ID34- EUROPEAN MULTIDISCIPLINARY AND WATER-COLUMN OBSERVATORY - EUROPEAN RESEARCH INFRASTRUCTURE CONSORTIUM (EMSO ERIC): CHALLENGES AND OPPORTUNITIES FOR STRATEGIC EUROPEAN MARINE SCIENCES

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Abstract – EMSO (European Multidisciplinary Seafloor and water-column Observatory, www.emso-eu.org) is a large-scale European Research Infrastructure I. It is a distributed infrastructure of strategically placed, deep-sea seafloor and water column observatory nodes with the essential scientific objective of real-time, long-term observation of environmental processes related to the interaction between the geosphere, biosphere, and hydrosphere. The geographic locations of the EMSO observatory nodes represent key sites in European waters, from the Arctic, through the Atlantic and Mediterranean, to the Black Sea (Figure 1), as defined through previous studies performed in FP6 and FP7 EC projects such as ESONET-CA, ESONET-NoE, EMSO-PP (Person et al., 2015).

Keywords - Seafloor and water-column, Research Infrastructure, environmental processes

I. INTRODUCTION

Through the EMSO-Preparatory Phase project, funded by the EC FP7, the governance and management structure of EMSO RI was agreed among the participant countries interested in supporting the infrastructure (Italy, France, United Kingdom, Germany, The Netherlands, Ireland, Norway, Sweden, Portugal, Spain, Greece, and Turkey). EMSO RI has then entered in the final phase to establish the EMSO ERIC (European Research Infrastructure Consortium), the legal body that will be in charge of running EMSO observatory nodes as a unique integrated marine infrastructure. The process towards the foundation of EMSO ERIC is close to completion, with the EMSO ERIC. The EMSO ERIC will be hosted by Italy with participation of Italy, France, The United Kingdom, Greece, Spain, Ireland, The Netherlands, Germany, Portugal and Romania. Other countries such as Norway, Sweden, Turkey, and Malta have expressed their interests.

II. THE STRATEGIC SCOPE

The oceans cover 70% of the Earth's surface and contain roughly 97% of the Earth's water supply; Oceans dynamics drive most of the ecosystems on Earth, representing the largest most complex Biome on Earth, and control on the Climate at global scale. 70% of volcanism on Earth occurs underwater, being the source of hazards often unpredictable. Thus, the oceans are the very foundation of human life, and the suitable place to study the interactions between the physical, chemical, and biological components of the environment, including their effects on all types of organisms.

The fundamental challenge is to build the foundation for an innovative approach to ocean observation long-term fixed-point observatories provides continuity, vigilance and high time-resolution data in a broad time scale (milliseconds to years). Continuous observation allows the detection of unpredictable events such as earthquakes, tsunamis, dense water cascades, plankton blooms, water mass movements, and influence of eddies, which cannot be detected by intermittent, short-term ship expeditions. Furthermore by monitoring the water column from the surface to the seafloor, phenomena can be investigated that are beyond the capacity of remote sensing approach (Best et al., 2014).

III. TECHNOLOGICAL DEVELOPMENT

To understand the expected changes in the coming decades, it requires a significant technological effort in the field of marine sensors that allow us a continuous and interactive recording of a variety of parameters that make feasible a complete observation of the oceans based on the following approach:

a) Research Infrastructure Technology:

The aim is through EMSODEV EU funded project to provide the basis to equip EMSO sites with a standardised tool for ocean parameter measurements by developing a multidisciplinary sensor system called EGIM (EMSO Generic Instrument Module). More specifically the objective is to offer features beyond the state of the art using a comprehensive set of sensors and devices that meet particular technology readiness thresholds to collect observations including temperature, pressure, salinity, dissolved oxygen, turbidity, chlorophyll fluorescence, currents, and passive acoustics. Relatively novel sensors will also be considered including those for pH, pCO2, and nutrients (Figure 2). These generic variables can be used to directly address a wide range scientific topic:

