientific community develop an action plan to contribute to the next decade of Ocean Science. We need to do this in a context wider than just sea level as another OceanObs paper notes:

“International co-ordination of data rescue is needed for several reasons, most obviously to avoid duplication of effort but also because those countries or organizations with the resources or requirements for data digitization may not be the same as those with holdings of undigitised data.”[3]

We need to coordinate our plans, share resources and expertise to effectively rescue and reuse observational data.

[1] Intergovernmental Oceanographic Commission of UNESCO. "Summary Report of the First Global Planning Meeting: UN Decade of Ocean Science for Sustainable Development". Decade Reports and Documents No.4 (2019).

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Extending Australia's tide gauge records through data digitisation

Kathleen L. McInnes[1], **Rebecca Gregory**[1], **Julian O'Grady**[1], **William Mitchell**[2]
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High quality tide gauge records of sufficient duration, temporal resolution and spatial coverage are required to understand trends, the role of interannual variability and sea level extremes at the regional scale. Australia's extensive coastline extends from the tropics to the mid-latitudes and is influenced a range of meteorological and climatological drivers that cause sea level extremes and interannual variability. Understanding how extreme sea levels may be changing as a result of climate change requires analysis of long tide gauge records. However, in Australia, fairly complete digital records of quality-controlled, hourly sea level observations are available at only two locations; the Fremantle record that commenced in the late 19th Century on Australia's west coast in Perth and the Fort Denison record that commenced in the early 20th Century on the east coast in Sydney. Most other digital tide gauge records in Australia commenced in the mid-1960's or later. However, tidal records, mainly in the form of marigrams are available at a number of locations along Australia's coast and offer the opportunity to increase the number and diversity of coastal locations where long, hourly sea level observations in Australia are available for research of past changes in sea level and extremes. Here we will report on progress towards digitising one of these records, located at Williamstown in Melbourne on Australia's south coast. At this location a combination of records including paper tide charts and tide registers of daily high and low water levels have been digitised from 1875 through to 1965 after which the digital record commences. This talk will discuss the progress on this record and other records that are potentially available for digitisation.

Irish sea levels since 1840

David T. Pugh and Gerard D. McCarthy
National Oceanography Centre, Liverpool, UK and
Irish Climate Analysis and Research Units (ICARUS), Maynooth University, Ireland

Tides and sea level around Ireland have a history of being under-observed and analysed. However, careful searching through various sources has revealed a wealth of contemporary and historical 19C sea level data.

The earliest source of systematic data comes from the Ordnance survey and the then Astronomer Royal, G B Airy. In 1842 they made tide pole measurements at 22 sites around Ireland from June to August. Data are 5-minute readings during the day and high water/low water observations at night, all reduced to GMT and to fixed benchmarks, which still exist. Other contemporary sources are used to compare 19C sea levels to present-day observations, made by the Irish Ordnance Survey, the Irish Office of Public Works, and our own measurements.

Sea-level change from historical records to present times – case studies for Port Arthur (1839-1842 to 2002), Macquarie Island (1912-1913 to 2009) and Hobart (1889-)

Richard Coleman[1], John Hunter[1], Chris Watson[2], Benoit Legresy[3], Laurent Testut[4], and others (Burgette, Brolsma, Handsworth, Pugh, Ridgway, Tregoning, ...)

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A number of case studies are presented to outline some of the methodologies required to extract sea level estimates over more than 100 years.

Historical sea level measurements were made at Port Arthur, Tasmania by T.J. Lempriere, related to a still existing benchmark struck by Capt James Clark Ross on his way to Antarctic expeditions from 1839-47. A modern tide gauge was established close to the original tide gauge site and measurements made

during 1999-2002. Connections were made to the original benchmark using a variety of geodetic techniques. Reconstructed sea-level trends were derived by Gehrels et al. (2011) using sedimentary records from salt marsh cores taken during late 2006 extending the historical sea level record in Tasmania.

During Sir Douglas Mawson's Australian Antarctic Expedition of 1911-14, 9 months of sea level records were made on Macquarie Island between Aug 1912-May 1913. These data were complemented with observations during 1969-71, 1982, 1998-2007. To arrive at sea level and land level change values, a variety of issues had to be dealt with, from benchmark reconstruction, crustal displacement estimates, co-seismic and post-seismic earthquake deformation modelling as well as standard/non-standard tide gauge analyses.

A recording tide gauge was installed in Hobart in December 1889, near the site of the current CSIRO building. The first set of observations were the times and heights of High Water and Low Water. The tide gauge hut still exists and operates today. However, putting together a complete historical sea-level record has yet to be accomplished. Much of the original tide data was digitised by Ken Ridgway from 6 leather-bound volumes, but one volume of records is missing (destroyed in the 1967 Hobart bushfires?). The available vertical datum information is 'next to useless' and so recovery of useable Hobart tide gauge records prior to 1989 is a new priority and challenge.

Can we estimate long-term sea level changes from the medimaremetre data?

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Evaluation of changes in sea level during the end of the XIX - the first half of the XX century is mainly based on a limited number of historical tide gauge records and any new record or indirect information is precious. Since the end of the XIX century, many French ports were equipped by medimaremetres, the gauges designed by Charles Lallemand for measuring mean sea level. By construction, the medimaremetre consisted of a vertical tube connected to the sea through a kind of porous porcelain crucible in order to damp tides and higher frequency sea level oscillations. Uncontrolled properties of this porcelain crucible and some systematic errors made the medimaremetre data to be ignored in the recent sea level researches. In this study, we examine the quality of sea level measurements performed by a medimaremetre operated in Nice from 1887 to 1909 and transferred in 1913 to the nearby town of Villefranche-sur-Mer where it stayed in operation until 1974. We compare the data to two available historical tide gauge records from Marseille and Genova and analyse the low frequency variabilities in the decadal sea level variations and trend in this part of the Mediterranean (the Ligurian Sea) since the end of the XIX century.

Some Experiences of Sea Level Data Archaeology

Philip Woodworth
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Data archaeology (DA) in the context of this meeting refers to the discovery of historical sea level records, usually in the form of paper tabulations or charts. This is then followed by the conversion of the scientific information that they contain into computer data sets, thereby making the data available for research. Inevitably, each DA exercise is different because the original records (which of course must always be preserved safely) take different forms.

A simple example of DA involves the discovery of historical tidal tabulations in an old document. The easy part is typing the tabulations into a computer. Sometimes the tabulations will be hand-written so your brain has to get used to that. It is essential that the typing and checking is done at least twice, and ideally by more than one person, in order to avoid conversion errors. You can then, in theory, write a paper comparing the historical tides or sea levels to modern values and perhaps learn something on how they have changed.

However, in practice, the problems usually start when you come to think about the data you have collected. For example, how were the historical measurements made? This could mean knowing the type of tide gauge, or the method by which someone noted the heights and times of high and low waters. Who was responsible for the measurements and why did those people make them? That can take you into the social history of the time. Are there ancillary data sets to help with quality control? For example, air pressure information can check whether the IB relationship with sea level was the same then as now. And then, when you have found your apparently big changes in the tide or sea level, have you enough information to say whether that knowledge is useful scientifically, or whether the changes have arisen due to some local processes (e.g. river dredging or harbour reconstruction)? It is sometimes possible to do without such ancillary information. For example, if you observe similar changes at more than one location on a coastline then that provides an assurance that they are really to do with the ocean, but it is obviously highly desirable to have them.

This presentation will present several examples of DA of sea level information from the 18-19th centuries. Two examples consisted of sets of numbers without much scope for quality control by ancillary data sets (tidal measurements by James Cook at Tahiti and by Nevil Maskelyne and Manuel Johnson at St. Helena). However, in spite of the limitations of the data, these examples were important in providing a feel for how these famous scientists worked. Another example took the form of tabulations of high and low waters together with air pressure values which proved to be extremely useful (James Clark Ross's measurements at Port Louis, Falklands). In a final example, we were awash with many years of high water heights and times and ancillary information, which inevitably raised many more questions (William Hutchinson's measurements at Liverpool).

There have not been so many exercises in sea level DA that it would be difficult to construct a spreadsheet pointing to them all (say for data from before 1850), what forms the original and modern data sets take, where they can be found, the publications that have come from them etc. That would be very useful to future researchers. (Perhaps the PSMSL could be imposed on by expanding its 'Other Long Records' list). In addition, GLOSS has circulated questionnaires in the past to determine where interesting historical sea level records might exist that require help with DA. That exercise could be repeated.

Including recovered data in the Permanent Service for Mean Sea Level (PSMSL) global sea level dataset: opportunities and challenges

Andy Matthews, Liz Bradshaw, Kathy Gordon

The Permanent Service for Mean Sea Level (PSMSL) is the internationally recognised global sea level data bank for long-term sea level change information from tide gauges, and provides advice on the collection, publication, analysis and interpretation of sea level data. Each year, the PSMSL collect data from about 800 stations supplied by over 60 authorities worldwide, with some records dating back to the start of the 19th century. Data from the PSMSL plays a vital role in our understanding of sea level change over the past two centuries. As a result, additions to the PSMSL from recovered series would be particularly valuable.

Recent work, such as the recovery of historical data in Boston (Talke et al, 2018) and near Ravenna (Bruni et al, 2019) have involved great effort to extend existing records. However, they often do not meet the strict conditions of vertical datum control and data provenance required to be included in the PSMSL's scientific quality RLR (Revised Local Reference) dataset. Here, we explore some proposals concerning how the PSMSL can incorporate these series into its distributed dataset in a way that balances data integrity with convenience to users.

References:

Bruni, S., Zerbini, S., Raicich, F., & Errico, M. (2019). Rescue of the 1873–1922 high and low waters of the Porto Corsini/Marina di Ravenna (northern Adriatic, Italy) tide gauge. J Geod 93, 1227–1244. https://doi.org/10.1007/s00190-019-01238-w

Talke, S. A., Kemp, A. C., & Woodruff, J. (2018). Relative sea level, tides, and extreme water levels in Boston harbor from 1825 to 2018. Journal of Geophysical Research: Oceans, 123, 3895– 3914. https://doi.org/10.1029/2017JC013645

Methodology to transfer data from marigrams with NUNIEAU software

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In 2004, Cerema was involved in the sea level data rescue on the French Mediterranean Sea. We received a package of fifteen years of weekly paper marigrams for Port-Vendres harbor near Spain. These 750 paper marigrams have a size close to A3-format and in most cases there is only one signal on the paper.

To digitise these data we did a brief research about available software. Except for some interpolation that could be done with AutoCAD software, nothing seemed to be available.

We decided to create a MATLAB program based on

- the recognition of the color
- the referencing of the paper in analogy to what was available in GIS software.

The main principles were to "geo"-reference the marigram, to extract the good value for the color signal, to clean some parts and to digitalise. The software works with an image and a referencing file associated, all your job (or the job done by a subcontractor) can be review.

This was the beginning of NUNIEAU[4]. NUNIEAU was subsequently deposited under the organisation for the protection of authors and publishers of digital creations, and from 2006 NUNIEAU was available publically on a website.

Our needs and the feedback from external users lead us to debug and improve the software with different collaborations for

- Sea level rescue
    - Best cleaning of the image,
    - Improvement for the daily marigram with 5 to 15 signals in the Atlantic coast (SHOM),
    - Tools based on SHOM software to detect change in tidal constituents (gap in time, gap in altimetry) and integrate shifts in referencing files,
    - Summary reports,
    - English and German language versions,
- Water river levels
    - Some tools for rivers as mirror effects,
- Rainfalls
    - Management of non orthonormal system and checking tools.

NUNEAU is now a tried-and-tested software. Cerema has produced close to 10 000 referencing files with NUNIEAU. The French service for hydrometeorology and flood warning support launched a tender to rescue river water level and private companies have done the job. The French research organism IRD works to diffuse NUNIEAU for rainfall data rescue in West Africa. It could be used for temperature, pressure, and wind observations.

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[4] Ullmann A., Pons F., Moron V. (2005), Tool Kit Helps Digitize Tide Gauge Records, Eos Trans. AGU, 86(38), doi:10.1029/2005EO380004.

To focus on sea level, we do not have further ideas to speed up (i) the rescue of marigrams that contain many signals in the same marigram and (ii) long marigrams with a paper length of say 50 meters!

Participants are invited to bring some examples of their own marigrams and test the software.

