Chapter 30. Marine Scientific Research

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1. Introduction

A scientific understanding of the ocean is fundamental to carry out an effective management of the human a s01.72 5T9ea(a s01.72 5T9)10(e)phe s01.72 501 Tc 0.1552 Tw 31.05

marine environment and its resources, we need to know the geology and geophysics of ocean basins, the physical processes at work as the waters of the world's different oceans and seas move around, the input, distribution and fate of substances (both natural and artificial), the occurrence and distribution of flora and fauna (including

the assemblages and habitat dependencies that control the different ecosystems), the biological processes that regulate and sustain the productivity of ecosystems and the way in which all these elements interact. Marine scientific research is the main way in which we can move towards this goal.

From a more fundamental perspective, the ocean is still one of the least known areas of the world. Humanity in its search of understanding has reached beyond our solar system and seeks fundamental answers in the infinitely distant and in the infinitely small. It has been said that we know more about the morphological features on the surface of other planets publicly funded research for policy makers. From a more basic perspective, publicly funded projects in data intensive sciences, like earth sciences, geophysics, and genomics are requested to deposit and disseminate the raw data collected through open access repositories.

The traditional knowledge of those who work with the sea has, in many cases, built up over millennia an understanding of many of these elements. It is essential that this traditional knowledge also be incorporated in our overall understanding of the ocean. Marine scientific research has an important role in validating traditional knowledge and identifying emerging issues. Marine scientific research is therefore fundamental to achieving sustainable use of the oceans.

2. The scale and extent of marine scientific research

The scale and extent of marine scientific research are as wide as the scope of the World Ocean Assessment: every field that needs to be covered in an assessment of the state of the world's marine environment needs to be explored scientifically. This Assessment therefore shows the results of the work that is being done in all these fields and assesses the major gaps in information, thus pointing the way to judgements on priorities for further scientific research.

In order to obtain a full picture, it is necessary to consider where, by whom and how the scientific research is being done. This is not an easy task, because until now no systematic collection of this information has occurred, although the Intergovernmental Oceanographic Commission of UNESCO (IOC/UNESCO) has initiated a process to produce regularly a Global Ocean Science Report (GOSR) aiming to conduct a global and regional assessment of capacity development needs in the field of marine science research and ocean observations.

One starting point is the question of who is doing this research. The IOC

Table 1. Regions of study of IOC experts

Area of Study declared by experts	Experts located in a coastal State of Area of Study	Experts located elsewhere	Total number of experts declaring an interest in the Area of Study
Arctic Ocean	59	78	137
North Atlantic Ocean	519	208	807
Baltic Sea	91	7	98
Black Sea	135	11	146
Mediterranean Sea	393	71	464

3.

Figure 1. Increase in number of scientific papers on oceanography. Adapted from Analysis of ScImago, 2014.

When the countries and territories are grouped into eight regions, the following breakdown emerges of the origins of the 213,760 articles published between 1996 and 2013 (Figure 2).

