MARINE AND BRACKISH WATER OBSERVATION SYSTEMS, NETWORKS AND EXISTING DATABASES

K.G. Adham
Zoology Department, Faculty of Science, University of Alexandria, Egypt

Keywords: marine, brackish-water, seas, oceans, real-time observation, necessity, sustainable, operational, integrated, agenda 21, chapter 17, restoring ecosystems, public health, technical topics, volunteer observing ships, geophysical data, data acquisition and processing, ocean profiling system, polarimetric infrared imaging, observation devices, seismic, broadband seismometer, earthquake recording system, optical disk, pilot projects, national, international, intergovernmental, organizations, agencies, institutions, existing databases, data management systems, datums, La Niña, El Niño, Ocean Hemisphere Network, Texas Coastal Ocean Observation Network, Water Level Observation Network for Latin America, Mediterranean Regional Subsystem of the Global Sea Level Observing System.

Contents

Summary

Marine and brackish water ecosystems and resources, especially those with high biodiversity, are being threatened by many anthropogenic activities. Urgent assistance is required to conserve these vital resources and implement sustainable management. One of the main objectives of the marine and brackish water monitoring system is to ensure effective planning, establishment and coordination of an operational observing system of ocean and all seas, to provide the information needed for oceanic and atmospheric forecasts. This is because ocean observations are needed for terrestrial weather prediction and for analysis and prediction of sea state and ocean weather. If the integrity of the ocean system has not been paid careful attention, all life would be expected to begin a final death spiral. The key to survival is in the sea. This chapter summarizes the main features of the observation mission of seas and oceans with special emphasis on the role of the oceans in global change research. It also highlights the efforts of worldwide agencies and actors and the characteristics of global observation systems that are capable of operating in real-time.

1. Introduction

In recent years, progress in science and technology has contributed to the increasingly prosperous way of life for many communities. On one hand, such progress brought about many benefits to human beings; on the other hand, it resulted in significant changes in the global environment. Saline waters such as seawater and brackish water, of which the storage potential is estimated to be as much as 97.5% of all the water on the earth, may have an increasingly important role, in the twenty-first century, in the water-resource plans of arid to semi-arid countries.

Ocean, land and atmosphere are interrelated earth systems that are strongly affected by the consequences of human population growth, industrialization, and demand for natural resources. The marine environment—including the oceans and all seas and adjacent coastal areas—forms an integrated whole that is an essential component of the global life-support system and a positive asset that presents opportunities for sustainable development (Agenda 21, Chapter 17), as adopted by the Plenary Session of the Earth Summit in Rio de Janeiro, on June 14, 1992.

Oceans and coastal waters comprise over 70% of the surface of the planet, so it is not surprising that humans depend strongly on the sea as a source of food, for transportation and trade, and for several other uses. Further, the ocean strongly affects large-scale weather patterns, as so forcefully demonstrated by El Niño and La Niña events.

It has long been recognized that the oceans critically affect human activities. Winds, waves, ice, ocean currents, and the hurricanes and typhoons that develop at sea have always affected cargo, fishing, and military ships at sea. Changes in the environment need to be monitored to mitigate damage based on these measurements and to anticipate future changes to the environment. Primitive ocean observation systems were initiated centuries ago to measure and try to predict these phenomena. However, the ocean is currently monitored far less effectively and completely than terrestrial systems.

A sustained observation program to detect, track, and predict changes in physical and biological systems and their effects is needed to measure the impacts of humans on the ocean as well as the impact of the ocean on human endeavors. In order to understand and ultimately predict how the ocean-atmosphere interaction affects weather and climate, and how human activities affect both the physical system and living marine resources, an integrated ocean observing system is needed to monitor the 'state' of the ocean.

There are already many observing systems and monitoring programs in place. These systems provide data that help mitigate losses to life and property, enhances profits to industry, ensures national security and provides information to mitigate anthropogenic changes to the environment. However, these observing elements are not integrated and do not constitute a complete system. In other words, they are not as cost effective as they could be; neither do they serve the complete needs of users.