Water Level Data Rescue in the United States

Stefan Talke
California State Polytechnic University, USA

Though water level measurements began in the early-to-mid 1800s in the United States, these records are (for the most part) not available from governmental databases, and have been 'lost and forgotten' until recently. This talk discusses how many of the records were documented and later found, and describes ongoing efforts to digitise the records and make them useful in a scientific context. The importance of meta-data, including letters, surveys, clock measurements, and time measurements, will be discussed. Similarly, the possibility of using modern statistical techniques to help QA the records will be explored. While much work has been done, more remains. Of the more than 5000 station years of data from between 1850 and ~1980 that have been identified, only about 1500 years have been recorded and a little over 600 station years digitised. These records are providing insights into historical sea-level rise, tidal change, altered river flow, and trends in extremes. Because the records often predate 20th century modifications of harbors, the water level records often record environmental changes, in addition to a less warm climate. For such reasons, data rescue can play an important part in understanding the effects of past changes, and our current trajectory.

Experiments in using software to digitize analog tide data

Stefan TALKE
California State Polytechnic University, USA

Many historical tidal records are not available as hourly data. In this situation, digitizing the original analog tide record (from a tide roll or marigram) by software may enable high-resolution data to be recovered. In this talk we discuss how 16 years of analog tidal records from Astoria (OR) were digitised at better than 6 minute frequency via a software-based line finding algorithm. We discuss the pros and cons of the software based method, lessons learned, and possible ways forward. We also discuss experiments in using character recognition to digitise tabulated data.

Digitalization of Station Warnemünde at the German Baltic coast

Jürgen Holfort
Federal Maritime and Hydrographic Agency (BSH), Germany

We will present the available data (1894-today) and the digitisation process of data from the tide gauge Station Warnemünde at the German Baltic Coast. In the process there are several difficulties and problems that arise: from delicate paper wrapped from long storage, handwritten corrections on the paper, inversion functions, slippage, etc. Even if not all data is already digitised, we explore the available data in several, mostly statistical ways. It is not only the possible scientific knowledge we are interested in (most of such work is done at a later stage at universities and not at the water level service) but we also use these investigations in our quality control.

Wednesday, 11 March 2020

The international ACRE initiative: Lessons from major global historical data rescue activities in the climate sciences

Rob Allan
International ACRE Project Manager,
C3S Data Rescue Service Manager,
Climate Monitoring and Attribution Group, Met Office Hadley Centre, UK

The interlinked Atmospheric Circulation Reconstructions over the Earth (ACRE) and Copernicus Climate Change Service (C3S) Data Rescue Service (DRS) initiatives, together with the various UK Newton Fund foci that are partnerships with the Met Office, are major components of international data rescue activities within the weather/climate science community. They provide users in various climate applications and services with new information and baselines with which to plan for and manage current and future global to regional physical and socio-economic impacts.

ACRE is an 'end-to-end' initiative, which undertakes and facilitates historical global terrestrial and marine weather data recovery, imaging/scanning, digitisation and cataloguing. It feeds these data into the international repositories responsible for such material, seeing specifically that they provide the best quality and quantity of surface weather observations for assimilation into all dynamical global 4D weather reconstructions or reanalyses. Under ACRE's broad international focus, it has developed various regional data rescue foci in Chile, the Pacific, China, Canada, Meso-America, the Indian Ocean, SE Asia, Japan, South Africa, British and Irish Isles, the Arctic, Argentina, Australia, Brazil, Peru and Antarctica (http://www.met-acre.net/chapters.htm).

The C3S DRS also has funding support for data rescue activities and the testing of new data rescue tools and procedures in three new/evolving ACRE regional data rescue regions in the Southern Hemisphere centring on Argentina, South Africa and the higher latitude Pacific sector of the Antarctic continent, which interlink with the new ACRE Australia regional focus.

All the above data, data images and their metadata flow into the developing Copernicus Climate Data Store (CDS), which will be the major sustainable international repository of this material.

In this presentation, I will endeavour to outline how these efforts and initiatives were established and are maintained, some of the various experiences and lessons that we have learned, and hopefully how such initiatives might link in with, or be a model or blueprint for, the activities of the international sea level data rescue/archaeology community.

Experience of Climate Data Rescue at Météo-France

Sylvie Jourdain
Météo-France, Direction de la Climatologie et des Services Climatiques, Toulouse, France

Météo-France, as National Meteorological Service (NMS), is responsible for preserving the memory of the French climate. Météo-France's Climate Archives hold historical meteorological records collected by the successive French national meteorological services (7,5 linear kilometers). Météo-France is the most important holding for French early climate instrumental data. These public records are stored at 90 locations in France mainland and French overseas territories. In addition, in the past, the previous French NMS, transferred 2 linear kilometres of physical meteorological records to the French National Archives (Archives nationales). These public records concern France and former French colonies and cover the period 1800-1970. A scientific research agreement between Archives nationales and Météo-France has been signed related to the Climate Data Rescue to affirm a commitment to collaborate together to enhance this transferred archive. These two holdings contain meteorological terrestrial, upper air and marine data in different kind of documents like meteorological forms, registers, notebooks, ship logbooks, listings and diagrams produced by different French administrations and the French Army.

The entire process of Climate Data rescue (DARE) is a long chain of actions: archiving, preserving, locating, inventorying, imaging, digital media archiving, making images available to users, data digitizing, data quality checking, integrating data in the national climatological database and making data available

to users. Almost all the actions are performed by meteorologists or climatologists. However, actions of imaging and data keying are partially outsourced, this requires dedicated funding. National coordination is made by the Direction of Climatology and Climate Services in Toulouse. In order to ensure the highest quality of records archiving, inventorying and recovering, WMO Guidelines have been incorporated into the structure and all the colleagues involved in DARE activities have been trained. Furthermore, operating mode, technical guide and standard forms are available in order to guarantee the homogeneity.

DARE is a permanent and lengthy process that can be costly, labor-intensive and time-consuming. It is necessary to prioritize the records to be imaged and digitised, and to develop a work plan and determine computer, personnel, space, imaging, digitising needs and to get funding. For example, Météo-France's data recovery is focused on some selected parameters (temperature, pressure, wind, humidity, sunshine duration, cloudiness and precipitation) and some long-term series are prioritized in order to build reference series. DARE involves rescuing both the data and metadata. Recovering data involves the source imaging and data keying for a full traceability. Each step of DARE has its specificities and difficulties. The most important remaining difficulty is the access to the original records because French climate data are hidden in many places in France. The second big challenge is due to the wide variety of producers, networks, type of stations, parameters, units etc. Climate data recovery also needs a good knowledge in the history of the meteorological observations (networks, producers, stations, instruments, meteorological operational procedures, etc.)

References:

Sylvie Jourdain; Émeline Roucaute; Philippe Dandin P. ; Jean-Pierre Javelle; Isabelle Donet; Sylvia Menassère; Nadine Cenac; 2015: Le sauvetage de données climatologiques anciennes à Météo-France: De la conservation des documents à la mise à disposition des données. *La Météorologie.* 89, p. 47-55. DOI: 10.4267/2042/56598, http://documents.irevues.inist.fr/handle/2042/56598.

Clive Wilkinson; Stefan Brönnimann; Sylvie Jourdain; Emeline Roucaute; Rick Crouthamel; Philip Brohan; Antonia Valente; Yuri Brugnara; Manola Brunet; Gilbert P. Compo; Alba Gilabert; 2019: Best Practice Guidelines for Climate Data Rescuev1, of the Copernicus Climate ChangeService Data Rescue Service[Ref: C3S_DC3S311a_Lot1.3.4.1_2019_v1-contract: 2019/C3S_311a_Lot1_Met Office/SC2]. DOI:10.24381/x9rn-mp92, https://doi.org/10.24381/x9rn-mp92

Overview of long term sea level observation and analysis in the IHO context. Usefulness of historical data on prospective studies at tide, water level, current IHO-working group (TWCWG)

G. Jan (SHOM, IHO-TWCWG Chair), TWCWG members (IHO group)

The IHO is an intergovernmental organization that works to ensure world's seas, oceans and navigable waters are surveyed and charted. It coordinates the activities of national hydrographic offices and promotes uniformity in nautical charts and documents. It provides guidelines to maximize the use of hydrographic survey data and develops hydrographic capabilities in Member States. The IHO-TWCWG is in charge of (1) monitoring developments related to tidal, water level and current observation, analysis, prediction, datums; (2) developing and maintaining the relevant IHO standards, specifications and publications for which it is responsible in liaison with the relevant IHO bodies and non-IHO entities; (3) developing standards for the delivery and presentation of navigationally relevant surface current and water level information; (4) providing technical advice and coordination on matters related to tides, water levels, currents and vertical datums (https://iho.int).

A selection of highlights is presented on historical sea level data rescue from the perspective of IHO-TWCWG.

The profile of data archaeology science is made of ad hoc studies due to scarcity of the historical data, due to time and costs. Sharing the data knowledge benefits science to deal with data continuity, referencing, uncertainty, to insure consistent time series. A view on tidal studies serves to illustrate that the longer the validated time series is, the better is the prediction originating from the time series.

IHO's scope for long time series' data includes methods, uncertainty control, application to chart datum for navigation, marine submersion and climate change. Historical data rescue can benefit research into sea level trends. It offers direct positive input for analysis of past storm events, and from this history

improved forecasts for future storm and coastal impact in the frame of climate change (D. Goutx, F. Baraer, A. Roche, G. Jan, 2013. La Houille Blanche, n° 2, 2014, p. 27-33 (French language). DOI 10.1051/lhb/2014013).

It opens the door for continuity or extending a time series, collecting and gathering with a prioritization depending on the coastal and ocean dynamics under studied and the regions of interest. The prioritization or opportunity rescue is a vast scientific landscape that is worthy of considerable dissemination. Collective knowledge, cross-check, and promotion of guidelines are essential.

Multidisciplinary expertise of historical information for the characterization of water levels during storm and coastal flooding events

Nathalie Giloy[1] **and "Historical Storms and Floodings" WG members**
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Characterization of coastal water level reached during extreme events is a strong societal concern for a better coastal risk management. Historical archives related to storms and floodings are still not often considered whereas they could be used to improve knowledge on extreme sea levels. In this context, the French national Working Group (WG) "Historical Storms and Floodings" has been created to offer multidisciplinary expertise on analysis of historical information. This WG includes researchers, statisticians and historians from different entities (IRSN, Artelia, BRGM, Cerema, EDF, LIENSs, SHOM and Université Populaire du Littoral Charentais).

A big challenge with a multidisciplinary approach is the management of different types of information coming from various scientific contexts and practices. The data varies from historical tide gauge observations, to historical local press, scientific essays, eye-witness testimonies, minutes from town hall meetings etc. Each document used needs to be analysed regarding the context in which it was written down and which were the objectives, which will then allow for a classification of its trustworthiness. These issues, the way there are addressed and the tools created within this working group will be presented.

As a starting point, the database called TEMPETES ET SUBMERSIONS HISTORIQUES ("Historical Storms and Floodings") was previously created by IRSN and has been provided to the WG members. This database aims at inventorying qualitative and quantitative information on storms and/or floodings that occurred on the English Channel and Atlantic coastlines. Currently, over 1500 sources describing more than 750 events are listed for the period from the 16th century up to now, for French coastlines and neighbouring countries. Thanks to ongoing research projects and studies carried out by WG members this database is continuously enriched by new documents and events.

In addition to the events themselves, water and surge levels are important variables of interest for the WG members. Most of the time, these values are not directly obtained from the available sources in the database and therefore a multidisciplinary expertise of the historical information is performed to estimate water levels reached during storm and flooding events. For this purpose, the available information in the database regarding one event is expanded with complementary data (such as historical city maps, sketches, profiles of the flooded dikes, historical local press, etc.), in order to elaborate a storm record. All this data is then used to reconstruct historical water levels i.e. total water levels and surge levels.

Historical and statistical analysis of extreme marine events for implantation on a surge numerical models of the Thau territory, France

Frédéric Pons[1]**, Céline Trmal**[1]**, Anne-Marie Fromental**[1]**, Nicolas Proust**[2]**, Ludovic Cesmat**[3]**, Stéphane Roumeau**[3]

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The study area is composed of the Thau watershed and the eastern part of Sète agglomeration. The Thau watershed includes the Thau lagoon where many small streams are flowing and a long narrow sand barrier separating the Thau lagoon from the Mediterranean Sea, a microtidal sea. On the other

side of Sète harbor, shallower lagoons and channels are present along the coast. In this area of low lands, extreme marine events could provoke hazards on beaches and in the lagoon shore.

To implement a sophisticated sea surge numerical model of the Thau watershed, a better knowledge of the marine events, in terms of wave, sea level and wind was needed. Two kinds of statistical analyses were carried out, the first one concerned maximum sea level and the second one proposed an intensity-duration-frequency analysis of sea level and waves.

For the first one, long historical data, such as during storm events from the XVII century to nowadays, were rescued. A database was created form the historical archive, the written press available since 1844, old reports, GIS database and scientific articles. A Bayesian flood frequency analysis (HBAY software) was used with Gumbel and GEV laws on sea level to take into account numerical recent sea level measurements and likelihood historical sea levels. This data rescue enables also to provide positions of historical channels between lagoons and sea or breaches which may reoccur in the future.

