EMSODEV

EMSO implementation and operation: DEVelopment of instrument module

DATA MANAGEMENT PLAN

D6.1

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1. EXECUTIVE SUMMARY

This document is the EMSODEV Data Management Plan (DMP) D6.1 Deliverable describing the data management concepts in the EMSODEV community and depicting scenarios for data acquired, processed, archived and distributed during the whole project lifecycle. This includes analysis of data policies, IPR issues, trustworthiness, and interoperability.

This document describes how EMSODEV is currently finalizing Data Policy issues, clarifying how important Open Data and Open Access are for the community and for EMSO ERIC, as well. The reader will learn about the links between the EMSO Generic Instrument Module (EGIM) architectural design/implementation and the dataset(s) to be managed. In particular, this deliverable was developed in parallel to the deliverable D2.1 – *Workshop on Scientific Requirements* which has also identified seven core parameters that should be accommodated by the EMSO Generic Instrument Module (EGIM) and five additional optional parameters. The sensors commonly used to acquire all these parameters are here considered. At the end, the importance of handling the DMP as a living document will be much clearer in the EMSODEV landscape, where the final Data Policy will reflect common goals of the EMSODEV scientific community and will also take into consideration lessons learned during several years of past experience, as well as upcoming solutions for Big Data management in Earth Science.

2. INTRODUCTION

This document provides the definition of the plan for the management of the data produced by the project, also referring to the equivalent planning which is under development in the EMSO ERIC.
Starting from the lessons learned from past experience and the current landscape of the various EMSO observatory data flows and statuses, the EMSODEV Data Management Plan focuses on EGIM data, both sensors data and metadata, describing state of the art design and implementation phases as well as negotiations towards the final Data Policy for the EMSODEV project.
It is obvious that general data management activities cannot forget Regional Data produced by Regional Nodes and provided to the EMSODEV Data Management Platform.
Data/Metadata access and dissemination policies are discussed as well as trustworthiness and reusability of data.

This report is structured as follows:

- an introduction to the Deliverable, also containing a Glossary of Terms.
- the Data Management Plan.
- information on observatories and data flows.
- final considerations.

2.1 Glossary

ASCII

ASCII abbreviated from the American Standard Code for Information Interchange, is a character-encoding scheme. ASCII codes represent text in computers, communications equipment, and other devices that use text.

ATOM

The Atom Syndication Format is an XML language used for web feeds, while the Atom Publishing Protocol (AtomPub or APP) is a simple HTTP-based protocol for creating and updating web resources.

Catalogue Service for the Web (CSW)

Sometimes seen as Catalog Service - Web, is a standard for exposing a catalogue of geospatial records in XML on the Internet (over HTTP). The catalogue is made up of records that describe geospatial data, geospatial services, and related resources.

Copernicus

Copernicus, previously known as GMES (Global Monitoring for Environment and Security), is the European Programme for the establishment of a European capacity for Earth Observation.

CSW

See "Catalog Service for the Web".

Data Chain

Any combination of two or more data elements, data items, data codes, and data abbreviations in a prescribed sequence to yield meaningful information.

Data Flow (Computer Science meaning)

Path taken by data within a device, network, or organization, as it moves from its source to a data repository or a data user.

Data Set (or Dataset)

A data set (or dataset) is a collection of data.
Most commonly, a data set corresponds to the content of a single database table, or a single statistical data matrix, where every column of the table represents a particular variable, and each row corresponds to a given member of the data set in question. The data set lists values for each of the variables, such as height and weight of an object, for each member of the data set. Each value is known as a datum. The data set may comprise data for one or more members, corresponding to the number of rows. The term data set may also be used more loosely, to refer to the data in a collection of closely related tables, corresponding to a particular experiment or event. An example of this type is the data sets collected by space agencies performing experiments with instruments aboard space probes.

Data Stream (Oceanography meaning)

Data Stream - A sequence of data packets used to continuously transmit or receive information, typically in real time and without any direct action on the part of the data consumer.

DIF

Directory Interchange Format is used to create directory entries that describe a group of data. The directory contains several fields, allowing users to find data useful to their needs.

DOI

Digital object identifier (DOI) is a serial code used to uniquely identify objects. The DOI system is particularly used for electronic documents such as journal articles and scientific datasets. Metadata about the object is stored in association with the DOI name.

Dublin Core

The Dublin Core Schema is a small set of vocabulary terms that can be used to describe web resources (video, images, web pages, etc.). It is particularly used to define metadata schemas.

EMODNET

The European Marine Observation and Data Network (EMODnet) consists of more than 100 organisations assembling marine data, products and metadata to make these fragmented resources more available to public and private users relying on quality-assured, standardised and harmonised marine data that are interoperable and free of restrictions on use. EMODnet is currently in its second development phase with the target to be fully deployed by 2020.

Experiment

Experiment is the work of collecting data oriented to investigate a natural phenomenon in one place or more over a certain time period.

Each Experiment provides a set measurements of parameters, images and samples acquired by a set of sensors arranged in an observatory. Annex A the term *campaign* in place of experiment is also used.

GEOSS

See “Global Earth Observation System of Systems”.

Global Earth Observation System of Systems

The Global Earth Observation System of Systems will provide decision-support tools to a wide variety of users. As with the Internet, GEOSS will be a global and flexible network of content providers allowing decision makers to access an extraordinary range of information at their desk.

This ‘system of systems’ will proactively link together existing and planned observing systems around the world and support the development of new systems where gaps currently exist. It will promote common technical standards so that data from the thousands of different instruments can be combined into coherent data sets. The ‘GEOSS Portal’ offers a single Internet access point for users seeking data, imagery and analytical software packages relevant to all parts of the globe. It connects users to existing databases and portals and provides reliable, up-to-date and user-friendly information – vital for the work of decision makers, planners and emergency managers. For users with limited or no access to the Internet, similar information is available via the ‘GEONETCast’ network of telecommunication satellites.

Global Positioning System (GPS)

The Global Positioning System is a space-based navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.

KML

Keyhole Markup Language is an XML notation for expressing geographic annotation and visualization within Internet-based, two-dimensional maps and three-dimensional Earth browsers. KML was developed for use with Google Earth, which was originally named Keyhole Earth Viewer. KML became an international standard of the Open Geospatial Consortium in 2008.

miniSEED

miniSEED is the subset of the SEED standard that is used for time series data. Very limited metadata for the time series is included in miniSEED beyond time series identification and simple state-of-health flags. In particular, geographic coordinates, response/scaling information and other information needed to interpret the data values are not included.

NetCDF

Network Common Data Form is a set of software libraries and self-describing, machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data.

OAI

The Open Archives Initiative is an organization to develop and apply technical interoperability standards for archives to share catalogue information (metadata). It attempts to build a "low-barrier interoperability framework" for archives (institutional repositories) containing digital content (digital libraries). It allows people (service providers) to harvest metadata (from data providers).