Existing Earth observation systems were designed for specific, limited purposes. As research programmes addressing global change have gathered momentum, it has become increasingly clear that these observation systems do not suffice for monitoring the Earth system as a whole. Nor do they adequately meet many of the basic observational needs of Earth system research. Hence, for the first time in history, scientists are making plans for a continuous 'health check' of the environmental status of the planet.

International law, as reflected in the provisions of the United Nations Convention on the Law of the Sea (1999) referred to in chapter 17 of Agenda 21, sets forth rights and obligations of States and provides the international basis upon which to pursue the protection and sustainable development of the marine and coastal environment and its resources. This requires new approaches to marine and coastal area management and development, at the national, subregional, regional and global levels.

In concert with international sponsoring organizations, scientists are developing three interconnected global observing systems—for climate, the oceans, and the land. ICSU is involved in the design phase of each of these systems, providing scientific support and ensuring that research needs for data are met. New approaches to marine and coastal area management and development are required at the national, subregional, regional and global levels. These approaches are integrated in the following programme areas: (a) Integrated management and sustainable development of coastal areas, including exclusive economic zones; (b) Marine environmental protection; (c) Sustainable use and conservation of marine living resources of the high seas; (d) Sustainable use and conservation of marine living resources under national jurisdiction; (e) Addressing critical uncertainties for the management of the marine environment and climate change; (f) Strengthening international, including regional, cooperation and coordination; (g) Sustainable development of small islands.

Implementation by developing countries of the activities set forth below shall be commensurate with their individual technological and financial capacities and priorities in allocating resources for development needs and ultimately depends on the technology transfer and financial resources required and made available to them.

2. Fundamentals of Observing Systems of Seas and Oceans

2.1. Background Approach (Agenda 21 Chapter 17)

In 1996, in the framework of the 28th International Geographical Congress "Land, Sea, and Human Effort" on August 4-10, the extended paper “Agenda 21 for Ocean Geography” was presented by A. Vallega discussing the role of geography in facing the need for inter-disciplinary and multi-spatial scale research. On the basis of this approach, the ocean subject was included in the 1996-2000 programme, adopted by the 19th General Assembly of the IGU (August 10), A. Vallega, as newly-elected Vice-president of IGU, was appointed to take care of this field. To deal with this task, the Oceans programme was drafted and discussed in a joint workshop (Paris, April 28-29, 1997) of the IGU and of the IOC. The programme was finalized and, on this basis, in 1998 the IGU-IOC Seminar “The role of ocean science and geography in facing ocean management for the third millennium” (Sagres, Portugal, September 3-5) was held. As a conclusion of that event, the Oceans 21 programme was adopted.

2.2. Conceptions of a Functional Observation System

The nature and complexity of the broad spectrum of economic and environmental issues faced by modern society has led to a wide array of government-sponsored measurement programs that are not cost-effective on regional to national scales. This calls for an integrated system that is responsive to a broad spectrum of user needs through the combined use of in situ and remote measurements of multidisciplinary environmental variables from shared use platforms. Moreover, secondary users can produce unforeseen added value (e.g. scientific uses of operational data collected for other purposes). The goal is a locally relevant, nationally coordinated, cost effective marine and brackish water observing systems for multiple, applied uses.

2.2.1. A Sustainable System

Arguably the most challenging problem for an ocean observing system is to maintain measurement programs for enough time to capture both episodic variations (e.g. storms) and the long-term variations and cycles required for planning, understanding, and action. Ocean scientists realize that long-period oceanic phenomena are usually more energetic than those with a shorter period, so longer records of sufficient resolution capture the more energetically significant tendencies. However, the degree of difficulty and commitment required to sustain consistent measurements over decades is tremendous. The observations must adapt to technological, institutional and economic change, as well as changing priorities.

It should come as no surprise that the innovative research environment, which embraces change, is poor at sustaining observing systems. Industry is innovative and sustains systems as needed but is focused on specific objectives, thus not encouraging integration. The observing system envisioned must be both integrating and sustaining while also fostering innovation. Perhaps no single sector of the government-industry-academic partnership is capable of achieving this goal. A combination of interests are needed to ensure that observing systems adapt to new technologies while maintaining continuity in time series of the quantities and qualities needed for general use.