On the last sixty years, an intensity-duration-frequency analysis on waves and sea levels were conducted to get mono-frequency scenarios of increase and decrease during storm based on Gumbel and GEV laws.

At the end, when establishing scenarios, the difficulties are how to integrate all the new knowledge as input in numerical modelling keeping a reasonable number of runs. The questions to the modeller are:

- How to define sea level on the open-sea borders when only statistic sea level are available in harbours,
- How to combine sea level, wave and wind in term of peaks,
- How to manage wave and wind direction to create an envelope of all the component effects.
- How to integrate historical channels between lagoons and sea or breaches which could appear.

In praise of Bunt
The 1838 levelling to compare mean sea levels in the English and Bristol Channels

David Pugh

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A geodetic levelling exercise, initiated and funded by the British Association for the Advancement of Science, found Mean Tidal Levels at Axmouth in the English Channel, and Portishead in the Bristol Channel, at the same level to within a few inches. This led to MTL, and subsequently Mean Sea Level (MSL), being adopted as a datum for marine science.

Hydrographic charts use a tidal low water level as the datum below which water depths are measured. Today, Lowest Astronomical Tide is internationally adopted, though earlier Low Water Spring Tide levels were used. Soundings on a chart give the minimum water depth for ship navigation, irrespective of the state of the tide. The hydrographic datum plane is not level: it depends on the tidal range in the area of the chart. The British Association for the Advancement of Science (BA) considered that a better datum for scientific purposes could be the mean level of the sea, which should approximate to a horizontal plane. To confirm this the BA, inspired by William Whewell, in 1834 planned a levelling exercise from the English Channel to the Bristol Channel to compare mean sea levels in two places with very different tidal ranges between High and Low Water.

The levelling and sea level measurements were eventually undertaken between November 1837 and July 1838, by Thomas G Bunt. The results were presented in the Report of the 1838 Meeting of the BA in Newcastle in August 1838 (Whewell, 1839; this includes an annex by Thomas Bunt on the details of the levelling instruments and procedures).

Bunt, by profession a land surveyor based in Bristol, worked on tidal analyses and field measurements for William Whewell, from about 1835 to 1841. Although Whewell's pre-eminence as a tidal scientist as well as a theologian and pioneer in the philosophy of science, attracted wide acclaim, he owed much to Bunt's practical skills. Bunt's levelling work and his pursuit of improved technology and analysis techniques were exemplary: his approaches were self-critical and increasingly exact. He also designed

a much-improved automatic tide gauge for Bristol, following the Palmer Sheerness gauge of 1831, which was widely copied.

First methodological steps to define the reliability of historical documents and datasets used to study past storms, storm surges and surge levels

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Recent advances in extreme events and sea level have created new opportunities to investigate history. The need and the importance of historical documents and historical datasets are then no longer to be demonstrated, as they are more and more used to improve knowledge on past storms and storm surges, extreme sea levels, etc.

Lately, some researches using historical datasets get rid of the historian's expertise and of the critical method developed over decades by historians to study qualitative and quantitative historical documentation. However, noncritical use of historical datasets can create misunderstandings, misinterpretations and misleading findings.

As historian, we offer to demonstrate how important the work of criticism and analysis of historical documents is. To do this, we will start from "Verdun, visions d'histoire", a famous example far away from the sea and storm context, and from examples directly taken from the documentation used by the WG "Historical Storms and Floodings". From these examples, we will warn against mistakes in the reading, the understanding, the interpretation and the use of historical documentation without critical approach. Moreover, we propose to lead a thinking with the audience on the construction of an evaluation grid to define the reliability of historical documents and data. This methodological work is still in process, so this oral aims to be interactive and participative.

Such a presentation highlights fact that researches employing historical documents and data require a multidisciplinary approach. This multidisciplinary approach must include the skills of historians, historical knowledge, debate and critical method.

Rescuing historical weather observations with citizen scientist volunteers

Ed Hawkins
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Our understanding of past changes in weather and climate rely on the availability of observations made over many decades. However, billions of historical weather observations are currently unavailable to science as they are still in their original paper form in various archives around the world. The large-scale digitisation of these observations would substantially improve atmospheric circulation reconstructions back to the 1850s. Recently, volunteer citizen scientists have been assisting with the rescue of millions of these lost observations taken across western Europe over a hundred years ago. The value of these data for understanding extreme weather events will be demonstrated.

Sea level data archaeology in the Thames Estuary, guiding future flood risk management for London

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London, located on the Thames Estuary in the UK, is one of the world's most important coastal cities, and the largest city in northern Europe. It has been estimated that 1.3 million people and £275 billion

worth of property are current at risk from flood flooding. The UK Environment Agency developed the Thames Estuary 2100 Plan to provide strategic direction for the continued management of coastal flood risk in the Thames Estuary to the end of the 21st century. The Plan was instrumental in introducing a novel, cost effective approach to manage increasing flood risk by defining adaptation pathways that can cope with large ranges of changes if needed. Within the adaptive Plan ten indicators of change are being monitored to help the Environment Agency assess whether they need to make the interventions identified in the Plan at an earlier or later date. The Plan therefore requires a regular review (every 5-years) of the indicators of change to be undertaken. The five-year review of the Plan was completed in 2016 and the 10-year review is currently underway, due to be completed in 2020. To help inform the upcoming Thames Estuary 2100 Plan - 2020 Review, we have digitised historic tide gauge data for 10 sites within the Estuary, stretching back more than 100 years. In this presentation, I will discuss the techniques we used to capture the data. Then I will describe how the datasets have helped us to better monitor changes in both mean and extreme sea levels in the Thames Estuary.

A composite method for past events characterisation providing insights in past, present and future coastal flood hazards: Joining historical, statistical and modeling approaches

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The characterisation of past coastal flood events is crucial for risk prevention. However, it is limited by the partial character of historical information on flood events and the lack or limited quality of past hydro-meteorological data. In addition coastal flood processes are complex, driven by many hydro-meteorological processes, making mechanisms and probability analysis challenging. These issues are tackled by joining historical, statistical and modelling approaches. We focus on a macrotidal site (Gâvres, France) subject to overtopping and investigate the 1900-2010 period. A continuous hydro-meteorological database is built and a damage event database is set up based on archives, newspapers, maps and aerial photographies. Using together historic information, hindcasts and hydrodynamic models, we identified 9 flood events, among which 5 significant flood events (4 with high confidence: 1924, 1978, 2001, 2008; 1 with a lower confidence: 1904). These flood events are driven by the combination of sea-level rise, tide, atmospheric surge, offshore wave conditions and local wind. The critical conditions leading to flood are further analysed, including the effect of coastal defences, showing that the present coastal defences would not have allowed to face the hydro-meteorological conditions of 09/02/1924 for instance, whose bi-variate return periods of exceedance Tr (still water level relative to the mean sea level and significant wave height) is larger than 1000 y. In addition, Tr is expected to significantly decrease with the sea-level rise, reaching values smaller than 1 y, for 8 of the 9 historical events, for a sea-level rise of 0.63 m, which is equal to the median amount of sea-level rise projected by the 5th Assessment Report of the IPCC in this region for RCP8.5 in 2100.

Historical tide-gauge sea-level observations in Alicante and Santander (Spain) since the 19th century

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A set of historical tide-gauge sea-level records from two locations in Santander (Northern Spain) and Alicante (Spanish Mediterranean coast) have been recovered from logbooks stored in national archives. Sea-level measurements have been digitised, quality-controlled and merged into three consistent sea-

level time series (two in Alicante and one in Santander) using high precision levelling information. The historical sea-level record in Santander consists of a daily time series spanning the period 1876-1924 and it is further connected to the modern tide-gauge station nearby, ensuring datum continuity up to the present. The sea-level record in Alicante starts in 1870 with daily averaged values until the 1920s and hourly afterwards, and is still in operation, thus representing the longest tide-gauge sea-level time series in the Mediterranean Sea. The long-term consistency and reliability of the new records is discussed based on the comparison with nearby tide gauge time series.

Changes in Mean Sea level around the British Isles over the past 200 years

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Long-term changes in average sea levels are of great importance in estimating future flooding risks and in understanding the impacts of climate change. Here we present an average Mean Sea Level curve for the British Isles based on a greatly increased set of observations covering the period 1813 to the end of 2018. An exhaustive data archaeology exercise covering sea level observations and levelling metadata has allowed robust connection of data from the 19th and early 20th century with modern records. We also apply updated and novel techniques to reduce sources of variability over the entire time period. We investigate the effect of extending the time series on sea level rise (SLR) trends and low order variability. The main data sources are the hitherto un-accessed archives of the Hydrographic Department of the Admiralty United Kingdom Hydrographic Office (UKHO), and publications of the Ordnance Survey (OS), the archives of the PSMSL, and various historical documentary as well as academic data sources covering the past two centuries.

The MSL data is analysed in 37 local clusters based on land based geodetic levelling errors being proportional to distance. Adjustments are made for changes from Ordnance Datum Liverpool to Ordnance Datum Newlyn in the early 20th Century (including local revisions), for Mean Tide Level (MTL) to Mean Sea Level (MSL), and for seasonal variations which can affect short periods of observations. We adjust for meteorological effects by regressing a barotropic tide and surge model using the newly available 20th Century reanalysis (V3) meteorological data available for 1836 onwards, and use data from a historical regional reanalysis prior to this date. Sources of uncertainty due to sampling and levelling or corrections for vertical crustal movements are discussed and addressed, and cluster trends are computed and compared.

We have two objectives: to confirm that the recovered old data improves confidence in computed trends; and to estimate an averaged century scale trend for sea level rise around Great Britain. If the adjusted mean sea level trend for each cluster is regarded as a separate independent estimate of a Great Britain Mean Sea Level Rise, then the average weighted trend for Great Britain is 1.523 millimetres per year, with a standard deviation of 0.629 mm/year, and a standard error of 0.12 mm/year. There is a significant acceleration in the rate of rise over the period 1813 to 2018.

Digitizing tide gauge records to extend recovered data along Argentinean coast

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Along the extensive Argentinean coast, the tidal range varies considerably, with values ranging from 1 m to 13 m. The longest historical series (1905-present) corresponds to the Port of Buenos Aires. During this period, 2 years of data (1963-1964) were lost and this information could not be recovered. Mid 50's records from the last century, taken from the rest of the tide stations have suffered several interruptions over the years. Currently, data are being retrieved from the Naval Hydrographic Service technical archive and are either in paper format or in obsolete media. The latest data sets recovered correspond to recorded heights in the Gulf of San Matías. Data archaeology efforts will continue to ensure proper recovery and stewardship.

Thursday, 12 March 2020

Sea Level Data Rescue and Products in China

Hui Wang, Wenshan Li
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1. National Network of Sea Level Observation

The introduction of the sea level observation network status and evolution history in China. The use of observation instruments, the relationship of the different datums, and the land subsidence in the sea-level-rise high risk areas.

2. Sea Level Data Rescue

Introduce our experience in rescuing the sea level data based on the archives, historical evolutions of observation instruments, and environmental change, and so on. Taking the long-term sea level observation stations for example, such as Lvsi, Xiamen, Zhapo, Kanmen, Xisha, and Nasha.

3. The Application and Knowledge Products from the Rescue Data

Introduction of the statistical and model products, such as the time and spatial characteristics (seasonal change, inter-annual end inter-decadal change, long-term trend, etc.), the extreme sea level events, flooding, storm surges, and so on.

Poster presentations

Inventory of Sea level data to rescue from SHOM archives and from other institutions

Yann Ferret, Vincent Donato & Nicolas Pouvreau
SHOM, France

Estimation of sea-level rise is a critically important parameter for communities at the coast. Rescue and analysis of historical water level records has proved to be a way to provide relevant information regarding the observed long-term sea-level evolution. Since the mid-1800's many systematic sea level observations in France have been obtained from mechanical tide gauges. Despite this rich history, long water-level data sets in digital form are still scarce. Extensive work in sea level data rescue is now undertaken at SHOM (French Hydrographic & Oceanographic Office) within the REFMAR and the SONEL frameworks. This effort aims to rescue the numerous existing historical data still preserved in paper form in the SHOM Archive Centre. An added purpose is to recover the rich French scientific and cultural heritage on sea level observations, and to provide new datasets for analysis by research community. This initiative responds to the GLOSS recommendations on the recovery of forgotten sea level measurements.

Data rescue performed at SHOM implies to inventory documents related to water level measurement (marigrams, ledgers), to scan and digitise those, and finally to quality control the digitised data. This is a time-demanding effort, and the work is still in progress. Here we present the first step of this process – Inventory of sea level documents. The sea level measurements are essentially related to French ports but also to some locations around the world. We have started with the content of SHOM archives, but we aim at including others institutions which produced data back in time, in order to get a general overview of the available sea level data in France. The up-to-date inventory is available for download at http://refmar.shom.fr/dataRescue.

