InSEA Project: Initiatives in Supporting the consolidation and enhancement of the EMSO infrastructure and related Activities

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The observation of the phenomena occurring on our planet was in the past based mainly on ground monitoring with both temporal and spatial approaches. On the other hand, in the part covered by the oceans until a few years ago the monitoring was carried out through discrete measurement campaigns in time and space with the disadvantage of not having information on the variability of oceanic processes. Only more recently, since the 90s of the last century, technology has allowed the installation of multidisciplinary systems on the seabed for long periods (years), even at great depths (thousands of meters). From the circumscribed campaigns in space and time, we have therefore moved on to the installation of observatories on the seabed, to record in a continuous way the physical and chemical parameters, in order to know the state of the oceans and of the whole planet. This produces two advantages:

1. A spatial improvement of the observations, because they extend from land to the previously less known and more extensive part of the planet, i.e. the oceans that cover seven-tenths of the Earth's surface;
2. A scientific improvement, because the oceans represent a fundamental element in the processes at the base of the Earth's climate, whose knowledge on large time scales makes it possible to understand the future evolution of these processes [e.g. Favali et al., 2015].

The possibilities provided by the new technologies have allowed the launch on a global and almost contemporary scale of multi-year programs aimed at the permanent installation and management of multidisciplinary and interdisciplinary systems on the seabed and along the water column. These systems are capable of producing data even in time real, being wired through electro-optical cables capable of powering, receiving data on the ground via optical fibres and controlling at the same time the submarine systems.
These programs involve many countries: United States of America (OOI-Ocean Observatories Initiative; http://oceanobservatories.org), Canada (ONC-Ocean Networks Canada; http://oceannetworks.ca), Japan (DONET-Dense Ocean floor Network System for Earthquakes and Tsunamis; http://www.jamstec.go.jp/donet), China (ECSSOS-East China Sea Seafloor Observation System), Australia (IMOS-Integrated Marine Observation System; http://imos.org.au), Taiwan (MACHO-Marine Cable Hosted Observatory; http://scweb.cwb.gov.tw/macho-web).

EMSO (European Multidisciplinary Seafloor and Water Column Observatory; http://www.emso.eu) is the European response to these initiatives with which it is in close collaboration also through common projects. The motto common to all these programs is: "Observing the Ocean to Save the Earth", to underline the importance of studying the oceans through time series of data to improve our understanding of their fundamental role in regulating terrestrial processes.

EMSO is a European research infrastructure (RI) that aims to explore the oceans, to better understand the phenomena occurring within and below them and to explain the fundamental role that these phenomena play in the wider and more complex terrestrial systems. EMSO is a distributed infrastructure in the seas around Europe, ranging from the Arctic to the Atlantic, through the Mediterranean, up to the Black Sea, and consists of a system of nodes, normally observatories, located in key marine areas for the understanding of the complex phenomena occurring at sea. The Observatories are multidisciplinary platforms positioned along the water column and on the seabed. They constantly measure multiple biogeochemical and physical parameters in long time series for the study of climate changes, marine ecosystems and natural hazards and their mitigation.

EMSO offers data and services to a broad and diverse user group, ranging from scientists and industries to institutions and policy makers. It is a fundamental infrastructure to provide information relevant to the definition of environmental policies based on scientific data. EMSO shares scientific structures (data, tools, computing and archiving capacity) in a common European strategic framework.

EMSO is an infrastructure declared Landmark (i.e., it has been included among the pan-European research infrastructures considered successful) in the latest ESFRI Roadmap (European Strategy Forum on Research Infrastructures), published in March 2016. In addition, EMSO has become an ERIC (European Research Infrastructure Consortium) since October 2016, becoming an international legal entity created for pan-European research infrastructures. EMSO ERIC is currently supported by eight countries (Italy, France, Great Britain, Spain, Portugal, Ireland, Greece and Romania) with Italy hosting the registered office. Each country is represented by one or more Representing Entities, and INGV plays this role for Italy. In addition, INGV is the leader of the Joint Research Unit (JRU) EMSO-Italy, which is participated by several other research bodies (CNR, INFN, OGS, SZN, ENEA, ISPRA) and by universities, through the CONISMA consortium (35 universities involved in marine science). The JRU aims to aggregate and strengthen the Italian community and its role within the pan-European research infrastructure. Finally, EMSO is usefully inserted in the PNIR (Programma Nazionale delle Infrastrutture di Ricerca) among the EU-RIs, that is the European research infrastructures of interest for Italy, responding to all the characteristics necessary for its inclusion, that is to say: scientific, technological and managerial quality; added value at European level; high level connected services; free transnational access on a competitive basis (peer review); results available in open form.