Weather analysis/prediction requires sustained observations. Ocean observations are needed for terrestrial weather prediction and for analysis and prediction of sea state and ocean weather. Because the variability of the atmosphere and ocean occurs over a very large range of time scales, observations are needed for very long times if we are to separate natural from anthropogenic variability and begin to make predictions of phenomena affecting the ocean and its users. El Niño episodes contribute to large-scale temperature departures throughout the world, with most of the affected regions experiencing abnormally warm conditions during December-February. Some of the most prominent temperature departures include: 1) warmer than normal conditions during December-February across southeastern Asia, southeastern Africa, Japan, southern Alaska and western/central Canada, southeastern Brazil and southeastern Australia; 2) warmer than normal conditions during June-August along the west coast of South America and across southeastern Brazil; and 3) cooler than normal conditions during December-February along the Gulf coast of the USA.

National security is a full-time concern. An observing system cannot be put in a place only when and where it is needed, because background information has to be collected on the range of variability expected to encounter and also it has to be known in advance from where observations will be needed. In a training sense, the lulls in peacekeeping and war-fighting operations are opportunities for improving skills and tuning systems. The weather services observe and forecast the weather every day, no matter if the day will be good or stormy. They do this so they know how to do it when it is essential, and so the users of the weather information know how to obtain it and use it. Ocean observations are similar, especially for national security and marine weather prediction: it must be done every day, so it is accurate, timely, and useful when it is needed.

2.2.2. An Operational System

The elements of a typical system should meet certain criteria that, in effect, constitute a definition of what is meant by operational for this observing system. These elements could be summarized as:

- ***Relevant to needs***: Measurements should be in response to needs for information, including products derived from models.
- ***Long term***: Measurements, once begun, should continue into the foreseeable future. Continuity in the observed quantity is sought rather than in the method, and it is anticipated that more effective methods will become available with time.

- ***Systematic***: Measurements should be made in a rational fashion, with spatial and temporal sampling tuned to address the issues. Further, measurements should be made with the precision, accuracy, and care in calibration required to provide continuity in the quality of data in space and time even though different methodologies may be used.
- ***Subject to continuing examination***: Trade-offs must be subjected to evaluation on a continuing basis to take advantage of new knowledge and technology. Because of the scope and intended longevity of the observing system, it is realized that there are further practical constraints on the measurements.
- ***Cost effective***: To maximize the number of required observations using the available resources (financial and manpower), the observational methods used in the observing system must be economical and efficient.
- ***Timely***: The ability for users to access and retrieve observations with sufficient timeliness to meet their needs. Some requirements are for real-time data delivery. In other cases substantial quality control will require lapsed time between measurement and data delivery.
- ***Routine***: The observation tasks should be carried out by trained staff, responsible for acquisition and quality control of data and the dissemination of products. Thus for some variables, the collection of observations and related work may be integrated into agencies capable of making a long-term commitment; for other variables, the desired quality of routine observations may be best achieved by providing long-term support.

-
-
-

Bibliography

Agenda 21, Chapter 17 (1992). Report of the United Nations Conference on Environment and Development (Rio de Janeiro, 3-14 June 1992), No. A/CONF.151/26 (Vol. II). [A comprehensive report on the protection of oceans and all kinds of seas and the protection and rational use and development of the living resources].

CENR, Committee on Environment and Natural Resources (1997). Integrating the Nation's Environmental Monitoring and Research Networks and Programs: A proposed framework. Available Online: http://www.epa.gov/cludygxb/Pubs/framewrk.pdf. [Explores existing federal monitoring programs and proposes a method to integrate these programs across a range of temporal and spatial scales].

Cicin-Sain, B. and Knecht, R. W. (1998). *Integrated Coastal and Ocean Management (ICM):Concepts and Practices*. Washington, DC, Island Press. [Not a detailed "how-to" manual, but rather an introduction to the key concepts identified by various United Nations conferences and summits essential to a successful ICM plan].