Observations & Measurements

Open Geospatial Consortium standard models and XML Schema for encoding observations and measurements from a sensor, both archived and real-time.

Observatory

An infrastructure that is able to accommodate sensors and instruments either permanently installed or by demand. Observatories are able to provide certain services like power supply and communication links for all connected instruments.
According to the capacity of communication, the observatory can have the following possible configurations: Stand-alone observatory, Cabled Observatory. For an observatory in stand-alone configuration power is supplied by battery packs, capacity of connection is limited and achievable by means of data floating capsules or acoustic link from the surface. Cabled Observatories are connected directly to shore by means of submarine cable for power and real-time data transmission.

OGC

See "Open Geospatial Consortium".

Open Geospatial Consortium

The OGC (Open Geospatial Consortium) is an international "*not for profit*" organization committed to define quality open standards for the global geospatial community. These standards are made through a consensus process and are freely available for anyone to use to improve sharing of the world's geospatial data. OGC standards are used in a wide variety of domains including Environment, Defence, Health, Agriculture, Meteorology, Sustainable Development and many more. Members come from government, commercial organizations, NGOs, academic and research organizations.

OpenData

Open data means that data can be freely used, shared and built-on by anyone, anywhere, for any purpose. This is the summary of the full Open Definition, which the Open Knowledge Foundation created in 2005 to provide both a succinct explanation and a detailed definition of open data. As the open data movement grows, and even more governments and organisations sign up to open data, it becomes ever more important that there is a clear and agreed definition for what "open data" means if we are to realise the full benefits of openness, and avoid the risks of creating incompatibility between projects and splintering the community. - See more at: http://blog.okfn.org/2013/10/03/defining-open-data/#sthash.jbLHYSCX.dpuf

OpenSearch

OpenSearch is a collection of technologies that allow publishing of search results in a format suitable for syndication and aggregation. It is a way for websites and search engines to publish search results in a standard and accessible format.

O&M

See "Observation and Measurement".

Resource Description Framework (RDF)

The Resource Description Framework is a family of World Wide Web Consortium (W3C) specifications originally designed as a metadata data model. It has come to be used as a general method for conceptual description or modelling of information that is implemented in web resources, using a variety of syntax notations and data serialization formats. It is also used in knowledge management applications.

RS232

The RS232 and RS485 standard describes a communication method where information is sent bit by bit on a physical channel. This type of transmission is known as "Serial Protocol". RS232 and RS485 are Serial Transmission Protocols.

RS485

See RS232.

SEED

The Standard for the Exchange of Earthquake Data is a data format intended primarily for the archival and exchange of seismological time series data and related metadata. See also miniSEED.

SensorML

SensorML is an approved Open Geospatial Consortium standard. SensorML provides standard models and an XML encoding for describing sensors and measurement processes. SensorML can be used to describe a wide range of sensors, including both dynamic and stationary platforms and both in-situ and remote sensors.

Sensor Observations Service

Standard Open Geospatial Consortium web service interface for requesting, filtering, and retrieving observations and sensor system information. This is the intermediary between a client and an observation repository or near real-time sensor channel. The SOS standard is applicable to use cases in which sensor data needs to be managed in an interoperable way. This standard defines a Web service interface that allows querying observations, sensor metadata, as well as representations of observed features. Further, this standard defines means to register new sensors and to remove existing ones. Also, it defines operations to insert new sensor observations.

SOS

See "Sensor Observations Service".

Time Series

A sequence of numerical data points in successive order, usually occurring in uniform intervals. In plain English, a time series is simply a sequence of numbers collected at regular intervals over a period of time.

Universally Unique Identifier (UUID)

A universally unique identifier is an identifier standard used in software construction. A UUID is simply a 128-bit value. The meaning of each bit is defined by any of several variants.

World Geodetic System (WGS)

The World Geodetic System is a standard for use in cartography, geodesy, and navigation including by GPS. It comprises a standard coordinate system for the Earth, a standard spheroidal reference surface (the datum or reference ellipsoid) for raw altitude data, and a gravitational equipotential surface (the geoid) that defines the nominal sea level.

XML

Extensible Markup Language is a simple, very flexible text format derived from SGML (ISO 8879). Originally designed to meet the challenges of large-scale electronic publishing, XML is also playing an increasingly important role in the exchange of a wide variety of data on the Web and elsewhere.

3. DATA MANAGEMENT PLAN (DMP) FOR THIS EMSO NODE/USE CASE SCENARIO

According to EU H2020 indications [R1], following UK DCC tool indications [R2].

3.1 EGIM Architecture and Core Parameters Description

The EMSODEV main concept is to develop a key standard system for integrating the EMSO nodes. The key standard system is the EGIM, EMSO Generic Instrument Module, a multi-parameter module composed of the sensors required to acquire regional to global scale key data to capture short-term as well as long-term variations and changes in the ocean. EGIM is a vehicle for process integration; designing, testing, deploying, and receiving data from the EGIM provides a common project to meld the expertise and experience of the different members of EMSO. An EGIM Software Package will be developed to spur EGIM to a common range of standard user-oriented functions. The basic architecture of the EGIM is shown in the figure below where also the several Tasks planned in WP3 for prototyping are depicted.

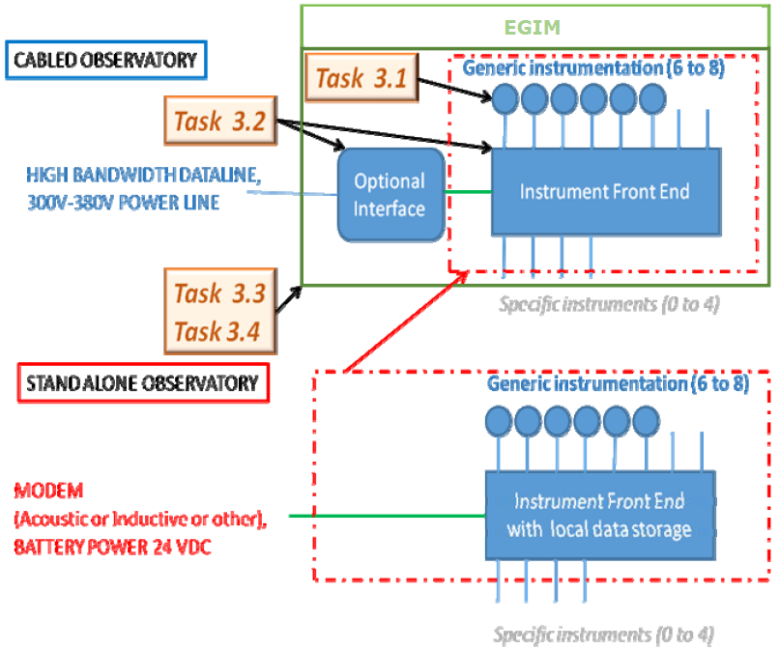

Figure 1 - EGIM basic architecture.