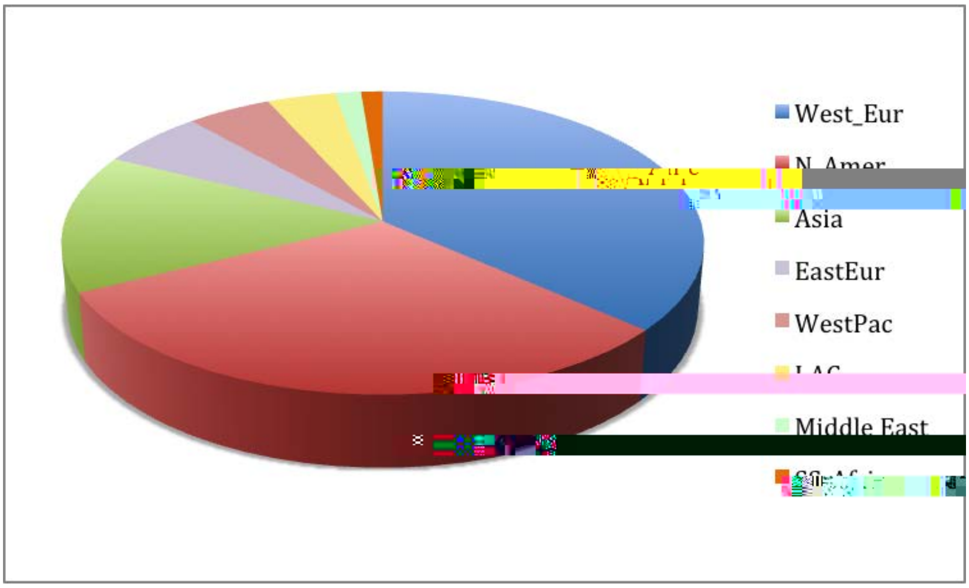

Figure 2. Geographic areas of origin of scientific papers on oceanography 1996 – 2013. Source: Analysis of ScImago 2014.

These proportions per region, with North America and Western Europe having the highest number, do not differ significantly from those obtained when analyzing papers from other scientific disciplines. This suggests that they accurately reflect the level of scientific activity in general, not merely a situation specific to the marine sciences, and therefore that this analysis may reflect common, broad issues on available research infrastructure, investment and institutional development that, together with appropriate national policies, do control the development of scientific research in general.

Almost as important as the personnel involved in marine scientific research are the facilities available to them. It is even more difficult than with the personnel to gain an overall view of how far researchers studying the marine environment have

Table

Ocean.

In geochemistry, the Geochemical Ocean Sections Study, GEOSECS, obtained very accurate sections and profiles of the distribution of chemical, isotopic, and radiochemical tracers in the ocean, building a global three-dimensional view of the chemical composition, including alkalinity, of the ocean, enabling the establishment of a solid baseline to measure acidification worldwide. GEOSECS is now being followed by GEOTRACES, which is measuring the distributions of trace elements in the sea.

Perhaps one of the most fundamental changes in marine scientific research was the realization that what was needed to underpin many of the more focused or local research efforts was a common infrastructure to observe the oceans at the global but also at other relevant temporal and spatial scales. In the late 1980s, That desire was reflected in the call made in Rio de Janeiro from the United Nations Conference on Environment and Development in June 1992 to develop GOOS as one of the mechanisms required to support sustainable development. This required that the initial focus on climate research had to be enlarged to include other aspects, like the impact of pollution and the status of marine living resources. The Health of the Ocean (HOTO) Panel was established as an group in 1993, and became a

(b) is an automated sea-surface temperature and salinity measurement system for making continuous underway measurements from the ship's water intake;

(c) is an electronic set of instruments to make precise conductivity, temperature, and depth measurements. The instrument is connected to the ship by a conducting cable; Accuracies better than 0.005 mS/cm are usually achieved for conductivity, better than 0.002^{o} C for temperature, and better than 0.1 per cent of full-scale range for depth;

(d) is an expendable (disposable) conductivity, temperature and depth profiling system.

(e) A beam of sound of known frequency is reflected from small particles moving with the water. Adequate sampling of this backscattering beam allows current measurements by the Doppler effect at different depths. ADCPs can, for example, be installed on the hull of the ship “looking downwards” or lowered from a ship to different depths to measure a wider range of current profiles. An accurate GPS positioning system can then be used on a moving ship to subtract the ship's speed from the measured current vector;

(f) . Measurements of the "partial pressure of CO_2" (pCO_2) on the ocean surface indicate whether the local ocean is acting as a source or a sink of CO_2. Measurements use a standardized infrared analyzer or a gas chromatograph to determine the concentration of CO_2. The probe is installed in the hull of a ship, and measu