Historical sea-level observations in Italy: potential data sources

Fabio Raicich
National Research Council (CNR), Institute of Marine Science, Trieste, Italy

Sea-level records in Italy date back at least to the 18th century, but the history of modern observations started in the mid-19th century. For over a century a variable number of stations (mostly between 10 and 30) were operational. Different agencies were in charge of one or more tide gauge stations, and real national networks were active only between 1896 and 1922 and from 1986 onwards. Therefore, except for the last few decades, the data collection, analysis and publication have often been made irregularly. Moreover, lots of charts and data were reported to have been lost because of the lack of proper preservation. A major consequence is that many tide gauge data and metadata have never been published and still remain in several archives.

A thorough survey of the available data has never been made at the national level, but some data sources can be identified, that potentially could be exploited in order to rescue (and save) sea level observations and related metadata, including geodetic information on benchmarks.

Major known archives are those of the Geographic Military Institute, whose data cover the whole Italian coastlines during the 1872-1922 period, and of the former 'Magistrato alle Acque' in Venice, with observations mainly made in the Adriatic Sea and the Venice Lagoon. Local archives holding relatively small amounts of data are located in the Hydrographic Institute of the Italian Navy in Genoa, and at CNR-ISMAR and the University, both in Trieste.

Most of the material consists of original charts that have never been analysed and original data tabulations. In some cases, data have already been published but not digitised.

Data from military organizations might require special permission for rescue and dissemination or might not be available.

Overview of historical tide gauge data in Germany

Jürgen Holfort
Federal Maritime and Hydrographic Agency (BSH), Germany

In German archives, analog tide gauge data is available back to end of the 19th century. Some of this data is from locations that nowadays are in other countries like Poland and Russia. Many of the station data after around 1955 are already digitised with a temporal resolution of 1 hour, tide gauges data from some few stations are scanned back to 1894 (e.g. Warnemünde) and single years of these data has been digitised with hourly resolution. We are continuously working on the digitalisation, but with actual resources, the last data will first be ready in several decades. Here we give an overview of what data is available and which steps in the digitisation process have already been done.

Working with historical sea level data at the State Oceanographic Institute in Moscow

O.P. Nikitin, A.O. Zhukovskaya
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Historically, in Russia, sea level observations were carried out at several hundred stations located on the coast and islands of 13 seas surrounding Russia, as well as on the Russian Pacific coast (many of the stations are currently closed). The time intervals for sea level observations at these stations are many decades, exceeding 100 years at some stations. For example, sea level in Kronstadt on the island of Kotlin near St. Petersburg has been measured since 1703 (at the same time, sea level data are available only from 1806, since the early data were lost during the 1941-1945 war).

The national sea level observing network is currently supported by the Federal Service for Hydrometeorology and Environmental Monitoring (FSHEM). Sea level data from coast stations are collected by 11 FSHEM regional centers and after 1-2 years after preliminary processing and quality control then transmitted to the Russian National Oceanographic Data Center (RNODC) in Obninsk. The

RNODC stores hourly or daily fixed time coastal sea level data in electronic form for a period starting in 1977. The primary data collected before 1977 (before the widespread use of computers) are stored in paper form at regional FSHEM centers and for this reason were not widely used.

Four FSHEM research institutes are responsible for periodic inspections and quality control of sea level measurements conducted by FSHEM regional centers. Shore stations in the Arctic seas are inspected by the Arctic and Antarctic Research Institute (St. Petersburg); in the Far Eastern seas – by the Far Eastern Hydrometeorological Research Institute (Vladivostok); in the Azov, Baltic, Black and White Seas - by the State Oceanographic Institute (SOI, Moscow) and in the Caspian Sea - by the Caspian Sea Research Center (Astrakhan). The RNODC is responsible for the international exchange of data and information about sea level. In particular, for many years, on a regular basis, once a year, the RNODC sends monthly mean sea level values from existing Russian GLOSS stations to the Permanent Service for Mean Sea Level (PSMSL). Many historical monthly mean sea level data from Russia have been delivered to PSMSL in the past. In general, the data (RLR & Metric) from 112 Russian stations are in the PSMSL database.

Each year, SOI receives reports (in paper form) from FSHEM regional centers that contain daily mean sea level values for the previous year. Many of these reports (from 1937 to the present) are stored in the SOI archive. Bibliographic information on new and recent reports is available on the SOI website in the IRBIS64 electronic library directory. Work is underway to upload information on all reports (since 1937) into the IRBIS64 system.

In the framework of some short-term archaeological projects in the SOI, the monthly mean sea level values until 1977 from the beginning of sea level observations at each station were digitised for the seas in the SOI area of responsibility. The North-West and North-Caucasian regional centers of FSHEM took part in these projects.

Together with colleagues from Azerbaijan, Iran, Kazakhstan and Turkmenistan, SOI participated in the creation of a historical data set of monthly mean sea level values for 23 stations located on the coast of the Caspian Sea. This data set for the entire observation period was posted on the website of the Coordination Committee for Hydrometeorology and Monitoring of Caspian Sea Pollution (CASPCOM).

A relational database of sea level observations was created on the SOI server in Moscow. Plots of sea level time series stored in the database can be viewed on SOI website.

Estimating Sea Level Rise along the West African coast : Example in Senegal, Mauritania and Cape Verde

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The impact of climate change on sea level has received a great deal of attention by scientists worldwide. In this context, sea level at global and regional scales have been analysed in a number of studies based on tide gauges observations and satellite altimetry measurements. This study focuses on local sea level trend estimation from three high quality tide gauge stations along the West African coast.

The study of the trend of sea level variability does not necessarily require direct manipulation of hourly tide gauge data. Time series of monthly or annual averages are suitable for investigation of the sea level variability. Here we analysed three monthly averaged sea level series from the Permanent Service of Mean Sea Level (PSMSL), i.e., those checked in terms of quality, continuity and local stability of the tide gauge reference: Dakar 2 (Senegal), Palmeira (Cape Verde) and Nouakchott (Mauritania).

The Mann-Kendall test, that is commonly used to detect the presence or not of significant trends in environmental, climate or hydrological time series, was run at 5% significance level for each of the three

stations. The results of this test indicate that the trends for the entire stations were statistically significant and in increase.

Once the presence of significant trends had been verified, the three tide gauges series were decomposed into several components, which can be identified as a non linear trend, seasonalities and noise components, using three techniques: Seasonal and Trend decomposition using Loess (STL), Singular Spectrum Analysis (SSA) and AutoRegressive Integrated Moving Average (ARIMA). The trend, that is a smooth component containing information about time series global change, shows on one hand, the slow rise in the sea level under the combined effect of thermal expansion due to the steric effect, precipitation, etc. and on the other hand, the effect of extreme weather events.

The findings by using the three techniques STL, SSA and Arima are very similar. The application of linear regression on the extracted trends shows that after correction for vertical land motions (VLM) due to postglacial rebound, the magnitudes of sea level changes are: Dakar 2 : +1.52 mm/year +/- *0.5* (1993-2018), Palmeira : +4.51 mm/year +/- *0.6* (2001-2018) and Nouakchott : 20.08 mm/year +/- *5.6* (2008-2014). The highest rate estimated at Nouakchott Station may be due to a high subsidence effect. A longer tidal height series, associated with a GNSS measurements, may confirm or contradict this suggestion.

An overview of historical tidal records in Norway

Torbjørn Taskjelle
Norwegian Mapping Authority Hydrographic Service, Stavanger, Norway

While many historical tidal records from Norway are already digitised, work still remains in this respect. Most notably, there are paper records from Oslo dating back to 1885 – with some gaps – whereas the current digital records only go back to 1914. Also for Oslo, paper records are available for the year 1939, which have not been digitised thus far. Time series from other locations could also be extended, or have gaps filled, by digitizing paper records. These paper records have various forms, such as sheets covering one or two weeks each, or rolls of paper covering about one month, and are of varying quality. Time scales are from 2 mm/hour to 25.7 mm/hour, vertical scales are from 1:10 to 1:20. In some cases sheets with tables of hourly values are available.

Reconstruction of the historical sea level time series of Saint-Jean-de-Luz / SOCOA (French Basque coast): Methodology for the digitalisation of paper marigrams

Inge van den Beld, Yann Ferret, Nicolas Pouvreau
SHOM, France

The reconstruction of historical tide data is important for studies on long term sea level rise and submersion of coastal areas. EZPONDA is a project funded by the European Regional Development Fund (FEDER) investigating the mechanical and chemical parameters driving the erosion of cliffs and the coastal defence structures of the French Basque coast. Within this project, the reconstruction of the historical sea level time series of Saint-Jean-de-Luz / SOCOA is carried out by SHOM. This task includes: 1) a digitisation process in order to obtain a digital raw dataset, and 2) a quality check and validation process.

Data is available from two main types of paper documents: 1) sea level data compiled in paper ledgers for the 1875-1920 period; and 2) the tide measurements recorded on marigrams for the 1942-1944 and the 1950-2001 periods. Both of the historical data sets have been collected by a floating mechanical tide gauge located in Socoa.

In this poster, we present the methodology used to digitise the historical tide marigrams. We particularly focus on the image processing method applied to these old documents.

ANNEX III

RESULTS FROM A POLL ON DATA RESCUE EXPERIENCES

At the end of the opening presentation by Elizabeth Bradshaw a poll was carried out via the application Slido (https://www.sli.do/). Slido is a Q&A and polling platform that enable participants to answer or comment on polling questions.

Three questions were asked in regards to participants' experiences with past data rescue projects: (i) What went well?; (ii) What challenges did you face?; and (iii) What would you do differently next time?.

What went well?

- Access to Hydrographic archives in Taunton (UK) 1830s data from 4 Admiralty dockyards fits curves;
- Discovering a broader community of people who were willing to help;
- Data inventory and identification of historical data;
- New data which would have been probably lost in future;
- No data recovered in recent years unfortunately;
- Lots of forgotten data published in the 19th Century has been scanned and is available;
- Have completed a project and what went well was discovering more data that I knew existed which really helped the project.

What challenges did you face?

- Digitise the marigrams;
- Finding metadata, in particular connecting different datums to tide gauge reference zero;
- The knowledge of tide observatory to tie the sea level data;
- The main challenge as you mentioned is resource, but also the technology to capture effectively;
- Locating data, funding, some records incomplete, records are different even within one location creating collation and coding challenges;
- Datum issues, particularly for the early record, still not resolved. Tracking down additional records, which I know exist but don't know where they reside;
- Define what it is the purpose of rescue data, sea level rise, or extreme event, work is not the same;
- Move from the inventory to the digitisation and quality control (need resources and expertise).

What would you do differently next time?

- First step => Scan all the data before they disappear in moving services;
- Since we don't have the capacity, we would always be open to ideas from external bodies on how best to achieve data capture;
- Put more human resources on digitizing and quality control the data;
- Try to characterize data quality before digitising everything;

- Get the digitised data published or recorded in more than one place for redundancy; Look meta-data, pick and choose the most important data or location and improve automatic process.