EMSODEV, by means of EGIM, will provide unprecedented support for full standardization across EMSO, which is a key factor to understand regional scale phenomena. Data will be made coherent and attractive for the modelling community and for other potential stakeholders. The project will define the state-of-the-art for open ocean observation technologies and, through the involvement of innovation-oriented European SMEs and large-scale industries, will reinforce positioning of European industry in a rapidly growing global market.

EMSODEV will also provide practical experience in joint purchasing, using, and benefiting from a sensor suite that is uniformly used across all the EMSO nodes, focusing on improvements from sensor integration to the provision of useful information and knowledge. This practical experience will also include user requirement updating and synthesis, setting and implementing maintenance and calibration best practices, data handling, and most importantly a fully uniform service activity that will ultimately be common to all sites while it will also underpin specific services as they are developed. Sensor development will be accompanied by common calibration, data archiving, data processing, data access.

The Marine Strategy Framework Directive (MSFD: 2008/56/EC [R6]) requires that Member States take measures to achieve or maintain Good Environmental Status (GES) by 2020. Marine monitoring is crucial, and the EGIM will measure parameters that can contribute to evaluating environmental status such as temperature, depth, salinity, turbidity, currents, noise and oxygen. With the increased pressure of human activities on the deep-sea environment, the EGIM will become a tool for monitoring of areas prior to and after human impact, also demonstrating how operational costs and maintenance risks can be constrained and minimized in the long-term.

With this aim, the project consortium agreed on seven core parameters that should be accommodated by the EGIM:

- Temperature
- Conductivity
- Pressure
- Dissolved O2
- Turbidity
- Ocean currents
- Passive acoustics

Moreover, up to 5 additional ports will be available for duplicate sensors or additional optional parameters that would be selected according to the site, in the following list:

- Fluorescence /Chlorophyll-A
- pH
- partial CO2 pressure
- partial CH4 pressure
- Imaging cameras.

All the core sensors must have a Technological Readiness Level (TRL) equal to nine (9); promising TRL 8 instruments could be discussed. The TRL is a concept originally developed within NASA for evaluating Space Technology. It has been widely used by various industries and organisations. Here we use the official EU table of the Horizon 2020 projects [R1]. The market for the optional sensors is developing. EGIM ports can also be used for development and trials of new sensors not yet at high TRL. EGIM will be designed for installation on the sea floor or in the water column, either connected to a cable or autonomous - powered by a local battery pack.
Information is collected from sensors on EGIM nodes. EMSODEV does addresses not only the Essential Climate variables (ECV) [R9], but also other essential ocean, solid earth and biodiversity variables. For example, passive acoustics are also dedicated to mammals and noise level of the sea, pressure is also measured at frequencies showing tsunami signals.

3.1.1 Scientific Parameters Requirements

The aim of ocean observatories is to monitor processes from the atmosphere-ocean interface, throughout the water column to the sea-floor, the sediments and earth's crust below (see Figure 2).

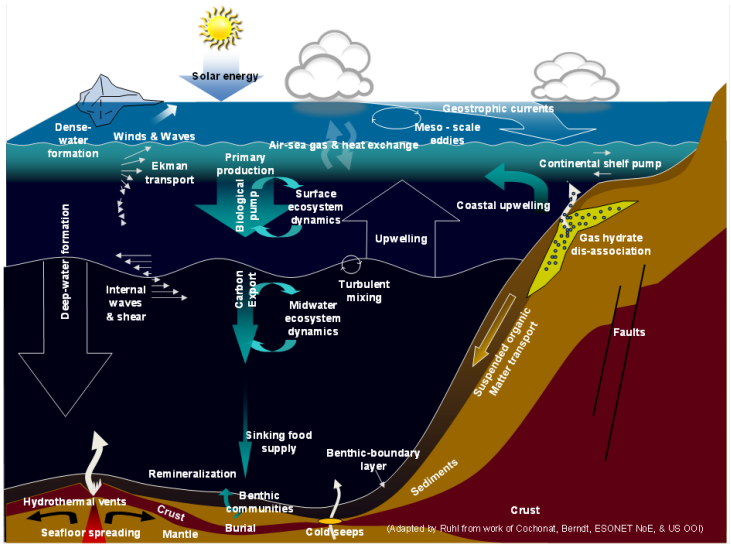

Figure 2 - Ocean processes that can be studied by means of observatories

These processes are expressed on different spatial and temporal scales from molecular processes and turbulent mixing at millimetre and centimetre dimensions and time scales of seconds to minutes to climate

change and mantle convection at global (104 km) dimensions and time scales of centuries to millennia. Fixed point observatories contribute uniquely to the temporal dimension with continuous vigilance on scales of seconds to years and decades, with the spatial dimension determined by the spacing of the array, in the case of EMSO around Europe.
Climate changes and the drivers producing them are amenable to detection by an effective network of ocean observatories operated over the next century. In order to do this, on EGIM, a sensor or instrument should:

- Meet a key scientific driver
- Meet depth and endurance requirements
- Have an High TRL level
- Have a Reasonable cost to be implemented

EMSO serves a range of scientific disciplines and it is important to consider the requirements already specified by other organisations such as Global Climate Change Observing System (GCOS) Essential Climate Variables.
These have been defined for Atmospheric, Terrestrial and Oceanic domains [R4]. For the oceanic domain, surface variables are defined to include the surface mixed later usually within the 15m of the ocean and sub-surface are deeper measurements.

GCOS Essential Climate Variables Oceanic Domain	
Surface	**Sub-surface**
Sea-surface temperature	**Temperature**
Sea-surface salinity	**Salinity**
Sea level	**Current**
Sea state	**Nutrients**
Sea ice	**Carbon**
Current	**Ocean tracers**
Ocean colour	**Phytoplankton**
Carbon dioxide partial pressure	

Table 1 - GCOS Essential Climate Variables

Most of the commonly used sensors within EMSO have applications across a wide range of disciplines and the challenge is to come to agreed specifications regarding location in the water column and on the sea floor, range, sensitivity, response time and accuracy requirements. Table 2 shows links between monitored variables and disciplines.

Variable	Geosciences	Physical Oceanography	Biogeochemistry	Marine Ecology
Temperature	X	X	X	X
Conductivity	X	X	X	X
Pressure	X	X	X	X
Dissolved O_2	X	X	X	X
Turbidity	X	X	X	X
Ocean currents	X	X	X	X
Passive acoustics	X			X

Table 2 - Multidisciplinarity of EGIM Core Parameters.

The different disciplines also have important differences with respect to the time scale of measurements, some requiring fast responses time defined in seconds or minutes whereas for other applications daily or weekly sampling intervals are acceptable. The general concept is that sensors or instruments should function for one year between servicing and recalibration.

3.1.2 Measured and Optional Parameters

The project agreed on a core set of seven parameters characterised by high TRL values for sensors, wide existing usage and relevance to multiple disciplines. The details can be found in the first version of D2.1 [R4] and will be reviewed by further WP2 deliverables. Here a table enlisting the core parameters are attached.

