World Meteorological Organization
Weather • Climate • Water

OCEANS AND THE LAW OF THE SEA: REPORT OF THE SECRETARY-GENERAL – PART II (2014)

CONTRIBUTION OF WMO

INTRODUCTION

1. The World Meteorological Organization (WMO)[1] is the United Nations system's authoritative voice on the state and behaviour of the Earth's atmosphere, its interaction with the oceans, the climate it produces and the resulting distribution of water resources. The interaction of the atmosphere with the oceans, which plays a critical role in shaping our climate through phenomenon such as El Niño and La Niña, lies therefore at the heart of the mission of WMO.

2. WMO is active in operational ocean forecasting in collaboration with the Intergovernmental Oceanographic Commission of UNESCO (IOC/UNESCO) through the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM).[2] WMO cooperates with the International Maritime Organization (IMO) and the International Hydrographic Organization (IHO), to provide marine safety services, in particular the World-Wide Metocean Information and Warnings Service.

3. Through its participation in the Global Ocean Observing System (GOOS),[3] the Global Climate Observing System (GCOS),[4] the World Climate Research Programme (WCRP)[5] and the Ocean Observations Panel for Climate (OOPC),[6] WMO is engaged in ocean observations and research for climate. As part of the Joint Group of Experts on Scientific Aspects of Marine Environmental Protection (GESAMP),[7] WMO contributes to marine environmental assessments, including on atmospheric inputs of chemicals to the ocean and impacts of dust transport and deposition on marine productivity.

4. In collaboration with the Food and Agriculture Organization (FAO), WMO supports studies on the impacts of climate change on marine productivity and fisheries. WMO is also a major information source on CO_2 concentrations in the atmosphere in relation to ocean acidification, as oceans absorb about 30 per cent of carbon dioxide produced by humans, buffering the impacts of global warming. WMO is currently working to improve forecasting and warning services for coastal inundation to address the needs of coastal states, especially Small Island Developing States (SIDS), and to develop climate services for marine and coastal communities, including for coastal adaptation and disaster risk reduction. In this regard, the Global Framework for Climate Services (GFCS),[8] a UN partnership led by WMO, guides the development and application of science-based

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1 See http://www.wmo.int/pages/index_en.html.
2 See http://www.jcomm.info/index.php?option=com_content&view=featured&Itemid=100001.
3 See http://www.ioc-goos.org/.
4 See http://www.wmo.int/pages/prog/gcos/index.php.
5 See http://www.wcrp-climate.org/.
6 See http://ioc-goos-oopc.org/.
7 See http://www.gesamp.org/.
8 See http://gfcs.wmo.int/.

climate information products and services in support of decision-making. The GFCS has four initial priority sectors, agriculture and food security, water, health and disaster risk reduction, which address directly climate-related ocean and coastal issues.

DEVELOPMENTS RELATING TO INTERNATIONAL SHIPPING ACTIVITIES

5. WMO plays its core role as authoritative voice for weather and climate information by ensuring safe navigation and timely response for marine emergency situations. Weather and sea information within the Global Maritime Distress and Safety System (GMDSS) is provided in the framework of the World-Wide Metocean Information and Warning Service (WWMIWS) coordinated by the WMO, in parallel with the World-Wide Navigation Warning Service (WWNWS) coordinated by IMO and IHO, for the implementation of the International Convention for the Safety of Life at Sea (SOLAS). An important application of ocean forecasting and analysis is to provide more reliable and timely information on dangerous sea state in open ocean and coasts (e.g. ports), through the WWMIWS framework.

6. The WMO Executive Council at sixty-fifth session (Geneva, 15–23 May 2013)[9] recognized that the WWMIWS introduced the role of METAREA Coordinators and identified their responsibilities to ensure that the provision of met-ocean information and warnings is consistent in meeting the obligations of SOLAS and the need to ensure consistency with other aspects of safety information provided under SOLAS, in particular navigation warnings provided under the auspices of IHO and coordinated by NAVAREA Coordinators. The Council also recognized the need of ensuring maritime weather and sea ice safety services, including the operational service in five new Arctic Ocean METAREAs, and underlined the need of coordination between WMO, IOC/UNESCO, IHO and IMO for the provision of tsunami warnings on the SafetyNet system.