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temperature, salinity and marine meteorological variables that are telemetered in real time through the WMO's Global Telecommunications System (GTS) to support increase in biological data took place. This new data was integrated to pre-existing data into the Ocean Biodiversity Information System (OBIS http://www.coml.org/global-marine-life-database-obis). Several of these new data streams are associated to the tagging and tracking of live animals, for example the Tagging of Pacific Pelagics (TOPP) programme in Western North America and the Australian Animal Tracking and Monitoring System (AATAMS). The tagging of marine animals, fish, birds, turtles, sharks, mammals, with electronic sensors is increasingly being undertaken by scientists worldwide to track their movements. Electronic tags such as archival, pop-up archival and satellite positioning tags are revealing when, where and how marine animals travel, and how these movements relate to the ocean environment. (http://www.scor-int.org/observations.htm). An Ocean Tracking Network is being developed. The network will track thousands of marine animals around the world using acoustic tags safely attached to the animals. At the same time, the network will be building a record of data relevant to climate change, through observation of changes in the animals' patterns of movement.

5. Socioeconomic aspects of marine scientific research

Three major points emerge from the foregoing analyses and the material in other chapters on the results of marine scientific research in the fields they cover.

First, the success of the management of human activities that affect the marine environment is conditional upon having reliable information about that environment. If adequate information is not being collected, then management decisions will be less than optimal. Parts of the world that do not have adequate infrastructure for an adequate collection of information about their local marine environment are disadvantaged. Although research based in other parts of the world may provide a good understanding of how the marine ecosystems operate, and of the pressures to which they are subject, such a general understanding must be supplemented by adequate local information. Such collection of local information is always likely to be more efficient, effective and economical.

Second, as the world's marine environment is very much interconnected, sub-optimal management in one part of the world is likely to affect the quality of the marine environment in other parts of the world. This is the case of land-based point-sources of pollution that, depending on circulation, can broadcast their negative impacts across maritime borders; or if stocks of marine living resources are not well managed in one part of the world, diminishing the landings of a certain target-species, this may increase fishing pressure on the same or similar species in other parts of the world.

Third, even though universities and other educational establishments produce good-quality marine experts throughout the world, graduates will experience pressure to move to those parts of the world where they can hope to have access to the best equipment for their further research. It is only in that way that they can hope to develop their careers most successfully. Such a "brain drain" will undermine efforts to establish adequate marine research in all parts of the world until appropriate local

Norwegian Institute of Marine Research (IMR) and FAO. The first R/V was commissioned in October 1974. The third version of the R/V is currently being built and expected to be commissioned in 2016. The International Seabed Authority (ISA) has three active training streams, the supporting the participation of qualified researchers from developing countries in cooperative research on the seabed; the aimed at training developing countries' scientists and managers and the that, in a twofold approach, receives young scientists and managers from developing countries at ISA headquarters to learn about the goals and functions of ISA, but also receives young, highly qualified personnel to reside and contribute for short periods to ISA activities.

Many other international training initiatives on marine sciences, bi-lateral or multilateral, do exist, especially in the academic/education domain, but no comprehensive global reporting or cataloguing of these important efforts exists to date.

Gaps remain in the abilities to integrate the results of scientific research into the development of policy: capacity-building gaps thus exist in creating an effective science/policy interface first and foremost at the national level, but also at the regional and global levels.

Furthermore, efforts to fill the capacity-building and information gaps identified in other chapters will be much less productive if they are not made against a background of developing a global coverage of systems that can provide adequate integrated management information to global, regional and national authorities. This will be both more efficient and more economical, because a coherent body of scientific information will ensure that unexpected results of human activities and efforts to manage them will not go undetected, and will avoid duplication and overlap.

As this chapter has suggested, systematic information and knowledge about the progress of marine science is lacking. This therefore strengthens the case for supporting within the UN System the IOC's efforts to develop a World Ocean Science Report (see Decision EC-XLVII/6.2) that would eventually complement the existing World Science Report of UNESCO.

References

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