Variable	Range	Accuracy	Sensitivity
Conductivity	0 to 9 S/m	0.001 S/m	0.00005 S/m
Temperature	-5 to +35°C	0.005 °C	0.0001 °C
Pressure	0 to 600 bar	0.1 % FSR	0.002 FSR
Dissolved oxygen	0 to 500 µM	5%	0.1 µM
Turbidity	0 to 150 (0 to 50) NTU	10%	0.013 NTU
Currents	0 to 5 m/s (50 m measuring distance)	2%	-
Passive acoustics	20 – 200000 Hz	-	-190dB ± 3dB (re 1V/µPa)

Table 3 - EGIM Core Parameters.

For more information, please refer to EMSODEV Deliverable D2.1 [R4] and further WP2 deliverables.

EGIM SUPPORTED OPTIONAL PARAMETERS			
Parameter	Range	Accuracy	Sensitivity
Fluorescence /Chlorophyll-A	0 to 50 µg/l	-	0.02µg/l
pH	0 to 14 pH unit	0.005 pH unit	-
partial CO_2 pressure	0 to 4000 µatm	±1 % of reading	< 1 µatm
partial CH_4 pressure	0 to 40,000 µatm	±3 %	< 1 µatm

Table 4 - EGIM supported optional parameters

High Definition video and Still imaging Specifications		
Resolution	1600×1200	pixels
Minimum video capture speed	20	Frames per second
Sensitivity	0.05	lux
Sensor type	CMOS	
Sensor size	0.5	inches
Output protocol	TCP/IP	
Sensitivity to IR light	850 -900	Nano metres

Table 5 - High Definition Video and Still imaging specifications.

Lighting system		
Minimum luminosity at one (1) meter	1000	Lux
Lighting temperature	6500	K

Table 6 - Lighting System specifications.

3.1.3 Off-the-shelf Instrumentation Survey and Selection

Sub-sea instrumentation has diverse applications. Oceanographic Research is a small fraction of total activity as exemplified by results from a market review done within the EU NEXOS project (http://www.nexosproject.eu/). Table 7 reports the outcomes of the assessment. For detailed information on this activity, please refer to Deliverable D2.1 [R4].

Market Assessment for Ocean Instrumentation and Sensors (EU NEXOS Project)					
Aim **Market**	**R&D**	**Industrial/ Economic Perspective**	**Legal**	**Role of Sensors**	
Sensor aim from the perspective of market sectors				**Today**	**2020**
Monitoring and Environmental Quality	√	-	√	**	***
Offshore Oil & Gas	√	√	√	**	***
Industrial water quality measurements	-	√	√	**	**
Oceanographic Research	√	√	√	**	**
Fisheries	√	√	√	*	**
Aquaculture	√	√	√	*	**
Ocean Renewable Energy	√	√	-	*	**
Deep Sea Mining	√	√	-	-	***
Port Security	√	√	√	*	***

Table 7 - Market Assessment for Ocean COTS.

In the table above, the √ sign states that Ocean Instrumentations and Sensors related to the Market enlisted in the first column are also compliant with aims of the corresponding field of application (R&D,

Industrial/Economic Perspective, Legal). The most right columns describe the intensity of the sensors contributions to enlisted markets, nowadays and in the medium term. Intensity is represented by one, two or three asterisks respectively representing good (*), high (**) and very high (***) contribution.

Sensors are often multi-purpose and suppliers are not wholly dependent on one single group of clients but they design their products with multiple users and applications. EMSODEV will exploit capabilities of such a mature market for sensors. A general classification of the sensors in marine industry is:

- Sensors in which the technology is mature (High TRL) and there is more than one compliant manufacturer.
- Sensors where the TRL is intermediate and there may be only one leading technology with other manufacturers trying to improve their product.
- Sensors with no off- the- shelf supplier and support.

In terms of overall market activity for marine science and technology, Oil and Gas remains the largest sector according to a survey of the UK Marine Scientific Industries (see Figure 3) and EMSODEV, when necessary, looks at it as a reference model. As in that sector, EMSODEV looks for robust and tested equipment with high TRL, being more interested in information and services acquired rather than in the sensor itself. As depicted in Figure 3, the market has developed into multiple tiers, with instrument manufacturers sourcing components, the instruments being packaged into operational systems, operators managing the systems, data banks archiving and processing information and service providers delivering products to the final users. The total market is much larger than the value of the hardware deployed in the ocean.

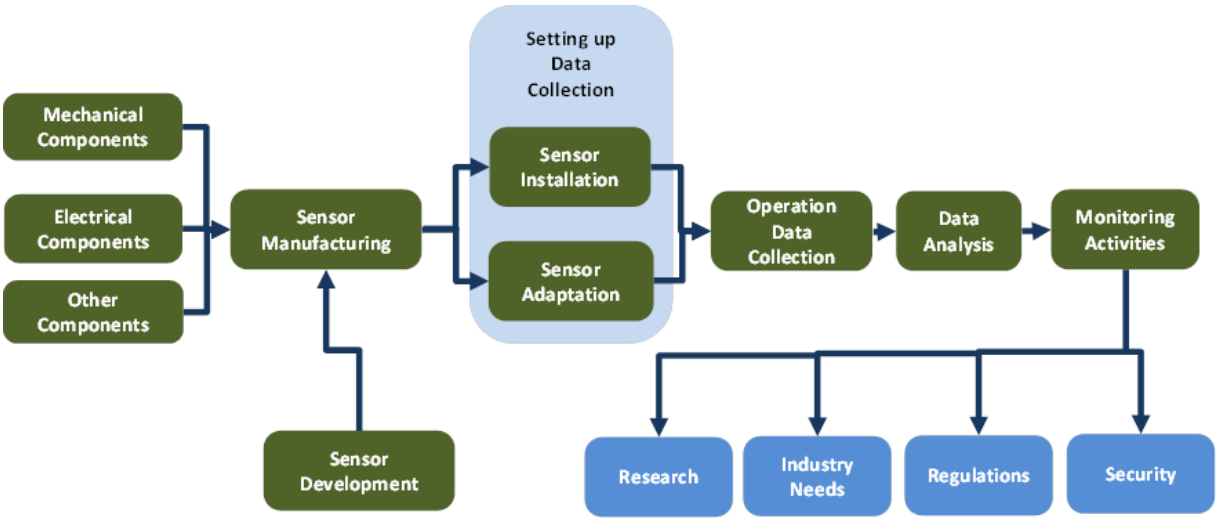

Figure 3 - Value Chain of Environmental Monitoring Services.

A mature market is able to supply Commercial off the Shelf (COTS) sensors for most of the anticipated EGIM-EMSO core variables. This is demonstrated by the commissioning of two DELOS (Deep Sea Long Term Observing System) platforms on behalf of British Petroleum (BP) to provide environmental information at 1400m depth off Angola in an area of oil and gas exploitation. This now functions as part of the FixO^3 network. Since the system is part of an oil field installation, it uses entirely tried and tested COTS instrumentation modules, sensor and equipment that can be serviced within the routine operations of the oil field. The DELOS platform hosts a full suite of 11 instruments.