7. In this context a review of the overall structure of the *Manual on Marine Meteorological Services* (WMO-No. 558)[10] and the *Guide to Marine Meteorological Services* (WMO-No. 471) is ongoing by WMO with a view of developing clear guidelines for Members for the preparation or issuing services for the GMDSS Marine Broadcasting System.

8. In April 2013, WMO signed a Memorandum of Understanding with the International Mobile Satellite Organization (IMSO) to strengthen their cooperation in improving safety at sea. According to the Memorandum of Understanding the two organizations will collaborate on matters such as the use of satellite telecommunication services for the collection and dissemination of marine meteorological and oceanographic data to promote the safety of life and property at sea and the safe and efficient operation of ships.

MARINE SCIENCE AND TECHNOLOGY

Marine science, observations and services

9. The GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC) is charged with delivering requirements for the Ocean Component of GCOS (which has sibling atmosphere and terrestrial panels), the physics variables for GOOS (which is establishing sibling biogeochemistry and biology panels), and observations for the World Climate Research Programme (WCRP) in addition to scientific advice to the Joint WMO-IOC Commission for Oceanography and Marine Meteorology (JCOMM). OOPC takes a systems approach to evaluating observing system design based on requirements, and reviewing its implementation. Due to the many connections OOPC

[9] See ftp://ftp.wmo.int/Documents/PublicWeb/mainweb/meetings/cbodies/governance/executive_council_reports/english/pdf/1118_en.pdf.

[10] See https://www.wmo.int/e-catalog/detail_en.php?PUB_ID=306.

needs to make, the sixteenth OOPC session (Washington D.C., 3-5 September 2013)[11] has developed a work plan for 2013–2018 as a framework to inform engagement with partners and focusing panel activities around priority system evaluations.

10. An evaluation of the Tropical Pacific Observing System (TPOS) has been the priority activity in 2013/14, culminating in a TPOS 2020 workshop at Scripps Institution of Oceanography (San Diego, 27–30 January 2014)[12] to address the adequacy and sustainability of TPOS and its TAO-TRITON[13] mooring array in relation to current and future observation needs in the tropical Pacific Ocean. Future priorities include: sustained observations of boundary currents, observations for improving air sea flux estimates, and integrating open ocean to coastal observing. In addition, OOPC takes a variables review of observing system performance against requirements, for quality of ocean temperature measurements relative to requirements. OOPC will be working with the GOOS biogeochemistry and biology panels to ensure that their requirements for underpinning physics/environmental information are met.

11. The next OOPC meeting will be held in Barcelona, Spain, on 22–24 July 2014. The suggested agenda will be on the development of the next GCOS and new GOOS Implementation Plans, assessing the requirements for and implementation of Essential Climate Variables (ECVs), debriefing from the TPOS Workshop, and the development of more effective observing system metrics to communicate the performance of the observing system relative to requirements.

12. The world's oceans are of great importance to society, and information about the current state of the ocean has many existing and potential applications. In this context, ocean forecasting and analysis are key tools to maximize the benefit to society; in support of the safety of life and property at sea and in coastal areas, risk management for ocean-based economic / commercial / industrial activities, the prevention and control of marine pollution, sustaining healthy and productive oceans, and developing integrated coastal area management services. Efforts of the research communities for the past decades have achieved significant improvement in ocean forecasting and analysis, providing sound understanding on the ocean dynamics and marine ecosystem behaviour. Moving forward, several ocean forecast systems presently are in operation producing analyses and forecasts of the ocean state in near-real time.

