Recommendations – G7 expert workshop on future of the oceans and seas

Background

The ocean is the largest feature on Earth - covering over 70% of its surface and is its largest connected ecosystem. It delivers vital services for life – governing regional weather and climate around the globe and providing resources - both non-living and living - while also generating hazards that threaten life and property. The ocean and seas are worth over $2.5Trillion per annum in direct economic benefit (and ten times more when including less tangible ecosystem services)[1] and would be the world's 7th largest economy in their own right. However, 90% of their economic value depends on healthy marine ecosystems that are increasingly under pressure from human activity.

The ocean is changing, with some 30-35% of critical marine habitats having been overused or destroyed, ocean acidity having increased by 26%, and oxygen generally depleting in the coastal ocean. Indeed, the health of the ocean is such a crucial economic development issue that it has warranted an explicit UN sustainable development goal (SDG 14) to "*conserve and sustainably use the oceans, seas and marine resources for sustainable development*". Similarly, SDG 13 looking at Climate Action recognises the significant impacts of climate change which can lead to sea-level rise, decrease of sea ice extent and thickness, changes in ecosystem productivity and biodiversity, extreme weather events and changing weather patterns which are all influenced by the oceans and seas.

The changing ocean environment is a critical global issue which threatens the sustainable use of the ocean by future generations. Despite this, many parts of the ocean interior are poorly observed and significant challenges remain in developing and delivering the knowledge necessary to assess the ongoing changes and their impact on economies, policies and sustainable use of the oceans and seas. Tackling this issue requires a concerted international observational effort.

Satellite observations provide unparalleled broad scale views of the ocean, but only see the surface and permit very limited mapping of the ocean interior and seafloor. Research vessels remain essential to studying ocean processes and to benchmark data from autonomous systems, but research vessel surveys are too infrequent and limited in geographic coverage. Over the past 10 years, autonomous floats (such as ARGO) have revolutionized our ability to measure physical properties of the ocean interior and rapid technological developments in autonomous sampling platforms and sensors promise increased access to the deep ocean to measure a broad range of physical, chemical and biological properties. However, further innovation is necessary to provide a suite of sensors fully capable of capturing key biological processes, and consideration should be given for options to help facilitate ocean observations from the range of available observing platforms and systems.

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[1] *Hoegh-Guldberg, O. et al. 2015. Reviving the Ocean Economy: the case for action – 2015. WWF International, Gland, Geneva, Switzerland, 60 pp*

Together these platforms and systems constitute an expensive global research and monitoring infrastructure that needs to be managed as a whole to maximize the data and information return on this collective investment. The experience with satellite deployments and Argo are examples of successful global coordination to help facilitate ocean observations that can be learned from.

Given that 93% of the global ocean is >200 m deep and spans many different jurisdictional boundaries and is governed by established international law, ocean observing is "big science". Proper, sustained, comprehensive and globally coordinated observation of the ocean and seafloor is necessary so that we have the tools to provide the data and understanding required to inform, with evidence, policy decisions about use of the ocean, especially against the background of human-induced change and natural variability. A comprehensive ocean observing programme would need to operate under a sound international framework in order to i) coordinate the deployment of global ocean observing assets to optimize their usage, ii) promote global data sharing and best enhance international access to data and data interoperability, iii) produce regular authoritative assessments of the state of the oceans and the ecosystems they contain. Developing such a system will enable us to deal with the critical issues outlined below.

1) Making sense and improving projections of global and regional-scale long-term change and variability. This includes understanding the ocean and seas' role in climate change and the resultant changes in weather patterns, sea-level rise, changes in waves and current regimes, de-oxygenation, warming as well as processes like ocean acidification. An ambitious step change in our knowledge on the mutual interactions between the above changes and biodiversity and ecosystem functioning is also required for improved predictions and scenario analyses of the oceans and seas state. This advancement in knowledge is a prerequisite to improve the ability to predict the near-term to decadal scale to help respond to, adapt and mitigate these changes.

2) Sustaining the productive capacity and resilience of the sea's and ocean's ecosystems as they come under increasing pressure from human activities. The ability to assess the impact of wider environmental changes and stressors such as on the prevailing conditions of our seas is needed, such as through pollution, eutrophication, environmental change, acidification, habitat loss and over-exploitation of resources. Likely population increases (possibly up to 9.7 billion by 2050)[2], may lead us to consider the oceans and seas as unlimited sources of high quality protein via near shore coastal aquaculture and open ocean fishing. We require a timely and sustained flow of information on ocean ecosystem state in order to manage the human exploitation of living resources in a sustainable manner.

3) To minimise human impacts on the ocean and seas by sustainably harvesting renewable marine resources and responsibly exploiting finite marine resources.