The EMSO community itself has considerable experience and knowhow. It is important to record what type of equipment the partners are using in their observatories. There are opportunities for EMSO infrastructure to be used to introduce sensors that are not yet at a high TRL. This will improve the technology and the performance of the sensors accelerating development towards meeting user and industry requirements. The scientific community also needs to develop links with the “Integrators”: the companies and organizations that assemble sensors and instrumentation into systems to deliver solutions to their clients in the private and industry sector. In this aim, it is important that the EMSODEV community collates and shares information in order to facilitate good procurement decisions.

3.2 EMSODEV draft data policy

The present operational status of EMSO, and data acquisition and dissemination activities, have 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.
Some data are presently (EMSO interim phase) displayed through a provisional Data Portal relying on interconnected data management systems supplied by a subset of the partners and accessible through PANGAEA® (http://dataportals.pangaea.de/emso). An open data policy has already been adopted in compliance with the recommendations being developed within the GEOSS initiative (The Global Earth Observation System of Systems) to allow for the shared use of the data infrastructure and the free exchange of scientific information and knowledge. Some of the partners also enabled Data Access to Regional Data in a visualization-only mode. This is the case of Multidisciplinary Oceanic Information SysTem (MOIST, http://www.moist.it). A compatibility between near real time data and delayed mode archived and quality-controlled data is needed. FixO3 provides a background to find common solutions. One example is the EMSO Azores DOI constitution sequence (http://www.emso-fr.org/EMSO-Azores/Data-access). It is widely agreed that a more effective data access service, leveraging automatic handling of information, should be implemented.
EMSODEV will accelerate EMSO integration across research and monitoring sites and will create the framework to coordinate and streamline efforts needed to achieve sustained infrastructure operation of both observation components and data management, thus providing additional impetus to the EMSO-ERIC organisation and to the expansion of the user base.

To this aim, EMSODEV currently works hard a commonly agreed Data Policy based on past experience and negotiation activities already put in place by the community during the several activities of joint research. EMSODEV also exploits the huge work performed by the ESONET Network of Excellence (http://www.esonet-noe.org/About-ESONET) and FixO^3 project (http://www.fixo3.eu/). The global community needs will be matched to the individual member requirements in order to identify a strongly agreed set of rules opening a path to availability of widely shared, disseminated, and preserved information to the whole EMSO community. Therefore, suggestions and requirements presented by national initiatives, like RITMARE Italian flagship project (http://www.ritmare.it, English version of project website available at http://www.ritmare.it/en/index.php?option=com_content&view=featured&Itemid=101), are going to be taken in strong consideration. By taking advantage of the FixO^3 Data Policy [R4] and other inputs received by the community, the project identified a set of new concepts and rules being the pillars for discussion and then final definition of the EMSODEV Data Policy. For convenience, the FixO^3 Data Policy concepts are reported in the following list and are also merged with elements from the RITMARE Data Access Policy. For RITMARE, in fact, four elements concur in defining an Access Policy as open as possible and EMSODEV will keep these into consideration:

1. when data are produced with public funds, public use, even outside the project community, must be encouraged;

2. open sharing of data quickly improves knowledge and project/research results; this also leads to a better organisation of both scientific and management work;

3. sharing data promotes visibility and scientific production for the individual researchers who produced them;

4. sharing enables reusing of data by others having different (even partially) goals from the data 'producers' leading to a bigger exploitation of acquired data and improving further research with new inputs.

Trans National Access (TNA) Data requirements are not discussed here because this issue is out of the scope of the EMSODEV project. EMSO will take care of defining data access and provision of TNA users in its own Data Policy.

On moratorium related aspects, it is probably worth providing some considerations made during the negotiation. Even if it is commonly agreed that observational data and metadata should be made available without undue delay to users, the need of a delay (moratorium) could arise in exceptional circumstances and should be covered by the Data Policy. Differences were found in the expected length of moratorium periods (FixO^3 two year max, RITMARE 6/12/18 months max depending on the case) and this will have to be agreed in the near future.

The next two paragraphs include the basic principles for data sharing and dissemination and for data requirements as derived from previous achievements of the marine community.

3.2.1 Data sharing and dissemination policy basic concepts

1 Research infrastructures strongly support free, open and immediate access to data and metadata produced by their facilities and are committed to working towards the realisation of this principle, taking into consideration ethical matters. This is in accordance with the Aarhus Convention on environmental data, the INSPIRE directive and the Directive 2003/4/EC (on public access to environmental information).
2 All data, metadata or data services generated during the project will be made available to an agreed standard and in an agreed format via a website. Appropriate domain specific ontologies and controlled dictionaries such as the BODC vocabularies (also used in SEADATANET) should be used within EMSODEV metadata descriptions.
3 Data provision/deposition is under the responsibility of data providers.
4 Free and open access without any restrictions shall be granted to all data and metadata.
5 It is recognised that under exceptional circumstances, data access may be restricted for a limited period of time. This must be agreed with the project steering committee in advance.
6 All data, data products and metadata derived from EMSODEV must be appropriately attributed in any publications to the members responsible for their acquisition.
7 Data and associated metadata will be subject to long-term archiving.
8 A metadata catalogue developed through EMSODEV shall be made accessible via the website, in a standard format.
9 A standards & services registry shall be made available via the website.
10 Unless stewardship of data is explicitly transferred, the general responsibility for data sets that have been made available via the EMSODEV data dissemination services entirely remains with the contributing institution.
11 Data will be provided by partners for visualisation on the data portal and, if agreed, by the data tool. All provided data must be accompanied by a link to the complete dataset residing in the data owner's data management infrastructure (or an appropriate data centre) to foster its use for scientific purposes.

3.2.2 Data basic requirements

1 Data will be deposited in an appropriate data centre providing long-term archiving services
2 Access to data will be made simply and easily through the EMSODEV metadata catalogue available on the web site.
3 Data providers will adhere to standards to allow their data and metadata to be embedded within the adopted data catalogue or other adopted dissemination means:
   a. Metadata shall be provided for each data set.
   b. If metadata is integrated within a data file, the file needs to be in an agreed format. Acceptable data formats are NetCDF or ODV.
   c. If metadata is provided as a separate file, this shall be encoded in an agreed format, preferably INSPIRE compliant XML formats that are ISO19115 compatible.
   d. Metadata needs to be made available via standard protocols such as OAI-PMH or OGC CSW or via HTTP or FTP.
   e. Data shall be made available via the internet either via HTTP/S possibly in the form of REST services or via FTP.
   f. Real time sensor data shall be provided via the OGC Sensor Observation Service (SOS). In this case, the data shall be delivered in the OGC Observations & Measurements (O&M) format. SensorML/O&M profiles will be established in order to guarantee interoperability between partners/systems.
   g. High bandwidth data (video, acoustic, images) shall also be provided via a Sensor Observation Service. The Observations & Measurements protocol will hold accompanying metadata and a link to the actual file(s).