13. Building on these developments, WMO and IOC/UNESCO jointly coordinate through JCOMM global efforts to implement operational ocean forecasting services, through; (a) developing technical guidance for modelling and data assimilation; (b) improved data flow between real time observations, new observations and forecasting and analysis systems; (c) enhanced coordination of review requirements as well as performance verification for operational forecasting systems and services; and, (d) coordination of the development of coupled ocean-atmosphere forecasting systems and climate coupled models as needed. The research and operational communities are working in tandem, to ensure seamless transition of technologies into operation, and to keep abreast of the state-of-art knowledge in planning, producing and assessing the services and products. Following its fourth session (Yeosu, Republic of Korea, 23–31 May 2012), JCOMM has been working towards the completion of its work plan for the intersessional period, focusing on the following priorities: (a) sustainable observations; (b) data management and interoperability; (c) products and services including for coastal zones; (d) ocean forecasting; and (e) capacity development.

14. Within JCOMM, an ad hoc Task Team on JCOMM Coordination for Marine Environmental Emergency Responses was established in 2013 to support Members / Member States to respond to marine environmental emergencies, in particular by supporting responsible centres to extend their technical capabilities, exchange diagnostic and forecast data, as well as provide enhanced coordination for services and information provision in a way that meets requirements as defined by

[11] See http://www.ioc-goos.org/index.php?option=com_oe&task=viewEventRecord&eventID=1338&lang=en.
[12] See http://ioc-unesco.org/index.php?option=com_oe&task=viewEventRecord&eventID=1383.
[13] Tropical Atmosphere Ocean project, Triangle Trans-Ocean Buoy Network; See http://www.pmel.noaa.gov/tao/.

the International Atomic Energy Agency (IAEA) and IMO. The Task Team held its first meeting on 1 August 2013 in Vienna, Austria in conjunction with the Consultants meeting on marine and aquatic modelling for radiological emergencies (29–31 July 2013, Vienna, Austria), focusing on a system that tracks oceanic radioactive plumes using dispersion modelling should leverage the existing framework for tracking atmospheric radioactive hazards in operational Numerical Weather Prediction centres, operated in conjunction with atmospheric dispersion modelling infrastructures and expertise.[14]

15. WMO participates in the ITU-WMO-IOC/UNESCO Joint Task Force to investigate the potential of using submarine telecommunications cables for ocean and climate monitoring and disaster warning. On 19–20 March 2013 the Joint Task Force held in Madrid, Spain a workshop on Propelling a Pilot Project on Green Cables, which focused on the strategic steps for the pilot project to facilitate the deployment of dual-purpose submarine telecommunication cables in the high seas. The workshop explored scientific and societal needs, new engineering technology requirements, sensor standards and testing protocols, business opportunities, and legal implications, all to promote the development of submarine telecommunication cable projects that wish to be equipped with a suitable suite of sensors.[15]

16. To facilitate the transmission of tsunami alerts, the WMO Global Telecommunication System (GTS) provides an important dedicated network for the early warning systems coordinated by IOC/UNESCO. Close liaison with IOC/UNESCO in the development and monitoring of telecommunication networks for tsunami is ensured for establishing and monitoring user performance of an 'all hazards network' under the WMO Information System (WIS).

17. WMO is a partner in PEARL (Preparing for Extreme And Rare events in coastal regions),[16] a project funded by the 7th Framework Programme for Research and Technological Development (FP7) of the European Union (EU) that brings together world leading expertise in both the domain of hydro-engineering and risk reduction and management services to pool knowledge and practical experience in order to develop more sustainable risk management solutions for coastal communities focusing on present and projected extreme hydro-meteorological events. The project will examine seven case studies from across the EU to develop a holistic risk reduction framework that can identify multi-stressor risk assessment, risk cascading processes and strengthen risk governance by enabling an active role for key actors. The research programme links risk and root cause assessment through enhanced FORIN methodology, event prediction, forecast and warning, development of adaptive structural and non-structural strategies and active stakeholder participation. The project aims to develop novel technologies and methods that can improve the early warning process and its components; it builds a pan-European knowledge base gathering real case studies and demonstrations of best practice across the EU to support capacity development for the delivery of cost-effective risk-reduction plans. Additionally, the project provides an interface to relevant ongoing tsunami work: it plugs into global databases, early warning systems and processes at WMO, and contributes to community building, development of guidelines and communication avenues at the global level through the International Water Association (IWA). In the PEARL, within a consortium of 24 partners led by UNESCO Institute for Water Education (UNESCO-IHE), WMO takes the lead of Work Package 7 for dissemination, mainly to apply the developed framework and tools through the Integrated Flood Management (IFM).