ANNEX IV

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ANNEX V

LIST OF ACRONYMS

ACRE	Atmospheric Circulation Reconstructions over the Earth
ARIMA	AutoRegressive Integrated Moving Average
BSH	Federal Maritime and Hydrographic Agency (Germany)
BRGM	Bureau de Recherches Géologiques et Minières (France)
BODC	British Oceanographic Data Centre (UK)
CASPCOM	Coordination Committee for Hydrometeorology and Monitoring of Caspian Sea Pollution
C3S	Copernicus Climate Change Service
Cerema	Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement (France)
CNR	National Research Council (Italy)
CNRS/INSU	Centre National de la Recherche Scientifique/Institut National des Sciences de l'Univers (France)
CSIRO	Climate Science Centre (Australia)
DA	Data Archaeology
DAO	Dominion Astrophysical Observatory (Canada)
DARE	Data Rescue
DOI	Digital Object Identifier
DRS	Data Rescue Service
DRWG	Data Rescue Working Group
FEDER	European Regional Development Fund
FSHEM	Federal Service for Hydrometeorology and Environmental Monitoring (Russia)
GE	Group of Experts
GLOSS	Global Sea Level Observing System
GNSS	Global Navigation Satellite System
ICARUS	Irish Climate Analysis and Research Units
I**-DARE**	International Data Rescue

IEDRO	International Environmental Data Rescue Organization
IMEDEA	Mediterranean Institute for Advanced Studies (Spain)
IRSN	Institut de Radioprotection et de Sureté Nucléaire (France)
ISMAR	Institute of Marine Sciences (Italy)
ISP	Internet Service Provider
IHB	International Hydrographic Bureau
IHO	International Hydrographic Organization
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IPCC	Intergovernmental Panel on Climate Change
LIENSs	LIttoral ENvironnement et Sociétés (France)
MSL	Mean Sea Level
MTL	Mean Tide Level
NMDIS	National Marine Data and Information Service (China)
NMS	National Meteorological Service
NOC	National Oceanography Centre (UK)
NODC	National Oceanographic Data Center
NUNIEAU	NUmérisation des NIveaux d'EAU (software)
PSMSL	Permanent Service for Mean Sea Level
REFMAR	Réseaux de référence des observations marégraphiques (France)
RLR	Revised Local Reference (data set of the PSMSL)
SHN	Servicio de Hidrografía Naval (Argentina)
SHOM	Service hydrographique et océanographique de la marine (France)
SOI	State Oceanographic Institute (Russia)
SONEL	Système d'Observation du Niveau des Eaux Littorales (at University of La Rochelle, France)
SSA	Singular Spectrum Analysis
STL	Seasonal and Trend decomposition using Loess
TWCWG	Tide and Water Level and Current Working Group (of IHO)
UIB	University of the Balearic Islands (Spain)

UKHO	United Kingdom Hydrographic Office (UK)
UNESCO	United Nations Educational, Scientific and Cultural Organization
UTAS	University of Tasmania (Australia)
VLIZ	Flanders Marine Institute (Belgium)
VLM	Vertical Land Motion
WCRP	World Climate Research Programme
WG	Working Group
WMO	World Meteorological Organization

IOC Workshop Reports

The Scientific Workshops of the Intergovernmental Oceanographic Commission are sometimes jointly sponsored with other intergovernmental or non-governmental bodies. In most cases, IOC assures responsibility for printing, and copies may be requested from:

Intergovernmental Oceanographic Commission – UNESCO
1, rue Miollis, 75732 Paris Cedex 15, France

No.	Title	Languages
1	CCOP-IOC, 1974, Metallogenesis, Hydrocarbons and Tectonic Patterns in Eastern Asia (Report of the IDOE Workshop on); Bangkok, Thailand, 24-29 September 1973 UNDP (CCOP),	E (out of stock)
2	CICAR Ichthyoplankton Workshop, Mexico City, 16-27 July 1974 (UNESCO Technical Paper in Marine Sciences, No. 20).	E (out of stock) S (out of stock)
3	Report of the IOC/GFCM/ICSEM International Workshop on Marine Pollution in the Mediterranean; Monte Carlo, 9-14 September 1974.	E,F E (out of stock)
4	Report of the Workshop on the Phenomenon known as 'El Niño'; Guayaquil, Ecuador, 4-12 December 1974.	E (out of stock) S (out of stock)
5	IDOE International Workshop on Marine Geology and Geophysics of the Caribbean Region and its Resources; Kingston, Jamaica, 17-22 February 1975	E (out of stock) S
6	Report of the CCOP/SOPAC-IOC IDOE International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific; Suva, Fiji, 1-6 September 1975.	E
7	Report of the Scientific Workshop to Initiate Planning for a Co-operative Investigation in the North and Central Western Indian Ocean, organized within the IDOE under the sponsorship of IOC/FAO (IOFC)/UNESCO/ EAC; Nairobi, Kenya, 25 March-2 April 1976.	E, F,S, R
8	Joint IOC/FAO (IPFC)/UNEP International Workshop on Marine Pollution in East Asian Waters; Penang, 7-13 April 1976	E (out of stock)
9	IOC/CMG/SCOR Second International Workshop on Marine Geoscience; Mauritius 9-13 August 1976.	E, F, S, R
10	IOC/WMO Second Workshop on Marine Pollution (Petroleum) Monitoring; Monaco, 14-18 June 1976	E, F E (out of stock) R
11	Report of the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions; Port of Spain, Trinidad, 13-17 December 1976.	E, S (out of stock)
11 Suppl.	Collected contributions of invited lecturers and authors to the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions; Port of Spain, Trinidad, 13-17 December 1976	E (out of stock), S
12	Report of the IOCARIBE Interdisciplinary Workshop on Scientific Programmes in Support of Fisheries Projects; Fort-de-France, Martinique, 28 November-2 December 1977.	E, F, S
13	Report of the IOCARIBE Workshop on Environmental Geology of the Caribbean Coastal Area; Port of Spain, Trinidad, 16-18 January 1978.	E, S
14	IOC/FAO/WHO/UNEP International Workshop on Marine Pollution in the Gulf of Guinea and Adjacent Areas; Abidjan, Côte d'Ivoire, 2-9 May 1978	E, F
15	CPPS/FAO/IOC/UNEP International Workshop on Marine Pollution in the South-East Pacific; Santiago de Chile, 6-10 November 1978.	E (out of stock)
16	Workshop on the Western Pacific, Tokyo, 19-20 February 1979.	E, F, R
17	Joint IOC/WMO Workshop on Oceanographic Products and the IGOSS Data Processing and Services System (IDPSS); Moscow, 9-11 April 1979.	E
17 suppl.	Papers submitted to the Joint IOC/WMO Seminar on Oceano-graphic Products and the IGOSS Data Processing and Services System; Moscow, 2-6 April 1979.	E
18	IOC/UNESCO Workshop on Syllabus for Training Marine Technicians; Miami, U.S.A., 22-26 May 1978 (UNESCO reports in marine sciences, No. 4 published by the Division of Marine Sciences, UNESCO).	E (out of stock), F, S (out of tock), R
19	IOC Workshop on Marine Science Syllabus for Secondary Schools; Llantwit Major, Wales, U.K., 5-9 June 1978 (UNESCO reports in marine sciences, No. 5, published by the Division of Marine Sciences, UNESCO).	E (out of stock), S, R, Ar
20	Second CCOP-IOC Workshop on IDOE Studies of East Asia Tectonics and Resources; Bandung, Indonesia, 17-21 October 1978	E
21	Second IDOE Symposium on Turbulence in the Ocean; Liège, Belgium, 7-18 May 1979.	E, F, S, R
22	Third IOC/WMO Workshop on Marine Pollution Monitoring; New Delhi, 11-15 February 1980.	E, F, S, R
23	WESTPAC Workshop on the Marine Geology and Geophysics of the North-West Pacific; Tokyo, 27-31 March 1980.	E, R
24	WESTPAC Workshop on Coastal Transport of Pollutants; Tokyo, Japan, 27-31 March 1980.	E (out of stock)
25	Workshop on the Inter-calibration of Sampling Procedures of the IOC/ WMO UNEP Pilot Project on Monitoring Background Levels of Selected Pollutants in Open-Ocean Waters; Bermuda, 11-26 January 1980.	E (Superseded by IOC Technical Series No.22)
26	IOC Workshop on Coastal Area Management in the Caribbean Region; Mexico City, 24 September- 5 October 1979.	E, S
27	CCOP/SOPAC-IOC Second International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific; Nouméa, New Caledonia, 9-15 October 1980.	E
28	FAO/IOC Workshop on the effects of environmental variation on the survival of larval pelagic fishes. Lima, 20 April-5 May 1980.	E
29	WESTPAC Workshop on Marine Biological Methodology; Tokyo, 9-14 February 1981.	E
30	International Workshop on Marine Pollution in the South-West Atlantic; Montevideo, 10-14 November 1980.	E (out of stock) S
31	Third International Workshop on Marine Geoscience; Heidelberg, 19-24 July 1982.	E, F, S
32	UNU/IOC/UNESCO Workshop on International Co-operation in the Development of Marine Science and the Transfer of Technology in the context of the New Ocean Regime; Paris, France, 27 September-1 October 1982.	E, F, S
32 Suppl.	Papers submitted to the UNU/IOC/ UNESCO Workshop on International Co-operation in the Development of Marine Science and the Transfer of Technology in the Context of the New Ocean Regime; Paris, France, 27 September-1 October 1982.	E
33	Workshop on the IREP Component of the IOC Programme on Ocean Science in Relation to Living Resources (OSLR); Halifax, 26-30 September 1963.	E
34	IOC Workshop on Regional Co-operation in Marine Science in the Central Eastern Atlantic (Western Africa); Tenerife, 12-17 December 1963.	E, F, S
35	CCOP/SOPAC-IOC-UNU Workshop on Basic Geo-scientific Marine Research Required for Assessment of Minerals and Hydrocarbons in the South Pacific; Suva, Fiji, 3-7 October 1983.	E
36	IOC/FAO Workshop on the Improved Uses of Research Vessels; Lisbon, Portugal, 28 May-2 June 1984.	E
36 Suppl.	Papers submitted to the IOC/FAO Workshop on the Improved Uses of Research Vessels; Lisbon, 28 May-2 June 1984	E
37	IOC/UNESCO Workshop on Regional Co-operation in Marine Science in the Central Indian Ocean and Adjacent Seas and Gulfs; Colombo, 8-13 July 1985.	E
38	IOC/ROPME/UNEP Symposium on Fate and Fluxes of Oil Pollutants in the Kuwait Action Plan Region; Basrah, Iraq, 8-12 January 1984.	E
39	CCOP (SOPAC)-IOC-IFREMER-ORSTOM Workshop on the Uses of Submersibles and Remotely Operated Vehicles in the South Pacific; Suva, Fiji, 24-29 September 1985.	E
40	IOC Workshop on the Technical Aspects of Tsunami Analysis, Prediction and Communications; Sidney, B.C., Canada, 29-31 July 1985.	E
40 Suppl.	First International Tsunami Workshop on Tsunami Analysis, Prediction and Communications, Submitted Papers; Sidney, B.C., Canada, 29 July-1 August 1985.	E
41	First Workshop of Participants in the Joint FAO/IOC/WHO/IAEA/UNEP Project on Monitoring of Pollution in the Marine Environment of the West and Central African Region (WACAF/2); Dakar, Senegal, 28 October- 1 November 1985.	E
43	IOC Workshop on the Results of MEDALPEX and Future Oceano-graphic Programmes in the Western Mediterranean; Venice, Italy, 23-25 October 1985.	E
44	IOC-FAO Workshop on Recruitment in Tropical Coastal Demersal Communities; Ciudad del Carmen, Campeche, Mexico, 21-25 April 1986.	E (out of stock) S
44 Suppl.	IOC-FAO Workshop on Recruitment in Tropical Coastal Demersal Communities, Submitted Papers; Ciudad del Carmen, Campeche, Mexico, 21-25 April 1986.	E
45	IOCARIBE Workshop on Physical Oceanography and Climate; Cartagena, Colombia, 19-22 August 1986.	E
46	Reunión de Trabajo para Desarrollo del Programa "Ciencia Oceánica en Relación a los Recursos No Vivos en la Región del Atlántico Sud-occidental"; Porto Alegre, Brasil, 7-11 de abril de 1986.	S
47	IOC Symposium on Marine Science in the Western Pacific: The Indo-Pacific Convergence; Townsville, 1-6 December 1966	E
48	IOCARIBE Mini-Symposium for the Regional Development of the IOC-UN (OETB) Programme on 'Ocean Science in Relation to Non-Living Resources (OSNLR)'; Havana, Cuba, 4-7 December 1986.	E, S
49	AGU-IOC-WMO-CPPS Chapman Conference: An International Symposium on 'El Niño'; Guayaquil, Ecuador, 27-31 October 1986.	E
50	CCALR-IOC Scientific Seminar on Antarctic Ocean Variability and its Influence on Marine Living Resources, particularly Krill (organized in collaboration with SCAR and SCOR); Paris, France, 2-6 June 1987.	E
51	CCOP/SOPAC-IOC Workshop on Coastal Processes in the South Pacific Island Nations; Lae, Papua-New Guinea, 1-8 October 1987.	E
52	SCOR-IOC-UNESCO Symposium on Vertical Motion in the Equatorial Upper Ocean and its Effects upon Living Resources and the Atmosphere; Paris, France, 6-10 May 1985.	E
53	IOC Workshop on the Biological Effects of Pollutants; Oslo, 11-29 August 1986.	E
54	Workshop on Sea-Level Measurements in Hostile Conditions; Bidston, UK, 28-31 March 1988.	E
55	IBCCA Workshop on Data Sources and Compilation, Boulder, Colorado, 18-19 July 1988.	E
56	IOC-FAO Workshop on Recruitment of Penaeid Prawns in the Indo-West Pacific Region (PREP); Cleveland, Australia, 24-30 July 1988.	E
57	IOC Workshop on International Co-operation in the Study of Red Tides and Ocean Blooms; Takamatsu, Japan, 16-17 November 1987.	E
58	International Workshop on the Technical Aspects of the Tsunami Warning System; Novosibirsk, USSR, 4-5 August 1989.	E
58 Suppl.	Second International Workshop on the Technical Aspects of Tsunami Warning Systems, Tsunami Analysis, Preparedness,	E