3.2.3 Open Access policy

Currently, all research and innovation activities rely on previous work and in most cases their success depends not only on the work of the scientists but also on their ability to access and share information and results. As a consequence and in order to maximize the return on investment for this project and for future related research and innovation activities, EMSODEV has adopted an Open Access Policy envisioning to grant free open access to any scientific information generated under the scope of the project to the general public. Nevertheless, any

foreground generated within the project will be analysed to evaluate whether there is a potential exploitation prior to any dissemination action. Once EMSODEV IPR has been assured, any publishable scientific and technical result arising from the scope of EMSODEV will be subject to a double Open Access strategy (Figure 3). Initially, the published article or the final peer reviewed manuscript will be archived in an online repository after or alongside its publication according to the requirements of "green" open access. As discussed in Section 3.2.1, this strategy must be coupled to match decisions made by the Consortium in terms of an eventual moratorium period (embargo) due to exceptional circumstances. However, it is already stated that, if the embargo period requested by the scientific publisher surpasses the 6 months limit settled by the EC, the publication will be moved to "gold" open access granting its immediate open access by the scientific publisher. The requested costs will be charged to the devoted budgetary provision of the project.

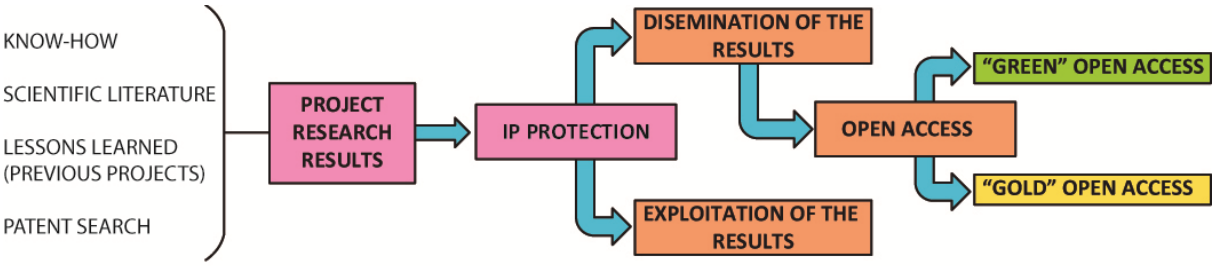

Figure 4 - Scheme of the open access policy of the EMSODEV project.

Following the recommendation of the EC, the different partners of EMSODEV will assume to do their best effort to deposit at the same time the research data needed to validate the results presented in the deposited scientific publications, into an open access online repository. Regarding the copyright, EMSODEV will always try to make use of Creative Commons to retain their copyright and grant adequate licenses to publishers. Most publishers allow researchers to deposit an Open Access version of a paper in a repository, even if the journal is not Open Access. Moreover, EU funded data repositories such as OpenAire (https://www.openaire.eu/) and Zenodo (http://www.zenodo.org) have to be taken into account as possible solutions for providing data availability in these portals.

With all these actions EMSODEV demonstrates its alignment with the vision of the EC that sees knowledge as a source of competitive advantage and open access as the most appropriate tool to:

- Accelerate the research and discovery process, leading to increased returns on R&D investment.
- Avoid the duplication of research efforts, leading to savings in R&D expenditure.
- Enhance opportunities for multi- and inter-disciplinary research, as well as inter-institutional and inter-sectorial collaborations and increased returns on public investment in Architecture & Design and the potential for the emergence of new industries based on scientific information.
- Increase openness and transparency and thereby contribute to better policy making and ultimately benefit society and citizens.

3.3 EGIM Data Collected during first deployments

3.3.1 DMP at initial stage

Data set description

The aim of EMSODEV is to develop and deploy an instrument module to measure a specific set of variables suitable for all sites and depths, including: temperature, conductivity (salinity), pressure (depth), turbidity, dissolved oxygen, ocean currents, and passive acoustics (see Table 5). These variables are important in the context of climate system monitoring and are known as Essential Climate Variables, which were defined to support the work of the UN Framework Convention on Climate Change (UNFCCC) [R22] and the IPCC [R23][R24]. As sensor development progresses other variables can be considered, such as the remaining ECV and other key chemical variables (e.g. Chl-a, pH, CO2, CH4, H2S, Eh, and hydrocarbons).

Variable	Geosciences	Physical Oceanography	Biogeochemistry	Marine Ecology
Temperature	X	X	X	X
Conductivity	X	X	X	X
Pressure	X	X	X	X
Dissolved O_2	X	X	X	X
Turbidity	X	X	X	X
Ocean currents	X	X	X	X
Passive acoustics	X			X

Table 8 - Core variables captured by the EGIM

These seven variables will be fully addressed by EMSODEV. Further generic variables of interest include pCO2, pH, pCH4, Chlorophyll a, and time-lapse photography. These could be considered in case of specific needs and opportunities identified during the project lifecycle and based on additional national funds obtained by the observatory owners. Other parameters, such as seismic motion or detection of gas bubbles are assumed to be "specific" and not "generic" as they are less cross-disciplinary at this stage. Specific instrumentation and related common practices is in the scope of EMSO but does not address all the sites and all the targeted membership as strongly as the generic instrumentation does.

These generic variables can be used to directly address a wide range of geohazard warning and scientific applications related to understanding natural and anthropogenic variation and the possible impacts of climate change. They will also provide supporting data to a large set of additional uses. Some of these systems are able to detect passing tsunami waves and associated low frequency sounds related to earth motions. In the observatory setting, these data can then be relayed back to shore via seafloor cable or satellite telemetry within seconds to minutes respectively. Because nearly all tide gauges are along shorelines, offshore data can improve tsunami warning times. The systems are also able to detect storm and tide wave loading, and sedimentation dynamics that influence turbidity, such as re-suspension and benthic boundary layer (BBL) dynamics. By linking tide, turbidity, and current meter readings, interaction strength and thresholds for re-suspension and sediment transport can be further described. Furthermore, the measurement of these parameters on the seabed and in the water column can help determine how seabed processes interact with ocean circulation, biogeochemistry, and ecological variables. Combining generic sensors with specific sensors such as seismometers, geodetic sensors (e.g. tiltmeters, bottom pressure recorders), bubble flux observing systems, hydrothermal flow meters, and piezometers, the remaining key questions can be addressed.

Generic sensors can also help address questions related to physical oceanography using modules deployed at the surface, midwater or at the seafloor. The use of salinity and conductivity sensors spaced regularly along strings and additional ADCP coverage can capture themes related to ocean physics. These include understanding wind-driven and deep-ocean circulation, planetary waves, and interactions between the BBL and the seabed. Mobile systems, such as gliders, used in conjunction with the long-term observatories can also augment the impact of generic sensors.