18. WMO is also a partner in the RISC-KIT (Resilience-Increasing Strategies for Coasts - toolKIT),[17] a project coordinated by the Deltares (the Netherlands) that focuses on low-frequency,

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[14] For the report see http://www.jcomm.info/index.php?option=com_oe&task=viewDocumentRecord&docID=11482.

[15] See http://www.itu.int/en/ITU-T/Workshops-and-Seminars/gsw/201309/Pages/programme-19-20-Sep.aspx.

[16] See http://cordis.europa.eu/projects/rcn/111109_en.html and https://www.unesco-ihe.org/news/unesco-ihe-starts-research-project-pearl-develop-risk-management-strategies-coastal-regions.

[17] See http://cordis.europa.eu/projects/rcn/110483_en.html and http://www.deltares.nl/en/news/news-item/item/16418/new-toolkit-improves-coastal-protection.

high-impact hydro-meteorological events. Until 2017, eighteen partners (from ten countries and two international organizations including WMO) will deliver ready-to-use methods, tools and management approaches to reduce risk and increase resilience, through the development of open-source and free-ware RISC-KIT that will consist of: (a) a Coastal Risk Assessment Framework (CRAF) which can quickly assess present and future hot spot areas of coastal risk at a region scale due to multi-hazards; (b) a quantitative, high-resolution EWS/DSS for use on these hot spots; (c) a web-based management guide offering innovative, cost-effective, ecosystem-based DRR measures; and (d) a Coastal Risk Database of present and historic socio-economic and physical data. These tools will enable Europe's coastal managers, decision-makers and stakeholders to identify hot spot areas; produce timely forecasts and early warnings; evaluate the effect of climate-related, socioeconomic and cultural changes on coastal risk; and choose the best prevention, mitigation and preparedness measures for their coast. Through the RISC-KIT, WMO is working with other partners on a case study (Sandwip Island, Bangladesh) to demonstrate the applicability of the CRAF to non-European environments, adding to the hydro-meteorological data collection. The RISC-KIT will be implemented in close coordination with the Bangladesh national sub-project for WMO Coastal Inundation Forecasting Demonstration Project (CIFDP-B) (*see paragraphs 35 ff.*).

SUSTAINABLE DEVELOPMENT OF OCEANS AND SEAS

Scientific information and assessments to support decision-making

19. A significant body of oceanographic research of direct benefit for decision-making in climate related risks is spearheaded and coordinated by the WMO-IOC/UNESCO-ICSU co-sponsored World Climate Research Programme (WCRP).[18] Continuing contribution of research to development of observing systems in all oceans of the world, synthesis of the oceanographic data into quality-controlled and user-friendly information, validation of ocean models and their coupling with models of other components of the Earth System made it possible to conduct globally coordinated predictive experiments for the future state of climate system and project how it will evolve under different emission scenarios. In 2010–2013, under the auspices of the WCRP Coupled Model Intercomparison Experiment Project (CMIP5), more than 20 modelling centres produced a set of such complex predictions and made their results freely available to scientists worldwide. More than 350 articles were published using this unprecedented dataset. Many of them were reviewed in the most recent Report of IPCC entitled "Climate Change 2013: The Physical Science Basis", which was unveiled in September 2013.[19]

20. Oceanographic research in support of decision-making is developing especially fast in relation to the regional sea-level rise. While the global mean sea level is expected to rise in the 21st century up to approximately 80 cm, depending on the carbon emissions, the CMIP5 projects high regional variability of this increase. These results are corroborated by observations showing an increasing pace of sea-level rise with maximum around the Philippines. There is significant and unavoidable uncertainty in estimates and predictions of sea level and many other variables describing the future climate, and it is therefore extremely important that decision makers are able to take this uncertainty into account. Development of scientific methods for treatment of uncertainty in climate-related decision-making is one of key subjects of research conducted by WCRP in support of the emerging Global Framework for Climate Services (GFCS) (*see paragraphs 27 ff.*).