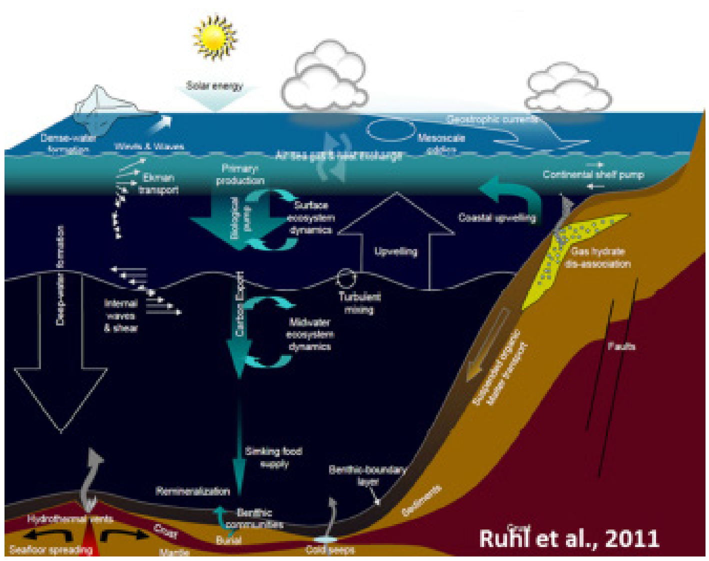
· Global change (e.g., temperature, conductivity).
· Ocean circulation (e.g., currents, conductivity and temperature).
· Benthic biologic processes (e.g., turbidity, oxygen).
· Large impact geo-hazard (e.g., pressure).
· Acidification (e.g., dissolved carbon dioxide and pH measurements).
· Underwater natural and man-induced noise (e.g., ground motion, sound propagation).

b) Reliable Ocean Science Measurements

Standardization in measuring physical and chemical parameters in the ocean increases the potential scientific impact of the collected data. The long-term recorded data or in situ ocean measurements are critical issues not yet resolved, since the sensors suffer extreme ambient conditions, corrosion, mechanical stress, sudden changes in temperature and their electronic components supports a remarkable wear. By implementing the EGIM, composed of the sensors required to acquire short-term as well as long-term variations and changes in the ocean facilitating regional predictions applications such as regional scale monitoring and modelling for climate change predictions; figure 2 Illustration of the main processes in the marine environment showing main interactions between atmosphere, surface ocean, biology, deep ocen, and solid earth after Ruhl et al., 2011

c) Big Ocean Data

The data management system will establish an einfrastructure to support the massive volume of data produced by individual, geographically distributed ocean sensors, acquiring time series describing phenomena involving different temporal scales. This platform will be serving scientists and other 3rd party data users all over the world, and delivering data products for a wide and heterogeneous group of stakeholders.



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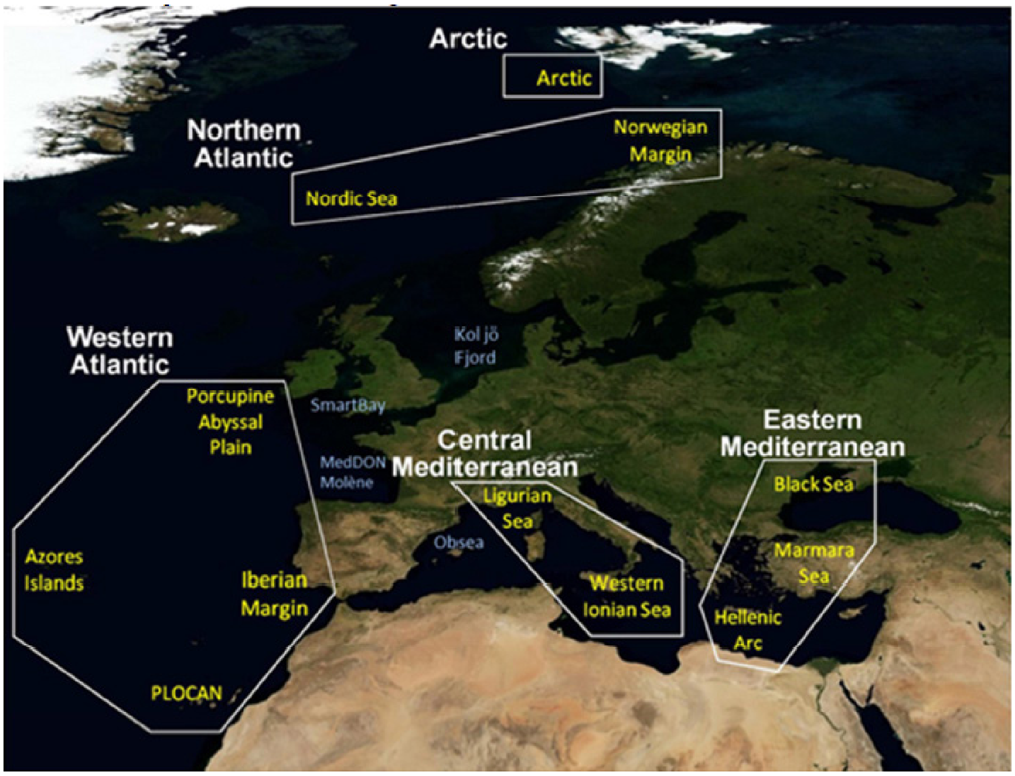