The oxygen sensor in the generic specification can address several aspects of biogeochemistry. Oxygen itself is important for aerobic life in the oceans, which includes all metazoans (e.g. zooplankton, fish, and benthic invertebrates). Oxygen in the oceans is replenished primarily by inputs related to photosynthesis and equilibration at the air-sea interface. By making some basic assumptions one can estimate how much oxygen has been utilized by measuring how much remains compared to saturation levels (apparent oxygen utilisation

[AOU]). Therefore, variations in oxygen minimum zones (OMZs), as well as oxygen dynamics in the rest of the water column are of interest. Generic modules will also be able to make sensitive measurements of how oxygen concentration relates to turbidity and temperature, which have both connections to time variant respiration and/or remineralisation.
As sensor technology develops, biogeochemical sensors are beginning to transit from specialized to generic instruments in the coming months and years, including pCO2, Chlorophyll A, pCH4 and pH sensors. The use of noble gas sensor technology is also envisaged aiming at serpentinization-methane formation processes in the oceanic lithosphere.
Carbon dioxide is an abundant greenhouse gas and is a key molecule in the oceans' biological pump. It is transferred from the atmosphere into the ocean and incorporated into phytoplankton production during photosynthesis. Some of this photosynthetic production is exported out of sunlit surface waters and sequestered for extended periods of time. There remains, however, much uncertainty in the transfer rates and dynamics of CO2 uptake.
Measuring chlorophyll-a as an indication of the amount of primary production through the water column has many implications for biogeochemistry and marine ecology. These include sedimentation processes from the sea surface to the seabed, the input amount and seasonality of organic material, and the latter's role as food supply and the resulting implications for the existing fauna in different habitats. Chlorophyll-a also provides insight into the importance of other parameters that trigger plankton blooms, as well as their seasonality/periodicity.
Moreover, the more specialized measurements of particulate fluxes greatly augment the breadth of biogeochemical themes that can be addressed. The most elemental of these themes is oceanic carbon and greenhouse gas uptake, storage dynamics, and estimating how anthropogenic change might alter the efficiency of the biological pump.
Another sensor with generic specification is the hydrophone, which is capable of detecting marine mammal sounds. Currently, there are hydrophone-based systems that can detect the position and identity of mammal sounds and thereby come up with estimates of density and distribution. Other sounds can also be detected, including geohazard events, anthropogenic sounds like those of passing ships, as well as rain, and the sounds of certain plankton and fish. Combining these systems with other ecological measurements will provide verification data that is needed to improve the detection of even more sounds.
ADCP systems providing horizontal and vertical currents and acoustic backscatter intensity can be used to make long-term observations of zooplankton and fish biomass and distributions, after calibration for those groups. For example, the relative density variations associated with diurnal vertical migrations and their variation from hours to decades can be quantified and calibrated. Knowledge of variability in zooplankton biomass is important for understanding the effects of climate change on ecosystems. In addition, zooplankton contribute to the transport of carbon and nitrogen to the deep sea via production of faecal pellets and active transport by diel vertical migration, important components of the biological pump.

Data set origin and rates

At the time of writing of this report, the EGIM output data format (e.g. XML-based structured data) is not yet defined and an agreement on adoption of a common format for all sensors data is on-going. Adoption of an abstract type of data can strongly improve use of automated searching, retrieval, and processing features.

Quantitative information on EGIM Data are not yet available since the EGIM module is still under development. Data size, average amount of data in a period, and dataset update policy/period will all strictly depend on the final choice of sensors and on the specific field of application. Moreover, a certain kind of dependency will be set also on the specific observatory deploying EGIM.

As described in the Description of Action document [R1] the EGIM module will be deployed on 3 EMSO nodes still to be selected (WP5). The EMSODEV deliverable D2.1 [R2] formalized requirements to address, so the EGIM can operate and obviously produce data on both autonomous and cable-connected observatories.

Detailed information on observatories can be found in Section 4. A classification of observatories on connection technology is depicted in the following table.

	Arctic	Atlantic	Mediterranean/ Black Sea
CABLED			Ligurian, Western-Ionian, Hellenic
STAND-ALONE	Fram-Strait	PAP, Azores, Canary Islands (PLOCAN), Iberian Margin	Black Sea

Table 9 - Autonomous and cable-connected EMSO Observatories.

More precise information will be available in the DMP during the project, and obviously at the final stage.

Standards and metadata

As far as the selection of standards to be used, the EMSODEV project agreed on adopting widely recognized metrology and calibration standards that result from research projects such as JERICO (http://www.jerico-fp7.eu/) and EMODNET (http://www.emodnet.eu/). EMSODEV data will adopt the most common standards from Open Geospatial Consortium (OGC), NASA, and INSPIRE for properly and effectively organising the Data Management Platform. WP6 will amend the present document along the project in a continuous manner to follow the evolution of the standards adoption process.

Real time data access will be ensured through adoption of several standards like OGC Sensor Web Enabled (OGC SWE, http://www.opengeospatial.org/projects/groups/sensorwebdwg) standards specifying interoperability interfaces and metadata encodings that enable real time integration of heterogeneous sensor webs into the information infrastructure. Developers use these specifications in creating applications, platforms, and products involving Web-connected devices such as flood gauges, air pollution monitors, stress gauges on bridges, mobile heart monitors, Webcams, and robots as well as space and airborne earth imaging devices. SWE specification like Sensor Observations Service (SOS), Sensor Model Language (SensorML), and Observations & Measurements (O&M), will be supported.

Metadata will be made available in various formats such as an extended Dublin Core format, ISO19139 and via Harvesting and Catalogue services such as Catalogue Service for the Web (CSW), OpenSearch and OAI-PMH via the EMSO Portal.

The low level engineering data formats, time stamping, metadata, and sensor metadata in terms of how they affect multiplexing within the EGIM will be collated to enable incorporation into practical design proposals.

Data sharing

EMSODEV data will be acquired by the EMSO Generic Modules (EGIMs). Through an EGIM Sensor Observation Service Gateway, data will be dispatched both to the EMSO Regional Data Nodes and to the Data Management Platform. This latter will process, store data and make it accessible, through EMSO Portal and other initiatives, to different research communities. The services of the Data Management Platform will allow access and use of data via web API (Application Programming Interface) that is a set of routines, protocols and tools available through the web for building software applications and accessing/using data.

Data will be made available via a series of initiatives such as Global Earth Observation System of Systems (GEOSS, http://www.earthobservations.org/geoss.php), Copernicus (http://www.copernicus.eu/) and EMODNET.

Any research infrastructure has to strongly support a free and open access data policy produced by their facilities, according to the European Commission (EC) guidelines.