SMALL ISLAND DEVELOPING STATES

21. The Programme of Action for the Least Developed Countries for the Decade 2011–2020 adopted by the Fourth United Nations Conference on the Least Developed Countries (Istanbul, Turkey, 9–13 May 2011) and the WMO Programme for Least Developed Countries, adopted by the

[18] See http://www.wcrp-climate.org/.
[19] See http://www.ipcc.ch/.

World Meteorological Congress at its fourteenth session (Geneva, 5–24 May 2003)[20] include those that are SIDS. In this context, during 2013 WMO undertook the following specific activities: (a) contribution and organization of Second Meeting of the Pacific Meteorological Council (Nadi, Fiji, 1–5 July 2013); (b) provision of advisory and training services to WMO Regional Training Centres (RTCs);[21] and (c) support for specialized training in applications.

22. For the Global Framework for Climate Services (GFCS) see paragraphs 32 f.

CLIMATE CHANGE AND OCEANS

Mitigating the impacts of climate change

23. Carbon dioxide is the single most important anthropogenic greenhouse gas in the atmosphere.[22] It contributes ~64% to radiative forcing by long-lived greenhouse gases since pre-industrial time (1750). It is responsible for ~84% of the increase in radiative forcing over the past decade and ~82% over the past five years. The pre-industrial level of ~278 ppm represented a balance of fluxes between the atmosphere, the oceans and the biosphere. Observations at the marine and terrestrial ground based stations contributing to the Global Atmosphere Watch (GAW) Programme of WMO are used to assess globally averaged levels of CO_2 in the lower atmosphere. The sites (about 120) are operated by WMO Members.

24. Atmospheric CO_2 reached 141% of the pre-industrial level in 2012, primarily because of emissions from combustion of fossil fuels, deforestation and other land-use change. The globally averaged CO_2 mole fraction in 2012 was 393.1±0.1 ppm. The increase in annual mean since 2011, 2.2 ppm, is greater than the increase from 2010 to 2011, the average growth rate for the 1990s (~1.5 ppm/yr) and the average growth rate for the past decade (~2.0 ppm/yr). Since the industrial revolution about 375 billion tonnes of carbon have been emitted to the atmosphere as CO_2 from fossil fuel combustion and cement production. Atmospheric measurements show that about half of this CO_2 remains in the atmosphere and that, so far, the ocean and terrestrial sinks have steadily increased. Uptake of CO_2 by the ocean leads to ocean acidification. Observations show that trends in ocean pCO_2 align with those in the atmosphere and show the "other side of CO_2 story". Starting in 2014, the *WMO Greenhouse Gas Bulletin* will include an insert on ocean acidification prepared with the collaboration of IAEA Ocean Acidification International Coordination Centre (OA-ICC) and IOC/UNESCO.

25. At it sixteenth session (Antalya, Turkey, 20–26 November 2013), the WMO Commission for Atmospheric Sciences noted that higher density and complexity greenhouse gas (GHG) observational network and better coordination of efforts with developments in other Earth system components such as the biosphere and the oceans are needed to provide actionable information to WMO Members on GHG emission control.[23] The Commission requested Members to undertake the necessary steps in the development of these high-quality observations for them to be compatible with the established GAW network and to improve the modelling tools to implement Integrated Greenhouse gas Information System (IGIS). The Commission agreed that WMO Programmes have a confirmed capacity to develop the atmospheric part of IGIS but it also stressed that full implementation of IGIS would require the established collaboration with other international organizations and coordination bodies, e.g., working together with GEO-Carbon,[24] GCOS and the Committee on Earth Observation Satellites (CEOS).