[2] World Population Prospects: the 2015 Revision, United Nations, http://esa.un.org/unpd/wpp/Publications/Files/Key_Findings_WPP_2015.pdf

Activities such as hydrocarbon and metal resources exploration/exploitation, large-scale deep-sea fishing, are likely to occur in increasingly hostile and remote environments such as deeper waters, at the seafloor and in high latitude environments. These expansions will increasingly challenge our understanding of these activities and their impact on marine biota and will in addition demand novel engineering approaches, thus posing significant environmental and engineering challenges.

To identify potential solutions to these challenges a workshop of technical and policy experts from G7 countries was held 8-9 March at the UK's National Oceanography Centre in Southampton. Following two days of productive discussions the following recommendations are proposed to the G7 Science Ministers for action with the aim of significantly enhancing ocean observation. The working group recognised that there were many other areas that would benefit from concerted action and welcomed parallel work being undertaken on resource efficiency and marine litter by Environment Ministers. However, as the focus of the meeting was on ocean observation, the recommendations below only relate to this aspect.

Recommendations

Recognising that sustained sea and ocean observations will be essential to improve scientific knowledge about ocean climate, marine ecosystems, their vulnerability to human impacts and the ways in which ocean processes affect human wellbeing, the expert group recommends that the G7 Science Ministers take action to build on existing systems such as GOOS to:

1. Support the development of a global initiative for an enhanced, global, sustained sea and ocean observing system, developing new technologies and integrating new physical, biogeochemical and biological observations while sustaining critical ongoing observations and ensuring full co-ordination with existing mechanisms. This should include but not be limited to:
    - Increasing the capability of the global Argo network to include more biological and biogeochemical observation and observation of the deep sea;
    - Utilising and enhancing global glider/autonomous surface vehicle capability to connect open ocean observing and the coastal shelf;
    - Developing the technologies needed for implementing fixed mooring and deep sea observations;
    - Developing new and innovative sensor technologies to improve the efficiency and effectiveness of sea and ocean observation, (especially biogeochemical and biological sensors), which can be deployed on a variety of platforms including deep sea observatories, drifting and autonomous vehicles mentioned above and seafloor observatories;

- Supporting and accelerating the development and implementation of ecosystem/ biodiversity Essential Ocean Variables (EOVs) for routine implementation;
- Improving sea-level observing networks and infrastructure to improve provision of global and regional sea-level information, especially in areas where sea-level changes are an increasing threat;
- Continuing critical regional observing in the tropics and maintaining and enhancing our observing capacity in the marine cryosphere (Arctic and Antarctic);
- Enhancing the effective use and international coordination of research ships and satellites to leverage their unique capabilities in the ocean observing strategy;
- Fostering increased collaboration with the shipping industry on ocean observations to explore increasing use of commercial fleets for observing of the ocean and seas.

2. Support an enhanced system of ocean assessment through the UN Regular Process for Global Reporting and Assessment of the State of the Marine Environment that would help develop a consensus view on the state of the oceans on a regular timescale. This would in turn enable sustainable management strategies to be developed and implemented across the G7 group and beyond.

   The enhanced assessment should:

   - ensure sustainable science-based ocean management and provide clarity on resource-management;
   - promote observing and data sharing and development of products and models that provide integrated ocean state knowledge;
   - promote co-ordination with relevant activities of the Intergovernmental Panel on Climate Change/ Intergovernmental Platform on Biodiversity and Ecosystem Services;
   - underpin and capture progress towards SDG-14 goal;
   - raise the profile of ocean observing in general ; and
   - reduce the time lag between collecting observations and their application to services for societal benefit through an interdisciplinary approach.

   In an era of rapid planetary change, up-to-date information on ocean health is vital in order to help minimise the costs and enhance the effectiveness of any remedial action the international community might need to take to help conserve marine resources.

3. Promote the improvement of global data sharing infrastructure such as GEO/GEOSS, among others, to address the challenges not only of physical / chemical data but also biological data. This should ensure the discoverability, accessibility, and interoperability of a wide range (research, citizen, and commercial) of ocean and marine data.

4. Strengthen collaborative approaches to encourage the development of regional observing capabilities and knowledge networks. Through enhancement of global coordination mechanisms and infrastructure, help build capacity to better use global ocean information as well as to monitor the oceans, in particular in developing countries.

5. Promote increased G7 political cooperation to both strengthen existing and enhance future routine ocean observations by identifying the additional actions needed that would enable effective and timely implementation of Recommendations 1 through 4.

In support of the actions outlined above and to ensure rapid follow-up, it is recommended that the working group continue and be overseen by a G7 officials group to monitor progress and identify G7 country leads to take forward specific activities. This official level group should report progress to the Senior Officials by the end of 2016 and ahead of the next meeting of Science Ministers in Italy in 2017.