Figure 1. Map of EMSO nodes (yellow) and shallow-water test sites (blue)

IV. SCIENTIFIC & SOCIETAL IMPACT OF EMSO RI

EMSO RI, with an extremely broad-ranging extension in term of environmental conditions, covers a relevant part of the Northern hemisphere from subtropical regions to the Arctic. Homogeneous Essential Climate Variables produced by EMSO RI are thus central to addressing the environmental challenges by delivering knowledge and tools to enable Europe to prepare for, and adapt to these changes. National and regional decision and policy makers are major users of EMSO ERIC data that must be shown the major advantages of having standardized information that may help the development of Regional intervention plans. By the use of standardized services new and innovative solutions can be drawn in order to address the major Societal Challenges.

Industrial interests can be illustrated according to the economic sectors:

· Requirement for impact assessment for marine renewable energy concepts (all EGIM parameters) and resource evaluation for marine turbines (underwater current variability is a direct input to the business plan);

· requirement for stand-alone observatories to monitor oil/gas spills either around large shipwrecks or oil/gas production leakages or gas storage leakages;

· requirement for impact assessment of marine mineral resources extraction fields (all EGIM parameters) and more precisely permanent monitoring of subsea particle clouds of dust (current and turbidity);

· requirement for geo-hazard monitoring around some oil & gas production fields, impact assessment of most oil & gas fields;

· requirement for monitoring fish behaviour at some key areas (conflict of fisheries with other marine uses, implementation of Ecosystem Approach to Fisheries (FAO 2003) replacing trawling by fixed gears);

· requirement for civil protection towards geo-hazard mitigation measures.

V. CONCLUSIONS

EMSO is one of the environmental RIs included on the roadmap of ESFRI (European Strategic Forum on Research Infrastructures) since 2006, and it is included as Landmark in the last ESFRI roadmap 2016 (www.esfri.eu/roadmap-2016). It provides a new kind of large-scale infrastructure for multidisciplinary and interdisciplinary investigation of deep ocean processes related to Marine Ecosystems, Climate Change and Marine Geohazard. This distributed ocean observatory significantly improve marine research capacity of EU Member States and increases the ability to respond to the major challenges related to environmental changes. EMSO contributes to the Global Monitoring for Environment and Security initiative (now renamed COPERNICUS programme, www.copernicus.eu).

The present operational status of EMSO in terms of the number of operating nodes (eight nodes running out of twelve expected), and data acquisition and dissemination, has been reached over ten years of research, development and coordination activities responding to local and regional requests, funded by the individual countries and by the EC through projects with different time-lines and budgets; enhancements to these nodes are ongoing on the same basis. An open data policy has already been adopted in compliance with the recommendations being developed within the GEOSS initiative (Global Earth Observation System of Systems, www.earthobservations. org/geoss.php) to allow for the shared use of the data infrastructure and the free exchange of scientific information and knowledge.

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