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[20] See ftp://ftp.wmo.int/Documents/PublicWeb/mainweb/meetings/cbodies/governance/congress_reports/english/pdf/960E.pdf.

[21] See http://www.wmo.int/pages/prog/dra/etrp/rtcs.php.

[22] See *WMO Greenhouse Gas Bulletin* no. 9, 6 November 2013 (http://www.wmo.int/pages/prog/arep/gaw/ghg/documents/GHG_Bulletin_No.9_en.pdf)

[23] See document CAS-16/Doc. 9 REV 1 APPROVED (https://docs.google.com/a/wmo.int/file/d/0B-qM81H4lhk-b1pnek90WUhMQkk/edit), section 9.3.

[24] See http://www.geocarbon.net/.

26. WMO views the potential ramification of geoengineering experiments as risky, especially considering the current uncertainties, gaps in scientific understanding of cause and effect, and the lack of comprehensive governance mechanisms. At it sixteenth session (Antalya, Turkey, 20–26 November 2013), the WMO Commission for Atmospheric Sciences noted that further research is needed to adequately understand the feasibility, the effectiveness and comprehensive effects of geoengineering.[25] The Commission advised that WMO should facilitate a process towards establishment of an international assessment mechanism for geoengineering research and applications, through the UN system. To address this, WMO and its partners will formulate a geoengineering position based on current scientific understanding and propose research actions to strengthen the science-basis to better inform decisions. In addition WMO is of the opinion that the future will require a UN-wide framework to govern these activities as consequences could be global and irreversible, involving the atmosphere, land and oceans.

Adapting to the impacts of climate change

27. Information products and services based on climate predictions at the regional and sub-regional scales can play an important role in adapting to climate change and supporting climate-sensitive sectors. The need of adapting to climate change and supporting climate-sensitive sectors (e.g. fisheries, tourism) in coastal regions and SIDS will require the development of specific climate products and services.

28. Launched at the Third World Climate Conference (WCC-3) (Geneva, 31 August – 4 September 2009),[26] the Global Framework for Climate Services (GFCS) is a global partnership of governments and organizations that produce and use climate information and services. At the extraordinary session of the World Meteorological Congress (Geneva, 29–31 October 2012),[27] the Intergovernmental Board on Climate Services (IBCS) was established and the GFCS implementation plan was adopted. The IBCS held its first session in Geneva on 1–7 July 2013 (IBCS-1).[28]

29. The GFCS aims to enable society to manage better the risk and opportunities arising from climate variability and change especially for those who are the most vulnerable to climate related hazards by developing and incorporating science-based climate information into planning, policy and practice. The agriculture and food security and water areas of GFCS deal directly with ocean and seas matters. The GFCS is already supporting various countries around the world. For example, Belize, with the support of GFCS, is in the process of establishing a climate services framework at national level to produce and use climate information and services including for the energy, tourism, citrus and sugar sectors.[29]

30. Climate services can help managing the freshwater-ocean interface, including storm-surges and waves and coastal inundation forecasting. The WMO Associated Programme on Flood Management,[30] which contributes to GFCS, focuses on the major water-related challenges in

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[25] See document CAS-16/Doc. 9 REV 1 (https://docs.google.com/a/wmo.int/file/d/0B-qM81H4lhk-b1pnek90WUhMQkk/edit), section 9.6.

[26] See http://www.wmo.int/wcc3/page_en.php. At WCC-3 13 heads of state/heads of government, 81 ministers and 2500 scientists unanimously agreed to develop the GFCS. A High Level Task Force (HLT) was then formed to propose elements for the GFCS. The HLT produced the report "Climate Knowledge for Action: A Global Framework for Climate Services" (http://www.wmo.int/hlt-gfcs/downloads/HLT_book_full.pdf) as the basis for GFCS. The Task Team, set up by the Sixty-third session of WMO Executive Council (Geneva, 6–8 June 2011) (ftp://ftp.wmo.int/Documents/PublicWeb/mainweb/meetings/cbodies/governance/executive_council_reports/english/pdf/63_session_1078_part1_en.pdf), developed the draft implementation plan and suggested the governance structure of the GFCS. During the same year, the GFCS office was set up within the WMO Secretariat.