In the seas surrounding Italy, EMSO has two permanent observing sites: one in the Western Ionian Sea (eastern Sicily) and the other in the Ligurian Sea, while some others have been indicated in the Tyrrhenian Sea (Campania) and in the Adriatic (Puglia) as multiparametric monitoring pilot sites. All these sites are being consolidated and strengthened through the current InSEA project.

According to the extended title of the InSEA project, its main goal is to launch initiatives to support the consolidation and enhancement of EMSO's infrastructures and its activities, which are positioned in the Italian territory and surrounding seas, with particular interest in the less developed member state (MS) regions (Campania, Calabria, Puglia and Sicily) or in transition regions (TR) (Abruzzo and Molise). The final scientific objective of the project is to improve the ability of the research infrastructures (RI) to record the geophysical and

environmental processes of the marine environment in the seas of the MS / TR areas of the national territory, in order to monitor the state of the seas due to climatic changes or anthropogenic effects and natural hazards.
The project is developed according to 6 Objectives of Realization (ORs) that intend to contribute to the achievement of the main Project target. They consist in the upgrading of localized marine infrastructures (OR1, OR2 and OR5), distributed or supporting laboratories (OR3 and OR4) and spatial measurement activities to support those activities of surveys in fixed time series points (OR6). The co-proposing bodies of OGS, ISPRA and SZN, partners in the JRU of EMSO-ERIC participate in these activities.
The close interconnection of the various ORs (see Figures 1 and 2) and their products will represent a leap forward in the capabilities of the entire RI to acquire important scientific data to take advantage of advanced and excellence research in the fields of geophysics, geology, geochemistry, volcanology, oceanography and biology.

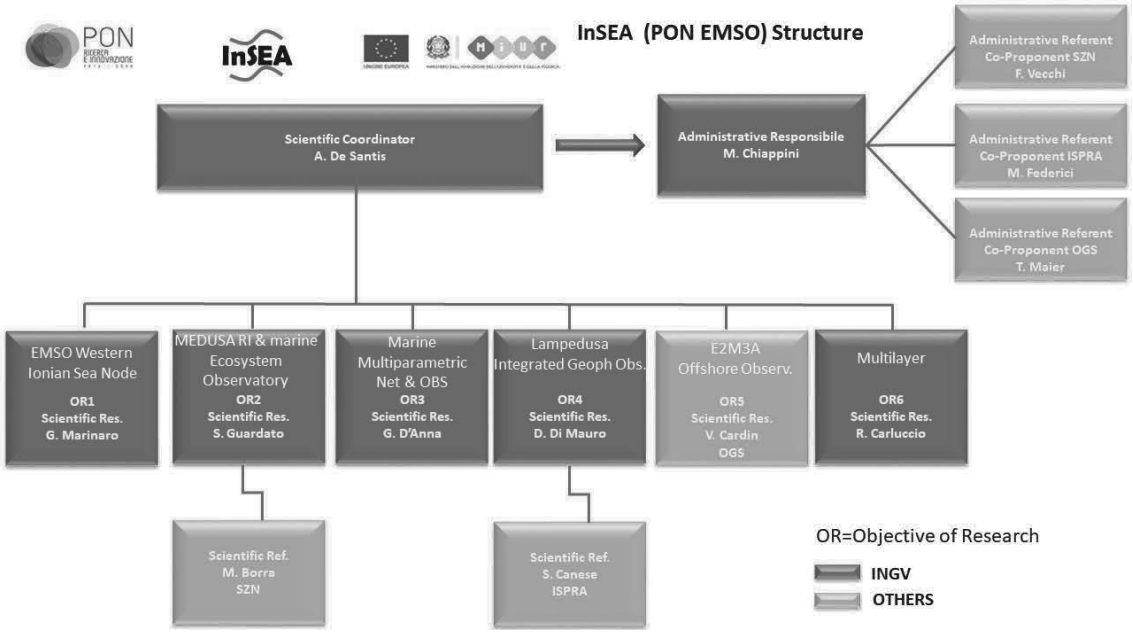

Figure 1 Organigram of the InSEA Project.