No.	Title	Languages
	Observation and Instrumentation. Submitted Papers; Novosibirsk, USSR, 4-5 August 1989.	
59	IOC-UNEP Regional Workshop to Review Priorities for Marine Pollution Monitoring Research, Control and Abatement in the Wider Caribbean; San José, Costa Rica, 24-30 August 1989.	E, F, S
60	IOC Workshop to Define IOCARIBE-TRODERP proposals; Caracas, Venezuela, 12-16 September 1989.	E
61	Second IOC Workshop on the Biological Effects of Pollutants; Bermuda, 10 September-2 October 1988.	E
62	Second Workshop of Participants in the Joint FAO-IOC-WHO-IAEA-UNEP Project on Monitoring of Pollution in the Marine Environment of the West and Central African Region; Accra, Ghana, 13-17 June 1988.	E
63	IOC/WESTPAC Workshop on Co-operative Study of the Continental Shelf Circulation in the Western Pacific; Bangkok, Thailand, 31 October-3 November 1989.	E
64	Second IOC-FAO Workshop on Recruitment of Penaeid Prawns in the Indo-West Pacific Region (PREP); Phuket, Thailand, 25-31 September 1989.	E
65	Second IOC Workshop on Sardine/Anchovy Recruitment Project (SARP) in the Southwest Atlantic; Montevideo, Uruguay, 21-23 August 1989.	E
66	IOC ad hoc Expert Consultation on Sardine/ Anchovy Recruitment Programme; La Jolla, California, U.S.A., 1989	E
67	Interdisciplinary Seminar on Research Problems in the IOCARIBE Region; Caracas, Venezuela, 28 November-1 December 1989.	E (out of stock)
68	International Workshop on Marine Acoustics; Beijing, China, 26-30 March 1990.	E
69	IOC-SCAR Workshop on Sea-Level Measurements in the Antarctica; Leningrad, USSR, 28-31 May 1990.	E
69 Suppl.	IOC-SCAR Workshop on Sea-Level Measurements in the Antarctica; Submitted Papers; Leningrad, USSR, 28-31 May 1990.	E
70	IOC-SAREC-UNEP-FAO-IAEA-WHO Workshop on Regional Aspects of Marine Pollution; Mauritius, 29 October - 9 November 1990.	E
71	IOC-FAO Workshop on the Identification of Penaeid Prawn Larvae and Postlarvae; Cleveland, Australia, 23-28 September 1990.	E
72	IOC/WESTPAC Scientific Steering Group Meeting on Co-Operative Study of the Continental Shelf Circulation in the Western Pacific; Kuala Lumpur; Malaysia, 9-11 October 1990.	E
73	Expert Consultation for the IOC Programme on Coastal Ocean Advanced Science and Technology Study; Liège, Belgium, 11-13 May 1991.	E
74	IOC-UNEP Review Meeting on Oceanographic Processes of Transport and Distribution of Pollutants in the Sea; Zagreb, Yugoslavia, 15-18 May 1989.	E
75	IOC-SCOR Workshop on Global Ocean Ecosystem Dynamics; Solomons, Maryland, U.S.A., 29 April-2 May 1991.	E
76	IOC/WESTPAC Scientific Symposium on Marine Science and Management of Marine Areas of the Western Pacific; Penang, Malaysia, 2-6 December 1991.	E
77	IOC-SAREC-KMFRI Regional Workshop on Causes and Consequences of Sea-Level Changes on the Western Indian Ocean Coasts and Islands; Mombasa, Kenya, 24-28 June 1991.	E
78	IOC-CEC-ICES-WMO-ICSU Ocean Climate Data Workshop Goddard Space Flight Center; Greenbelt, Maryland, U.S.A., 18-21 February 1992.	E
79	IOC/WESTPAC Workshop on River Inputs of Nutrients to the Marine Environment in the WESTPAC Region; Penang, Malaysia, 26-29 November 1991.	E
80	IOC-SCOR Workshop on Programme Development for Harmful Algae Blooms; Newport, U.S.A. 2-3 November 1991.	E
81	Joint IAPSO-IOC Workshop on Sea Level Measurements and Quality Control; Paris, France, 12-13 October 1992.	E
82	BORDOMER 92: International Convention on Rational Use of Coastal Zones. A Preparatory Meeting for the Organization of an International Conference on Coastal Change; Bordeaux, France, 30 September-2 October 1992.	E
83	IOC Workshop on Donor Collaboration in the Development of Marine Scientific Research Capabilities in the Western Indian Ocean Region; Brussels, Belgium, 12-13 October 1992.	E
84	Workshop on Atlantic Ocean Climate Variability; Moscow, Russian Federation, 13-17 July 1992	E
85	IOC Workshop on Coastal Oceanography in Relation to Integrated Coastal Zone Management; Kona, Hawaii, 1-5 June 1992.	E
86	International Workshop on the Black Sea; Varna, Bulgaria, 30 September – 4 October 1991	E
87	Taller de trabajo sobre efectos biológicos del fenómeno «El Niño» en ecosistemas costeros del Pacífico Sudeste; Santa Cruz, Galápagos, Ecuador, 5-14 de octubre de 1989.	S only (summary in E, F, S)
88	IOC-CEC-ICSU-ICES Regional Workshop for Member States of Eastern and Northern Europe (GODAR Project); Obninsk, Russia, 17-20 May 1993.	E
89	IOC-ICSEM Workshop on Ocean Sciences in Non-Living Resources; Perpignan, France, 15-20 October 1990.	E
90	IOC Seminar on Integrated Coastal Management; New Orleans, U.S.A., 17-18 July 1993.	E
91	Hydroblack'91 CTD Intercalibration Workshop; Woods Hole, U.S.A., 1-10 December 1991.	E
92	Réunion de travail IOCEA-OSNLR sur le Projet « Budgets sédimentaires le long de la côte occidentale d'Afrique » Abidjan, côte d'Ivoire, 26-28 juin 1991.	E
93	IOC-UNEP Workshop on Impacts of Sea-Level Rise due to Global Warming. Dhaka, Bangladesh, 16-19 November 1992.	E
94	BMTC-IOC-POLARMAR International Workshop on Training Requirements in the Field of Eutrophication in Semi-enclosed Seas and Harmful Algal Blooms, Bremerhaven, Germany, 29 September-3 October 1992.	E
95	SAREC-IOC Workshop on Donor Collaboration in the Development of Marine Scientific Research Capabilities in the Western Indian Ocean Region; Brussels, Belgium, 23-25 November 1993.	E
96	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Zanzibar, United Republic of Tanzania, 17-21 January 1994.	E
96 Suppl.	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers 1. Coastal Erosion; Zanzibar, United Republic of Tanzania 17-21 January 1994.	E
96 Suppl	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers 2. Sea Level; Zanzibar, United Republic of Tanzania 17-21 January 1994.	E
97	IOC Workshop on Small Island Oceanography in Relation to Sustainable Economic Development and Coastal Area Management of Small Island Development States; Fort-de-France, Martinique, 8-10 November, 1993.	E
98	CoMSBlack '92A Physical and Chemical Intercalibration Workshop; Erdemli, Turkey, 15-29 January 1993.	E
99	IOC-SAREC Field Study Exercise on Nutrients in Tropical Marine Waters; Mombasa, Kenya, 5-15 April 1994.	E
100	IOC-SOA-NOAA Regional Workshop for Member States of the Western Pacific - GODAR-II (Global Oceanographic Data Archeology and Rescue Project); Tianjin, China, 8-11 March 1994.	E
101	IOC Regional Science Planning Workshop on Harmful Algal Blooms; Montevideo, Uruguay, 15-17 June 1994.	E
102	First IOC Workshop on Coastal Ocean Advanced Science and Technology Study (COASTS); Liège, Belgium, 5-9 May 1994.	E
103	IOC Workshop on GIS Applications in the Coastal Zone Management of Small Island Developing States; Barbados, 20-22 April 1994.	E
104	Workshop on Integrated Coastal Management; Dartmouth, Canada, 19-20 September 1994.	E
105	BORDOMER 95: Conference on Coastal Change; Bordeaux, France, 6-10 February 1995.	E
105 Suppl.	Conference on Coastal Change: Proceedings; Bordeaux, France, 6-10 February 1995	E
106	IOC/WESTPAC Workshop on the Paleographic Map; Bali, Indonesia, 20-21 October 1994.	E
107	IOC-ICSU-NIO-NOAA Regional Workshop for Member States of the Indian Ocean - GODAR-III; Dona Paula, Goa, India, 6-9 December 1994.	E
108	UNESCO-IHP-IOC-IAEA Workshop on Sea-Level Rise and the Multidisciplinary Studies of Environmental Processes in the Caspian Sea Region; Paris, France, 9-12 May 1995.	E
108 Suppl.	UNESCO-IHP-IOC-IAEA Workshop on Sea-Level Rise and the Multidisciplinary Studies of Environmental Processes in the Caspian Sea Region; Submitted Papers; Paris, France, 9-12 May 1995.	E
109	First IOC-UNEP CEPPOL Symposium; San José, Costa Rica, 14-15 April 1993.	E
110	IOC-ICSU-CEC regional Workshop for Member States of the Mediterranean - GODAR-IV (Global Oceanographic Data Archeology and Rescue Project) Foundation for International Studies, University of Malta, Valletta, Malta, 25-28 April 1995.	E
111	Chapman Conference on the Circulation of the Intra-Americas Sea; La Parguera, Puerto Rico, 22-26 January 1995.	E
112	IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials (GESREM) Workshop; Miami, U.S.A., 7-8 December 1993.	E
113	IOC Regional Workshop on Marine Debris and Waste Management in the Gulf of Guinea; Lagos, Nigeria, 14-16 December 1994.	E
114	International Workshop on Integrated Coastal Zone Management (ICZM) Karachi, Pakistan; 10-14 October 1994.	E
115	IOC/GLOSS-IAPSO Workshop on Sea Level Variability and Southern Ocean Dynamics; Bordeaux, France, 31 January 1995	E
116	IOC/WESTPAC International Scientific Symposium on Sustainability of Marine Environment: Review of the WESTPAC Programme, with Particular Reference to ICAM, Bali, Indonesia, 22-26 November 1994.	E
117	Joint IOC-CIDA-Sida (SAREC) Workshop on the Benefits of Improved Relationships between International Development Agencies, the IOC and other Multilateral Inter-governmental Organizations in the Delivery of Ocean, Marine Affairs and Fisheries Programmes; Sidney B.C., Canada, 26-28 September 1995.	E
118	IOC-UNEP-NOAA-Sea Grant Fourth Caribbean Marine Debris Workshop; La Romana, Santo Domingo, 21-24 August 1995.	E
119	IOC Workshop on Ocean Colour Data Requirements and Utilization; Sydney B.C., Canada, 21-22 September 1995.	E
120	International Training Workshop on Integrated Coastal Management; Tampa, Florida, U.S.A., 15-17 July 1995.	E
121	Atelier régional IOC-CERESCOR sur la gestion intégrée des zones littorales (ICAM), Conakry, Guinée, 18–22 décembre 1995	F
122	IOC-EU-BSH-NOAA-(WDC-A) International Workshop on Oceanographic Biological and Chemical Data Management, Hamburg, Germany, 20-23 May 1996	E
123	Second IOC Regional Science Planning Workshop on Harmful Algal Blooms in South America; Mar del Plata, Argentina, 30 October–1 November 1995.	E, S
124	GLOBEC-IOC-SAHFOS-MBA Workshop on the Analysis of Time Series with Particular Reference to the Continuous Plankton Recorder Survey; Plymouth, U.K.,4-7 May 1993.	E
125	Atelier sous-régional de la COI sur les ressources marines vivantes du Golfe de Guinée ; Cotonou, Bénin, 1-4 juillet 1996.	E