[27] See http://library.wmo.int/pmb_ged/wmo_1102_en-p1.pdf.

[28] See http://ibcs-1.wmo.int/.

[29] See http://gfcs.wmo.int/content/national-consultation-belize.

[30] See http://www.apfm.info/.

relation to water management including in the coastal zone. A better understanding of climate and its impacts on coastal and oceanic fisheries is critical to the future management of these valuable resources for subsistence and market-based economies, and cultures. Developing countries and SIDS that depend heavily on fish for food and exports will also need special assistance in adapting to the effects of climate change on oceanic fisheries; in this regard, climate services can play an important role.

31. WMO Commission for Agricultural Meteorology (CAgM) and JCOMM are committed to improving access to and use of weather and climate data and products relevant to fisheries management. Interdisciplinary cooperation is needed to advance science on climate-to-fish-to-fisheries. The WMO-led International Workshop on Climate and Oceanic Fisheries (Rarotonga, Cook Islands, 3–5 October 2011)[31] was organized to contribute to this process. Many of the Pacific Island countries and territories depend heavily on oceanic fisheries and need to rely on the assistance of interdisciplinary teams to plan the sustainable use of their fisheries resources.

32. A Regional Workshop on Climate Services at the National Level for small island developing states in the Caribbean was organized by WMO in Port of Spain, Trinidad and Tobago, on 29–31 May 2013. The workshop brought experts from the National Meteorological and Hydrological Services (NMHSs) and stakeholders together along with key decision-makers. It facilitated the identification of appropriate mechanisms and networks to improve and sustain the flow of climate information for different users. Thus, it (a) enhanced understanding of the needs for climate services in different user sectors; (b) improved knowledge of the existing interface mechanisms and provided recommendations for improvements where needed; (c) cleared understanding of capacity development needs to implement the GFCS at regional and national levels; and (d) strategic guidance on institutional arrangements, partnerships and processes required to operationalize the GFCS at the national level.

33. As part of a project funded by Canada that aims at enhancing capabilities of countries to understand, anticipate, prepare for and cope with the positive and negative impacts of climate variability and change, GFCS in partnership with the Secretariat of the Pacific Regional Environment Programme (SPREP) and key partners are organizing the Regional Consultation on Climate Services for SIDS in the Pacific from 31 March to 4 April 2014 in Rarotonga, Cook Islands.[32] One of the main objectives will be to identify concrete follow up actions to enable climate services in SIDS in the Pacific. The results of the consultation will be made available at the Third UN Conference on Small Island Developing States (Apia, Samoa, 1–4 September 2014).

34. Climate change affects coastal areas in a variety of ways; sea level rise, changes in the frequency and intensity of storms, increases in precipitation, and warmer ocean temperatures. The impacts of climate change are likely to worsen many problems in coastal zones, in particular, coastal inundation and associate disasters. They are increasing threats to the lives and livelihoods of people, living in low-lying, highly-populated coastal areas.[33]

35. WMO implements the Coastal Inundation Forecasting Demonstration Project (CIFDP),[34] to meet challenges of coastal communities' safety and to support sustainable development through enhancing coastal inundation forecasting and warning systems that are embedded in the national disaster management. This project aims to support countries to establish an integrated forecasting system on coastal inundation based on interdisciplinary collaboration between scientists, operational forecasters, coastal disaster managers and institutional end-users. Upon completion of national sub-projects of CIFDP, countries aim to implement an operational system for integrated coastal inundation forecasting and warning, providing objective basis for coastal disaster (flooding)