IOC, Intergovernmental Oceanographic Commission (1998a). 'The Strategic Plan and Principles for the Global Ocean Observing System (GOOS)', GOOS Report 41, IOC/INF-1091, IOC, UNESCO, Paris, 17pp. [Provides guidance for the development of data and information management plans].

IOC, Intergovernmental Oceanographic Commission (1998b). 'Living Marine Resources Panel of the Global Ocean Observing System (GOOS)', IOC-WMO-UNEP-ICSU-FAO, Paris, France, 23-25 March 1998, GOOS Report No. 54. 16 pp + 5 annexes. [Describes changes in ecosystems over time, including fluctuations in abundance and spatial distribution of species].

Law of the Sea (1999). International Tribunal for the Law of the Sea: Saint Vincent and the Grenadines v. Guinea, Contribution by UNESCO/IOC to the Report of the Secretary General to the 54th Session of the General Assembly on Oceans and the Law of the Sea. Available Online: http://www.itlos.org/case_documents/2001/document_en_68.pdf. [That case arose out of the arrest and detention by Guinea of the oil tanker "*Saiga*", which was flying the flag of Saint Vincent and the Grenadines].

Malone, T. C. (1998). Coastal GOOS: What is it and why do it? EEZ Technology, **3**: 25-29. [Review of the challenges and progress with the Coastal Module of GOOS].

NOPP's funded project (2000). Toward a US Plan for an Integrated, Sustained Ocean Observing System. Available online: http://www.nopp.org/resources/nopp/towardintegrated.pdf. [This report addresses major US societal needs and sets the objectives for an integrated and sustained ocean observing system.]

Topics from NOAA (2001). Technical Topics of Ocean Observation Systems, Program Solicitation for Small Business Innovation Research, US Department of Commerce. Available Online: http://www.oar.noaa.gov/ORTA/SBIR [This program solicitation supports creative advanced research in scientific and engineering areas that encourages the conversion of government-funded research into a commercial application.]

Vallega, A. (2000). Oceans 21 - Science for Sustainable Use of Ocean and Coastal Zones. IOC-IGU Interdisciplinary Programme. Meeting of the Steering Committee and Advisory Committee, Seoul, August 13. Available online: http://www.geog.nau.edu/igust/oceans21wp.html [This paper presents how the 'Oceans 21' programme may be operated by the IGU Commissions/Study Groups].

Biographical Sketch

Khadiga G. Adham is a Professor of Environmental Physiology at the University of Alexandria, Egypt. Besides her teaching duties at the Department of Zoology including courses of zoology, physiology and immunology, she has numerous studies in the areas of toxicology and environmental science. She is leading an academic group the interest of whom is focused mainly on surveying the deteriorating ecosystems in the region including the Mediterranean coasts and the northern Nile Delta Lakes. Fully aware of the impact imposed by poor environmental conditions upon native fauna like several fish and invertebrate species, she is analyzing the interrelation between environmental and biological factors to support reform and conservation efforts. Dr. Adham has been to Germany in a dissertation supervision mission and was granted postdoctoral fellowships to UK and USA. At the North East Wales Institute, UK, she worked on heat shock protein 70. At the Virginia Institute of Marine Science, USA, she studied the pathologic factors leading to the sharp decline of a susceptible oyster species along the US east coast. Dr. Adham has collaboration projects with some US and German universities. During the congress "Global Threats to Large Lakes: Managing in an Environment of Instability and Unpredictability, IAGLR/ILEC" held in June 2003 at DePaul University, Chicago, Ill. USA, Dr. Adham was awarded the Ibaraki Kasumigaura Prize by Ibaraki Prefecture, Japan, for the most outstanding papers on lake conservation. Dr. Adham is also involved in charitable activity as Chairman of 'Woman' and 'Elderly House' Committees and 'Member of the Board of Directors', Mustafa Kamel Charity, Alexandria.