No.	Title	Languages
126	IOC-UNEP-PERSGA-ACOPS-IUCN Workshop on Oceanographic Input to Integrated Coastal Zone Management in the Red Sea and Gulf of Aden. Jeddah, Saudi Arabia, 8 October 1995.	E
127	IOC Regional Workshop for Member States of the Caribbean and South America GODAR-V (Global Oceanographic Data Archeology and Rescue Project); Cartagena de Indias, Colombia, 8-11 October 1996.	E
128	Atelier IOC-Banque Mondiale-Sida/SAREC-ONE sur la Gestion Intégrée des Zones Côtières ; Nosy Bé, Madagascar, 14-18 octobre 1996.	E
129	Gas and Fluids in Marine Sediments, Amsterdam, the Netherlands; 27-29 January 1997.	E
130	Atelier régional de la COI sur l'océanographie côtière et la gestion de la zone côtière ;Moroni, RFI des Comores, 16-19 décembre 1996.	E
131	GOOS Coastal Module Planning Workshop; Miami, USA, 24-28 February 1997	E
132	Third IOC-FANSA Workshop; Punta-Arenas, Chile, 28-30 July 1997	S/E
133	Joint IOC-CIESM Training Workshop on Sea-level Observations and Analysis for the Countries of the Mediterranean and Black Seas; Birkenhead, U.K., 16-27 June 1997.	E
134	IOC/WESTPAC-CCOP Workshop on Paleogeographic Mapping (Holocene Optimum); Shanghai, China, 27-29 May 1997.	E
135	Regional Workshop on Integrated Coastal Zone Management; Chabahar, Iran; February 1996.	E
136	IOC Regional Workshop for Member States of Western Africa (GODAR-VI); Accra, Ghana, 22-25 April 1997.	E
137	GOOS Planning Workshop for Living Marine Resources, Dartmouth, USA; 1-5 March 1996.	E
138	Gestión de Sistemas Oceanográficos del Pacífico Oriental; Concepción, Chile, 9-16 de abril de 1996.	S
139	Sistemas Oceanográficos del Atlántico Sudoccidental, Taller, TEMA;Furg, Rio Grande, Brasil, 3-11 de noviembre de 1997	S
140	IOC Workshop on GOOS Capacity Building for the Mediterranean Region; Valletta, Malta, 26-29 November 1997.	E
141	IOC/WESTPAC Workshop on Co-operative Study in the Gulf of Thailand: A Science Plan; Bangkok, Thailand, 25-28 February 1997.	E
142	Pelagic Biogeography ICoPB II. Proceedings of the 2nd International Conference. Final Report of SCOR/IOC Working Group 93; Noordwijkerhout, The Netherlands, 9-14 July 1995.	E
143	Geosphere-biosphere coupling: Carbonate Mud Mounds and Cold Water Reefs; Gent, Belgium, 7–11 February 1998.	E
144	IOC-SOPAC Workshop Report on Pacific Regional Global Ocean Observing Systems; Suva, Fiji, 13-17 February 1998.	E
145	IOC-Black Sea Regional Committee Workshop: 'Black Sea Fluxes' Istanbul, Turkey, 10-12 June 1997.	E
146	Taller Internacional sobre Formacíon de Capacidades para el Manejo de las Costas y los Oéanos en le Gran Caribe, La Habana, – Cuba, 7–10 de Julio de 1998 / International Workshop on Management Capacity-Building for Coasts and Oceans in the Wider Caribbean, Havana, Cuba, 7–10 July 1998	S/E
147	IOC-SOA International Training Workshop on the Intregration of Marine Sciences into the Process of Integrated Coastal Management, Dalian, China, 19-24 May 1997.	E
148	IOC/WESTPAC International Scientific Symposium – Role of Ocean Sciences for Sustainable Development Okinawa, Japan, 2-7 February 1998.	E
149	Workshops on Marine Debris & Waste Management in the Gulf of Guinea, 1995-97.	E
150	Primera Sesión del Grupo de Trabajo COI sobre Algas Nocivas en el Caribe y Regiones Adyacentes (IOCARIBE-ANCA)/First Meeting of the IOC Working Group on Harmful Algae in the Caribbean and Adjacent Region (IOCARIBE-ANCA), 29 June – 1 July 1998, Havana, Cuba.	S/E ***(electronic copy only)***
151	Taller Pluridisciplinario TEMA sobre Redes del Gran Caribe en Gestión Integrada de Areas Costeras Cartagena de Indias, Colombia, 7-12 de septiembre de 1998.	S
152	Workshop on Data for Sustainable Integrated Coastal Management (SICOM) Maputo, Mozambique, 18-22 July 1998	E
153	IOC/WESTPAC-Sida (SAREC) Workshop on Atmospheric Inputs of Pollutants to the Marine Environment Qingdao, China, 24-26 June 1998	E
154	IOC-Sida-Flanders-SFRI Workshop on Ocean Data Management in the IOCINCWIO Region (ODINEA project) Capetown, South Africa, 30 November-11 December 1998.	E
155	Science of the Mediterranean Sea and its applications UNESCO, Paris 29-31 July 1997	E
156	IOC-LUC-KMFRI Workshop on RECOSCIX-WIO in the Year 2000 and Beyond, Mombasa, Kenya, 12-16 April 1999	E
157	'98 IOC-KMI International Workshop on Integrated Coastal Management (ICM), Seoul, Republic of Korea 16-18 April 1998	E
158	The IOCARIBE Users and the Global Ocean Observing System (GOOS) Capacity Building Workshop, San José, Costa Rica, 22-24 April 1999	E
159	Oceanic Fronts and Related Phenomena (Konstantin Fedorov Memorial Symposium) – Proceedings, Pushkin, Russian Federation, 18-22 May 1998	E
160	Under preparation	
161	Under preparation	
162	Workshop report on the Transports and Linkages of the Intra-americas Sea (IAS), Cozumel, Mexico, 1-5 November 1997	E
163	Under preparation	
164	IOC-Sida-Flanders-MCM Third Workshop on Ocean Data Management in the IOCINCWIO Region (ODINEA Project), Cape Town, South Africa, 29 November – 11 December 1999	E
165	An African Conference on Sustainable Integrated Management; Proceedings of the Workshops. An Integrated Approach, (PACSICOM), Maputo, Mozambique, 18 –25 July 1998	E, F
166	IOC-SOA International Workshop on Coastal Megacities: Challenges of Growing Urbanization of the World's Coastal Areas; Hangzhou, P.R. China, 27 –30 September 1999	E
167	IOC-Flanders First ODINAFRICA-II Planning Workshop, Dakar, Senegal, 2-4 May 2000	E
168	Geological Processes on European Continental Margins; International Conference and Eight Post-cruise Meeting of the Training-Through-Research Programme, Granada, Spain, 31 January – 3 February 2000	E
169	International Conference on the International Oceanographic Data & Information Exchange in the Western Pacific (IODE-WESTPAC) 1999, ICIWP '99, Langkawi, Malaysia, 1-4 November 1999	E ***(electronic copy only)***
170	IOCARIBE-GODAR-I Cartagenas, Colombia, February 2000	***under preparation***
171	Ocean Circulation Science derived from the Atlantic, Indian and Arctic Sea Level Networks, Toulouse, France, 10-11 May 1999	E
172	(*Under preparation*)	
173	The Benefits of the Implementation of the GOOS in the Mediterranean Region, Rabat, Morocco, 1-3 November 1999	E, F
174	IOC-SOPAC Regional Workshop on Coastal Global Ocean Observing System (GOOS) for the Pacific Region, Apia, Samoa, 16-17 August 2000	E
175	Geological Processes on Deep-water European Margins, Moscow-Mozhenka, 28 Jan.-2 Feb. 2001	E
176	MedGLOSS Workshop and Coordination Meeting for the Pilot Monitoring Network System of Systematic Sea Level Measurements in the Mediterranean and Black Seas, Haifa, Israel, 15-17 May 2000	E
177	*(Under preparation)*	
178	*(Under preparation)*	
179	*(Under preparation)*	
180	Abstracts of Presentations at Workshops during the 7th session of the IOC Group of Experts on the Global Sea Level Observing System (GLOSS), Honolulu, USA, 23-27 April 2001	E
181	*(Under preparation)*	
182	*(Under preparation)*	
183	Geosphere/Biosphere/Hydrosphere Coupling Process, Fluid Escape Structures and Tectonics at Continental Margins and Ocean Ridges, International Conference & Tenth Post-cruise Meeting of the Training-through-Research Programme, Aveiro, Portugal, 30 January-2 February 2002	E
184	*(Under preparation)*	
185	*(Under preparation)*	
186	*(Under preparation)*	
186	*(Under preparation)*	
187	Geological and Biological Processes at deep-sea European Margins and Oceanic Basins, Bologna, Italy, 2–6 February 2003	E
188	Proceedings of 'The Ocean Colour Data' Symposium, Brussels, Belgium, 25-27 November 2002	E
189	Workshop for the Formulation of a Draft Project on Integrated Coastal Management (ICM) in Latin America and the Caribbean (LAC), Cartagena, Colombia, 23–25 October 2003	E F ***(electronic copy only)***
	Taller de Formulación de un Anteproyecto de Manejo Costero Integrado (MCI) en América Latina y el Caribe (ALC), Cartagena, Colombia, 23–25 de Octubre de 2003	
190	First ODINCARSA Planning Workshop for Caribbean Islands, Christchurch, Barbados, 15–18 December 2003	E ***(electronic copy only)***
191	North Atlantic and Labrador Sea Margin Architecture and Sedimentary Processes — International Conference and Twelfth Post-cruise Meeting of the Training-through-research Programme, Copenhagen, Denmark, 29–31 January 2004	E
192	Regional Workshop on Coral Reefs Monitoring and Management in the ROPME Sea Area, Iran I.R., 14–17 December 2003	E ***(under preparation)***
193	Workshop on New Technical Developments in Sea and Land Level Observing Systems, Paris, France, 14–16 October 2003	E ***(electronic copy only)***
194	IOC/ROPME Planning Meeting for the Ocean Data and Information Network for the Central Indian Ocean Region	***(under preparation)***
195	Workshop on Indicators of Stress in the Marine Benthos, Torregrande-Oristano, Italy, 8–9 October 2004	E
196	International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean within a Global Framework, Paris, France, 3–8 March 2005	E
197	Geosphere-Biosphere Coupling Processes: The TTR Interdisciplinary Approach Towards Studies of the European and North African Margins; International Conference and Post-cruise Meeting of the Training-Through-Research Programme, Morocco, 2-5 February 2005	E
198	Second International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean, Grand Baie, Mauritius, 14–16 April 2005	E
199	International Conference for the Establishment of a Tsunami and Coastal Hazards Warning System for the Caribbean and Adjacent Regions, Mexico, 1–3 June 2005	E
200	Lagoons and Coastal Wetlands in the Global Change Context: Impacts and Management Issues — Proceedings of the International Conference, Venice, 26–28 April 2004 (*ICAM Dossier N° 3)*	E
201	Geological processes on deep-water European margins - International Conference and 15th Anniversary Post-cruise Meeting of the Training-Through-Research Programme, Moscow/Zvenigorod, Russian Federation, 29 January–4 February 2006	E
202	Proceedings of 'Ocean Biodiversity Informatics': an international conference on marine biodiversity data management Hamburg, Germany, 29 November–1 December 2004	E
203	IOC-Flanders Planning Workshop for the formulation of a regional Pilot Project on Integrated Coastal Area Management in Latin America, Cartagena de Indias, Colombia, 16–18 January 2007	*E* ***(electronic copy only)***
204	Geo-marine Research along European Continental Margins, International Conference and Post-cruise Meeting of the Training-through-research Programme, Bremen, Germany, 29 January–1 February 2007	E
205	IODE/ICAM Workshop on the development of the Caribbean marine atlas (CMA), United Nations House, Bridgetown, Barbados, 8–10 October 2007	E ***(electronic copy only)***
206	IODE/JCOMM Forum on Oceanographic Data Management and Exchange Standards, Ostend, Belgium, 21–25 January 2008	*(Under preparation)*
207	SCOR/IODE Workshop on Data Publishing, Ostend, Belgium, 17–18 June 2008	*(Under preparation)*