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[31] See http://www.wmo.int/pages/prog/wcp/agm/meetings/wofish11/index.php.
[32] See http://gfcs-climate.org/content/regional-consultation-gfcs-small-island-developing-states-pacific.
[33] See *WMO statement on the status of the global climate in 2012* (http://www.wmo.int/pages/prog/wcp/wcdmp/documents/WMO_1108.pdf) and *2010-2010: a decade of climate extremes* (http://library.wmo.int/pmb_ged/wmo_1103_en.pdf).
[34] See http://www.jcomm.info/CIFDP.

management; contributing to saving lives; reducing loss of livelihood and property; and enhancing resilience and sustainability in coastal communities.

36. The focus is to improve capabilities for operational monitoring and forecasts/warnings on coastal inundation from combined extreme events, such as extreme sea level rise (e.g. large waves, storm surges, high tide), fluvial flooding and tropical cyclones, and furthermore, for decision support system for emergency management Benefits of CIFDP implementation to countries are not only to enhance capacity of NMHSs for coastal risk warning, but also to improve interaction with users of the NMHSs' information services – primarily national disaster managers and decision makers. The CIFDP is implemented at national level by operational forecasting agencies, under the WMO framework and with technical guidance provided by WMO Groups of Experts. As of January 2014, five (5) national sub-projects of CIFDP are under way – Bangladesh, Dominican Republic, Fiji, Indonesia and Shanghai/China, in view of further extension to other countries that express their need for such a project.

37. For other projects related to coastal inundation see paragraphs 17 f.

INTERNATIONAL COOPERATION AND COORDINATION

38. WMO actively participated in UN-Oceans activities and processes throughout 2013 and attended the eleventh meeting of UN-Oceans (New York, 17 June 2013) and contributed to the preparation of the TST Issues Brief: Oceans and Seas for the eighth session of the Open Working Group on Sustainable Development Goals (New York, 3–7 February 2014).

ACRONYMS

CAgM	WMO Commission for Agricultural Meteorology
CEOS	Committee on Earth Observation Satellites
CIFDP	Coastal Inundation Forecasting Demonstration Project
CMIP	Coupled Model Intercomparison Experiment Project
ECV	Essential Climate Variables
EU	European Union
FAO	Food and Agriculture Organization
GAW	Global Atmospheric Watch
GCOS	Global Climate Observing System
GESAMP	Joint Group of Experts on Scientific Aspects of Marine Environmental Protection
GFCS	Global Framework for Climate Services
GHG	Greenhouse gas
GMDSS	Global Maritime Distress and Safety System
GOOS	Global Ocean Observing System
GTS	Global Telecommunication System
IAEA	International Atomic Energy Agency
ICSU	International Council for Science
IFM	Integrated Flood Management
IGIS	Integrated Greenhouse gas Information System
IHO	International Hydrographic Organization
IMO	International Maritime Organization
IMSO	International Mobile Satellite Organization
IOC/UNESCO	Intergovernmental Oceanographic Commission of UNESCO
IPCC	Intergovernmental Panel on Climate Change
ITU	International Telecommunications Union
IWA	International Water Association
JCOMM	Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology
NMHS	National Meteorological and Hydrological Services
OA-ICC	Ocean Acidification International Coordination Centre
OOPC	Ocean Observations Panel for Climate
PEARL	Preparing for Extreme And Rare events in coastal regions
SIDS	Small Island Developing States
SOLAS	International Convention for the Safety of Life at Sea
SPREP	Secretariat of the Pacific Regional Environment Programme
TAO	Tropical Atmosphere Ocean
TRITON	Triangle Trans-Ocean Buoy Network
TROS	Tropical Pacific Observing System
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNESCO/IHE	UNESCO Institute for Water Education
WCC-3	Third World Climate Conference
WCRP	World Climate Research Programme
WIS	WMO Information System
WMO	World Meteorological Organization
WWMIWS	World-Wide Metocean Information and Warning Service
WWNWS	World-Wide Navigation Warning Service