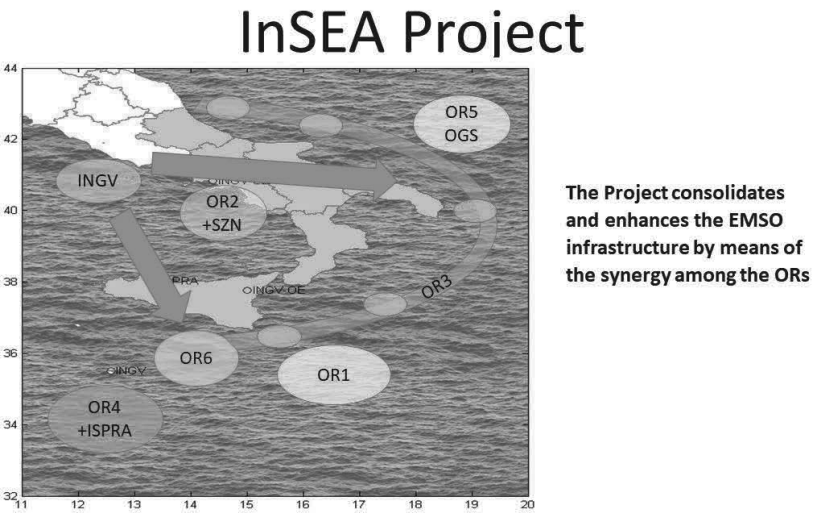

Figure 2 Spatial inter-connection among the different ORs and scientific Institutions involved in the InSEA Project.

The most relevant resources for each OR and how these will affect the existing RIs are presented as follows.
OR1 Western Ionian EMSO Node:

- Complete / partial systems (frame / acquisition / control / transmission / sensors) for 3/4 submarine multiparametric observatories.
- A power supply and two computer servers with NAS system for Catania ground station.
- Complete data center for Portopalo ground station.
- Reinforcing of winch and ROV.
- 1 smart cable system with some instrumented repeaters.

For the consolidation and reinforcing of the EMSO sites of SN1 (Catania) and SN2 (Porto Palo) in Sicily:
OR2- RI MEDUSA and Marine Ecosystem Observatory.

For the site in the Gulf of Pozzuoli (INGV):

- Assets for upgrading the MEDUSA out of water infrastructure (EMERGED-Top).
- Resources for expansion and upgrading of the CUMAS multi-parametric submarine module, (EMERGED-Bottom).

For the site in the Gulf of Naples (SZN):

- Mooring not wired in stand-alone mode.
- Infrastructure at the bottom (seabed platform) connected to a surface buoy.

These assets will improve the geodetic / acoustic / oceanographic monitoring capacity at the EMSO-MedIT site of the Gulf of Pozzuoli and its extension in the waters of the Gulf of Naples.

OR3- Marine Multiparametric Network and OBS:

- 7 submarine multi-parameter modules (MSM) of which 5 installed and 2 to be used to replace the operating ones at the scheduled deadlines for cleaning and calibrating the sensors in order to guarantee continuity of operation and data flow.
- 6 + 6 Broad Band Ocean Bottom Seismometers (BB-OBS / BB-OBS TR).
- 1 ultrasound tank.
- 1 winch with cable for a remote control deck unit acquired in EMSO MedIT.

To extend EMSO multi-parameter monitoring activities in MS and TR areas with relocatable systems (BB-OBS) and fixed at hydrocarbon extraction platforms.

OR4 - Lampedusa Integrated Geophysical Observatory:

- Magnetometers, solar compass and magnetotelluric station for the geomagnetic station.
- No. 3 complete systems of Ocean Bottom Magnetometer (OBM).
- Instrumentation for oceanographic boat and ISPRA ROV.
- n.1 Complete Digisonde.

To enhance the Integrated Geophysical Observatory of Lampedusa for the improvement of the calibrations of marine magnetic measurements in SN1 and SN2, and the use of ionospheric radio transmissions for both ship and buoy operations. The completed and integrated stations will also be key points of integrated geophysical observation at the southern of Europe. To reinforce the instrumental equipment of the M / V Lighea and the ISPRA ROV.

OR5-E2M3A offshore observatory:

- Buoy hull and acoustic releases for structural purposes of E2M3A and safety.
- Meteorological station.
- Instrumentation for the increase and diversification of biogeochemical measurements.
- Acoustic profilers for spot current measurements along the water column.

For the improvement and enhancement of the E2M3A (OGS) observatory.

OR6 Multilayer:

- Innovative systems for the observation of geophysical / environmental parameters from aircraft.
- Completion / integration provision for the AUV.

For the enhancement of the RI in the sites SN1 and SN2 (Sicily) from aircraft and marine AUV.

Reference

Favali P., Beranzoli L. and De Santis A., (2015). *Seafloor Observatories: A new vision of the Earth from the Abyss*. Springer – Praxis Publ. UK, 676 pp.