The European Seafloor Observatory Network (ESONET)

ESONET proposes a network of sea floor observatories around the European Ocean Margin, from the Arctic Ocean to the Black Sea, for strategic long-term monitoring as part of the European GMES (Global Monitoring for Environment and Security). The network will have capabilities in geophysics, geotechnics, chemistry, biochemistry, oceanography, biology and fisheries. Long-term data collection and alarm capability in the event of hazards (e.g. earthquakes) will be considered. Ten initial areas for ESONET development have already been identified, in addition to a mobile emergency response station.

The submarine terrain around Europe, from the continental shelves to 4,000 m depth, is known as the European Ocean Margin. This area extends for approximately 15,000 km from the Arctic Ocean to the Black Sea and accounts for ca. 3 million km2; an area comparable in size with the total land mass of Europe. Only a small fraction of this realm has been explored and new features, resources (minerals, hydrocarbons) and communities of animals are discovered every year. Also within this area are natural hazards such as submarine slides and earthquakes with associated tsunamis. Human impact on this zone is, however, poorly understood. The establishment of a long-term monitoring capability is essential for the management, conservation and protection of the human population from hazards in this zone. To provide the necessary spatial and temporal coverage it is important that different agencies, nations and scientific/technical disciplines work together sharing infrastructure, data, information and knowledge.

ESONET Objectives
The primary objective of ESONET is to produce a practical plan for long-term monitoring of the ocean margin environment around Europe, as part of GMES, with capability in geophysics, geotechnics, chemistry, biochemistry oceanography, biology and fisheries. The aim is to facilitate the co-operative development of an observatory network. ESONET will be complementary to oceanographic networks such as GOOS, EuroGOOS and DEOS and will work with industries deploying sea floor cable networks.
ESONET will be multidisciplinary, with stations monitoring the rocks, sediments, bottom water, biology and events in the water column. Both long-term data collection and alarm capability in the event of hazards (e.g. earthquakes) will be considered.

The ESONET Approach
There is world-wide recognition of the need for long-term in situ monitoring of the marine environment. Off Europe there is a history of long-term stations in physical oceanography, such as the Shetland to Faeroe transect of current meter stations monitoring interchange between the Atlantic and Arctic oceans which may play a significant role in climate change and monitoring of Mediterranean inflows and outflows. In biology, the most noteworthy results have been from long-term camera deployments (e.g. BATHYSNAP) in the NE Atlantic which showed first of all evidence of seasonal change in the abyss and then, over a ten-year time series, that major ecosystem changes occur. A third tradition is the extension of seismic networks into the sea from land. In recent years the oil industry has installed sensors and sea floor cable networks throughout oil and gas field areas for the management of production facilities.

Existing Capacity
A number of EU programmes have developed autonomous observatory capacity, e.g. ALIPOR (Autonomous Lander Instrument Platforms for Oceanographic Research) including BOBO, MAP (Module Autonome Pluridisciplinaire) and VESP (monitors flow from vent sites). In the UK, BATHYSNAP was a pioneering instrument and the DOBO (Deep Ocean Benthic Observatory) is operational in the NE Atlantic (Figure 1). These systems all typically have six to twelve month power and data storage capability and provide a cost-effective means of obtaining long-term observations but without real-time data access. The Italian-led GEOSTAR is a geophysics platform but has been extended to accommodate multidisciplinary sensors and real time data transmission capability. Similarly, OFOS is a platform currently deployed in the Adriatic, monitoring sediment pore water pressure and seismic activity.
Existing autonomous stations (BOBO, DOBO) are generally deployed on the sea floor by free fall, so that placing is not precise. To study events at, for example, vents or coral mounds, there will be a need for accurate location. GEOSTAR is deployed and recovered using a special mobile docker equipped with thrusters that can manoeuvre above the sea floor. VESP is deployed using a video launcher that allows selection of the drop site. Installation of deep-cabled observatories will require use of deep Remote Operated Vehicles (ROVs).

Vision
To create a unified GMES system around Europe ESONET will co-ordinate the existing European technical and infrastructure capability in sea floor observatories. It is not envisaged that a complete cabled network around Europe is feasible in the medium term; the ESONET logo is purely symbolic. A first step will be development of autonomous platform capability. Cabled systems from the coast will be proposed in particular areas of scientific or strategic importance or where the coast is particularly suitable for laying of a cable in deep water or where old communication cables could be re-commissioned. In other regions, clusters of stations around a telemetry buoy may be more appropriate. Existing or new satellite communication links will provide bi-directional transmission. One important aspect to be examined will be the feasibility of GMES stations using existing or proposed industrial networks. Whilst many sensors are well developed in some areas (e.g. biology, biochemistry), sensor design still requires improvement. These aspects will also be examined in ESONET.

Data management and distribution and archiving in a multi- disciplinary context will require significant innovations. ESONET is being implemented through a series of workshops, all potential stakeholders being invited, and through a series of feasibility and design studies.

Main Nodal Locations
Locations for elements of ESONET are based broadly on three criteria: geohazards, global change and environment monitoring. Ten initial locations (Figure 2) are currently being evaluated:

1. Arctic. Arctic water exiting into the Atlantic Ocean between Europe and Greenland is an important component of the global deep-water circulation of the planet and its heat budget. Establishment of a long-term station here is important for tracking of global change as ice cover decreases but there are also important deep sea habitats, such as mud volcanoes in the 'hausgarten' region off Svalbard
2. Norwegian margin. This is a region that has shown slope instability, with evidence of major slides which if repeated could result in catastrophic damage to offshore oil and gas installations and indirect effects of tsunamis striking the coasts of the British Isles and elsewhere. Special deep-water habitats such as coral reefs are also an issue
3. Porcupine Seabight/Abyssal Plain. This area has been an important area for bio-geochemical flux studies in the past but is also a very productive fisheries and oil-gas exploration area. It is a stable margin with little evidence of seismicity but with important deep-water habitats
4. Azores Mid-Atlantic Ridge. This area has special habitats associated with hydrothermal vents and sea floor morphology is distinct, with recent crust spreading from the mid-ocean ridge axis
5. Gulf of Cadiz- Iberian margin. This is a region of complexity with the junction of the Eurasian and African plates resulting in doming of the sea floor, mud volcanoes and other complex features. The interaction of the Mediterranean outflow with Atlantic waters is significant
6. Ligurian Sea. Existing cables installed for the ANTARES neutrino detector experiment make this a practical early site for ESONET development
7. SE France. Continuous loggers associated with the Banyuls Sola site (SOMLIT network)
8. Sicily. Important site which is close to the base of a volcano, Mount Etna, where the Italian SN-1 seismic observatory recently completed its first mission. The existing cable for NEMO neutrino experiment provides a focus for initial development
9. Hellenic Area. The eastern Mediterranean is characterised by significant seismicity, special habitats in deep basins and a very steep drop off in depth from the coastlines
10. Black Sea. With anoxic conditions in the deep and high sediment loads delivered to the system, this area has unique problems requiring long-term stations

In addition to the ten main nodal locations, there is a perceived need to be able to deploy observatories in the vicinity of anthropogenic or natural disasters. The recent wreck of the oil tanker Prestige in deep Atlantic waters off Iberia has demonstrated the inadequacy of existing infrastructure for monitoring continuing oil seepage and its environmental impact.