No.	Title	Languages
208	JCOMM Technical Workshop on Wave Measurements from Buoys, New York, USA, 2–3 October 2008 (IOC-WMO publication)	*(Under preparation)*
209	Collaboration between IOC and OBIS towards the Long-term Management Archival and Accessibility of Ocean Biogeographic Data, Ostend, Belgium, 24–26 November 2008	*(Under preparation)*
210	Ocean Carbon Observations from Ships of Opportunity and Repeat Hydrographic Sections (IOCCP Reports, 1), Paris, France, 13–15 January 2003	E ***(electronic copy only)***
211	Ocean Surface pCO_2 Data Integration and Database Development (IOCCP Reports, 2), Tsukuba, Japan, 14–17 January 2004	E ***(electronic copy only)***
212	International Ocean Carbon Stakeholders' Meeting, Paris, France, 6–7 December 2004	E ***(electronic copy only)***
213	International Repeat Hydrography and Carbon Workshop (IOCCP Reports, 4), Shonan Village, Japan, 14–16 November 2005	E ***(electronic copy only)***
214	Initial Atlantic Ocean Carbon Synthesis Meeting (IOCCP Reports, 5), Laugavatn, Iceland, 28–30 June 2006	E ***(electronic copy only)***
215	Surface Ocean Variability and Vulnerability Workshop (IOCCP Reports, 7), Paris, France, 11–14 April 2007	E ***(electronic copy only)***
216	Surface Ocean CO2 Atlas Project (SOCAT) 2nd Technical Meeting Report (IOCCP Reports, 9), Paris, France, 16–17 June 2008	E ***(electronic copy only)***
217	Changing Times: An International Ocean Biogeochemical Time-Series Workshop (IOCCP Reports, 11), La Jolla, California, USA, 5–7 November 2008	E ***(electronic copy only)***
218	Second Joint GOSUD/SAMOS Workshop, Seattle, Washington, USA, 10–12 June 2008	E ***(electronic copy only)***
219	International Conference on Marine Data management and Information Systems (IMDIS), Athens, Greece, 31 March–2 April 2008	E
220	Geo-marine Research on the Mediterranean and European-Atlantic Margins. International Conference and TTR-17 Post-cruise Meeting of the Training-through-research Programme, Granada, Spain, 2–5 February 2009	E ***(electronic copy only)***
221	Surface Ocean CO_2 Atlas Project Pacific Regional Workshop, Tsukuba, Japan, 18-20 March, 2009 (IOCCP Report Number 12)	E ***(electronic copy only)***
222	Surface Ocean CO_2 Atlas Project Atlantic and Southern Oceans Regional Meeting, Norwich, UK, 25-26 June, 2009 (IOCCP Report Number 13)	E ***(electronic copy only)***
223	Advisory Workshop on enhancing forecasting capabilities for North Indian Ocean Storm Surges, Indian Institute of Technology (IIT), New Delhi, India, 14–17 July 2009	E ***(electronic copy only)***
224	2009 International Nutrients Scale System (INSS) Workshop Report, Paris, France, 10–12 February 2009	E ***(electronic copy only)***
225	Reunión subregional de planificación de ODINCARSA (Red de Datos e Información Oceanográficos para las Regiones del Caribe y América del Sur)/ ODINCARSA (Ocean Data and Information Network for the Caribbean and South America region) Latin America sub-regional Planning Meeting, Universidad Autónoma de Baja California (UABC), Ensenada (México), 7-10 December 2009. 2010	E/S ***(electronic copy only)***
226	OBIS (Ocean Biogeographic Information System) Strategy and Work plan Meeting, IOC Project Office for IODE, Oostende, Belgium, 18–20 November 2009	E ***(electronic copy only)***
227	ODINAFRICA-IV Project Steering Committee, First Session, Ostend, Belgium, 20–22 January 2010. 2010	E ***(electronic copy only)***
228	First IODE Workshop on Quality Control of Chemical Oceanographic Data Collections, Ostend, Belgium, 8–11 February 2010. 2010	E ***(electronic copy only)***
229	Surface Ocean CO_2 Atlas Project Equatorial Pacific, North Pacific, and Indian Ocean Regional Workshop, Tokyo, Japan, 8–11 February 2010. 2010 (IOCCP Report Number 18)	E ***(electronic copy only)***
230	SCOR/IODE/MBLWHOI Library Workshop on Data Publication, Paris, France, 2 April 2010	E ***(electronic copy only)***
231	First ODINAFRICA Coastal and Marine Atlases Planning Meeting, Ostend, Belgium, 12–14 October 2009	E ***(electronic copy only)***
232	Eleventh International Workshop on Wave Hindcasting and Forecasting and Second Coastal Hazard Symposium, Halifax, Canada, 18–23 October 2009	E ***(electronic copy only)***
233	2010 Meeting of the Joint IODE-JCOMM Steering Group on the Global Temperature-Salinity Profile Programme Ostend, Belgium, 5–7 May 2010	E ***(electronic copy only)***
234	Southern and Indian Surface Ocean CO_2 Atlas (SOCAT) Workshop, CSIRO Marine Laboratories, Hobart, Tasmania 16-18 June 2010	E ***(electronic copy only)***
235	The Caribbean Marine Atlas (CMA) Review and Planning Workshop and Saint Lucia National Coastal Atlas Stakeholder Event, Bay Gardens Inn, Rodney Bay, Saint Lucia, 2–6 August 2010	E ***(electronic copy only)***
236	First Session of the IODE Steering Group for the IODE OceanDataPortal (SG-ODP-I), 20–22 September 2010, Ostend, Belgium	E ***(electronic copy only)***
237.	Ad hoc meeting of the IODE Steering Group for OBIS, Ostend, Belgium 18-19 November 2010	E ***(electronic copy only)***
238.	Implementing Adaptation to Climate Change in Western and Eastern Africa, Nairobi, Kenya, 3-5 November 2010	E ***(electronic copy only)***
239.	2nd Advisory Workshop on enhancing forecasting capabilities for North Indian Ocean Storm Surges, 11-15 February 2011, New Delhi, India	E ***(electronic copy only)***
240.	Ocean Biogeographic Information System (OBIS) Infrastructure Meeting, INCOIS, Hyderabad, India, 2–4 March 2011.	E ***(electronic copy only)***
241.	Best Practice on Tsunami and Coastal Hazards Community Preparedness and Readiness in Central America and the Caribbean, 11–13 August 2008, Panama City, Panama	E ***(electronic copy only)***
242.	Integrated Coastal Area Management (ICAM) Training Workshop for the English Speaking Caribbean States, 16–18 March 2011, Bridgetown, Barbados	E ***(electronic copy only)***
243.	Implementing Adaptation to Climate Change in Western and Eastern Africa: Targeting the Adaptation Fund. Nairobi, Kenya, 3–5 November 2010	*cancelled*
244.	SCOR/IODE/MBLWHOI Library Workshop on Data Publication, 4th Session, British Oceanographic Data Centre, Liverpool, United Kingdom, 3-4 November 2011	E ***(electronic copy only)***
245.	Surface Ocean CO2 Data-to-Flux Workshop, UNESCO, Paris, 12-14 September 2011	*cancelled*
246.	NEAMTIC/ICAM Workshop on Coastal Management Approaches for Sea-Level Related Hazards, Paris, UNESCO, 5–7 December 2011	E ***(electronic copy only)***
247.	Technical Workshop on the IODE OceanDataPortal, IOC Project Office for IODE, Ostend, Belgium, 27-29 February 2012	E ***(electronic copy only)***
248.	Inter-sessional working group for updating the IOC Strategic Plan for Oceanographic Data and Information Exchange (2012-2015), Ostend, Belgium, 1-2 March 2012	E ***(electronic copy only)***
249.	Operational Oceanography of IOC (for Group II Member States), 20–22 March 2012 Paris, UNESCO (Advisory Workshop)	E ***(electronic copy only)***
250.	Advisory Workshop on The Future of IOC towards next ten years and its Implications for Member States, Varna, Bulgaria, 19 March 2012	E ***(electronic copy only)***
251	Second Technical Meeting of Ocean Biogeographic Information System (OBIS), Ostend, Belgium, 21–22 June 2012	E ***(electronic copy only)***
252.	SCOR/IODE/MBLWHOI Library Workshop on Data Publication, 5th Session, Woods Hole Oceanographic Institution, Woods Hole, USA, 9-10 October 2012	E ***(electronic copy only)***
253.	Second IODE Workshop on Quality Control of Chemical and Biological Oceanographic Data Collections, 22-24 October 2012, IOC Project Office for IODE, Ostend, Belgium	E ***(electronic copy only)***
254.	Consultation on Scientific and Technical Aspects of Sustained Ocean Observations and Services, 5th March, 2013, Rio de Janeiro, Brazil	E ***(electronic copy only)***
255.	Earthquake and tsunami hazard in Northern Haiti: Historical events and potential sources (Meeting of experts)	E ***(electronic copy only)***
256	Sexto Taller Regional de Planificación Científica sobre Floraciones de Algas Nocivas en Sudamérica, Guayaquil, Ecuador, 22-24 Octubre 2003	S ***(electronic copy only)***
257	*(Under preparation)*	
258	*(Under preparation)*	
259	Noveno Taller Regional-COI de Planificación Científica sobre Florecimientos de Algas Nocivas en Sudamérica, 11-13 enero 2011, Puerto Varas, Chile	S ***(electronic copy only)*** *(Summary in E)*
260	*Caribbean Marine Atlas Review and Planning Meeting, Miami, USA, 10-13 December 2013*	
261	Indo-Pacific Ocean Forum on "Charting the Future of Sustained Ocean Observations and Services", Bangkok, Thailand, 25-28 Nov. 2013	E ***(electronic copy only)***
262	*First Planning Workshop For The Ocean Data And Information Network For The Westpac Region (ODINWESTPAC), Tianjin, China, 4-7 March 2014*	
263	*International Coastal Atlas Network Workshop 6: Expanding Participation in Coastal Web Atlas Development and Use, 16–17 June 2013, University of Victoria, British Columbia, Canada*	
264	9th WESTPAC International Scientific Symposium, Research Directors' Forum: A Healthy and Safe Ocean for Prosperity in the Indo-Pacific region, Nha Trang, Viet Nam, 22 April 2014	E ***(electronic copy only)***
265	Electoral Group 1 Consultation on the Future of the IOC, Utrecht, The Netherlands, 26–27 May 2014	E ***(electronic copy only)***
266	IOC-UNESCO-ISESCO workshop on Improving Tsunami Warning and Emergency Response in the North-Eastern Atlantic, Mediterranean and connected seas Rabat, 23-24 September 2014	A/E/F ***(electronic copy only)***
267	Proceedings of the First IOCAFRICA Ocean Forecasting workshop for the Western Indian Ocean region, Nairobi, Kenya, 11–15 August 2014	E ***(electronic copy only)***
268	Proceedings of the African Summer School on Application of Ocean Data and Modelling Products, Ghana, Kenya, April–September 2014	E ***(electronic copy only)***
269.	*Forum on Sustained Ocean Observations and Services in IOC Group V (Africa and Arab countries)*	E
270.	*Second China-Africa Forum on Marine Science and Technology, 9-10 April 2015, Nairobi, Kenya*	*Under preparation*
271.	WESTPAC Workshop on Research and Monitoring of the Ecological Impacts of Ocean Acidification on Coral Reef Ecosystems. Phuket, Thailand, 19–21 January 2015	E ***(electronic copy only)***
272.	Second IOCAFRICA Planning Meeting for the Second International Indian Ocean Expedition (IIOE-2), 6-8 October 2015, Catembe, Mozambique	E ***(electronic copy only)***
273.	Initiative de LOANGO : Atelier de la sous-région sur l'érosion côtière en Afrique centrale, Loango, République du Congo, 6–10 octobre 2008	F
274.	First Session of the Advisory Group for the Ocean Data and Information Network for the WESTPAC Region (ODINWESTPAC), Tianjin, China, 27-28 January 2016	E
275.	Scientific meeting of experts for coordinated scenario analysis of future tsunami events and hazard mitigation schemes for the South China Sea region, Xiamen, China, 16–18 November 2015	E
276.	Sources of Tsunamis in the Caribbean with Possibility to Impact the Southern Coast of the Dominican Republic, Santo Domingo, Dominican Republic, 6–7 May 2016	E & S
277.	VI IOC Regional Science Planning Workshop on Harmful Algae in the Caribbean and Adjacent Regions, Santo Domingo, Dominican Republic, 26-30 October 2015 / COI – VI Taller Regional de Planificación Científica sobre Algas Nocivas en el Caribe y Regiones Adyacentes, Santo Domingo, República Dominicana, 26-30 Octubre 2015	E/S
278.	Tsunami Hazard in Central America: Historical Events and Potential Sources. Meeting of Experts, San José, Costa Rica, 23-24 June 2016	E
279.	2nd International Conference on Marine/Maritime Spatial Planning, 15-17 March 2017, UNESCO, Paris	E
280.	Information Meeting on North-Eastern Atlantic, the Mediterranean and Connected Seas Tsunami Early Warning and Mitigation System (NEAMTWS) and NEAMWave 17 Tsunami Exercise: Summary Recommendations, Tunis, Tunisia, 13-14 September 2017	E/F/Ar
281.	Workshop on Sea-Level Measurements in Hostile Conditions, Moscow, Russian Federation, 13–15 March 2018	E/R
282.	IODE/OBIS-Event-Data workshop on animal tagging and tracking, Ostend, Belgium, 23–26 April 2018	E
283.	Sixth International XBT Science Workshop, Ostend, Belgium, 18–20 April 2018	E
284.	Sargassum and Oil Spills Monitoring Pilot Project for the Caribbean and Adjacent Regions Workshop, Mexico DF, Mexico, 2–4 May 2018	E
285	Drafting Workshop for the development of a training and Repository Portal for the Caribbean Large Marine Ecosystem	E

No.	Title	Languages
286.	Preparing for the Next Tsunami: Reducing Losses and Damages in the Coastal Western Mediterranean Areas: Summary Recommendations, Rabat, Morocco, 15-16 November 2018	E/F/Ar
287	Workshop on Sea level Data Archaeology, UNESCO, Paris, 10–12 March 2020	E
288	Workshop on data sharing between UN agencies as a contribution to the UN decade of ocean science for sustainable development, Online meeting, 20 April 2020, 14:00-16:30	E