As mentioned above, MOIST portal (www.moist.it) is a data management system for multi-parametric observatories focused on standards, open accessibility and web services. It can be an example of web interface operation as it allows users to discover and visualize the metadata and data related to seafloor campaigns with GEOSTAR-type observatories from 1998 to present. The figure below shows how the data are preserved and describes how to manage the various phases of the data-chain, from the retrieval from observatories to the web publication. Such as an example, keeping a PDF reader available is necessary to read sensor documentation and manual PDF.

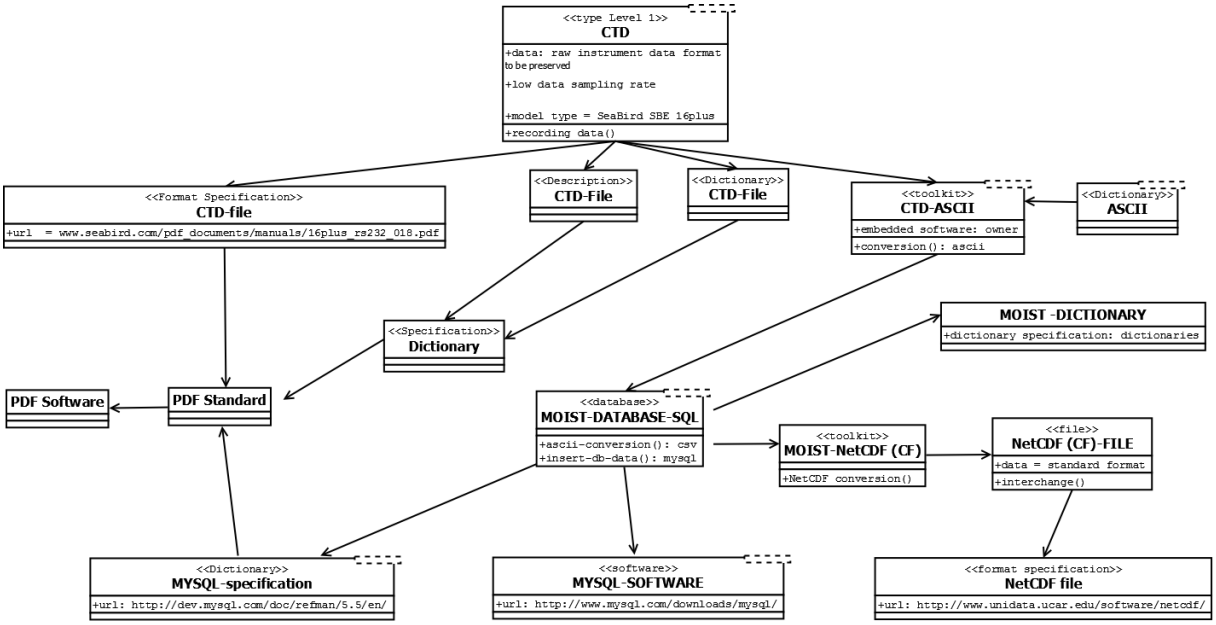

Figure 5 - Graph Data dissemination and chain for CTD data set.

Data are also shared through Creative Commons Attribution 4.0 International License (CC BY 4.0) through the MOIST website.

As already discussed in Section 3.2, the EMSODEV SC widely agreed that is not enough and a more effective data access service, leveraging automatic handling of information, should be implemented.

Archiving and preservation

Medium to long-term preservation will be ensured by the regional EMSO nodes. Long term archiving will be ensured by national and international certified long-term data archived such as those of the ICSU World Data System (PANGAEA) and the National Oceanographic Data Centers (NODC).

A common approach for Data Preservation can be derived from the work already done during several years-long research and analysis activities, later formalized through the SCIDIP-ES project (http://www.scidip-es.eu). See Annex A for a detailed description.

Discoverable Data

Starting from the landscape of various EMSO observatory data flows, status, and plans, the EMSO data management plan will be developed around the EGIM data, data and sensor metadata. It will also determine the PID and data policy, IPR issues, the sensor registry implementation procedure, the data/metadata dissemination in compliance with main data/catalogue discovery/aggregator systems. (e.g., GEOSS, EMODNET, RDA, WDS).

Accessible Data

As already reported, Data acquired by EGIMs will be made available to both EMSO Regional Data Nodes and the Data Management Platform. The latter will enable access and use of data via web API. This allows external interested developers and researchers to remotely access to data and implement new solutions that can extend the EMSODEV Data Management Platform through new features.

Assessable and intelligible Data

This issue is a key-point for EMSODEV. Discussion is in progress within the consortium. WP6 will drive the activity of Data Management such as assessability and intelligibility be ensured.

Data usable beyond the original purpose

Adopted sensors are often multi-purpose and designed for multiple users and applications. Since EMSODEV will exploit capabilities of such a mature market for sensors data produced by the project will be available for usage

beyond original purpose. Data collected clearly will be useful for the wider public needs and usable for the purposes of non-specialists.
Selection of certified repositories for long-term preservation and curation is in progress at the time of writing. The data should be stored together with the minimum software, metadata and documentation to make it useful. The way to implement this is still to be decided.
This issue is central for EMSODEV. Discussion is in progress within the consortium. WP6 activity within the Data Management framework will drive the decision.

Data interoperable to specific quality standards

By exploiting the capabilities of the consolidated ESONET architecture and addressing requirements produced by Architectural Design for Data Management Platform in Task 6.2, EMSODEV will promote standardization and integration of archived data from Regional EMSO Nodes. This will be done with the aim of improving the overall accessibility and reusability of local node data via the EMSO data portal. In cooperation with FixO^3, AtlantOS as well as MyOceans, this task will identify interoperability options as well as capabilities based on international standards (e.g. OGC SWE) to integrate regional EMSO nodes to the Data Management Platform.

3.4 Candidate Sensors according to present WP2 specifications

Here following is a non-exhaustive list of Sensors which EMSODEV could integrate into the EGIM, depending on the specifications of WP2, classified by sensor type. This list is provided as an initial description of the integration plans and is subject to change. It will be amended as the project progresses.

3.4.1 Description of Sensor Type #1: CTD

CTD data give information on sea water Conductivity, Temperature and Pressure. As an example we describe a SeaBird SBE 37-SM Microcat sensor, which is the data originator installed on NEMO-SN1 EMSO node.
Data are sent in ASCII format through a RS232-based serial protocol. The MicroCAT is supplied with a Windows 2000/XP software package, Seasoft© V2, which includes:
• SeatermV2© – terminal program for easy communication and data retrieval.
• SBE Data Processing© – programs for calculation, display, and plotting of conductivity, temperature, pressure (optional), and derived variables such as salinity and sound velocity.
Obviously where appropriate, data acquisition can be done through an ad-hoc external software without making use of the manufacturer software mentioned above. This is the case of INGV campaigns.
Temperature and conductivity are stored using 6 bytes/sample, time 4 bytes/sample, and optional pressure 5 bytes/sample; memory capacity is in excess of 530,000 samples. The MicroCAT can be powered by a 10.6 Amp-hour (nominal) battery pack consisting of twelve AA lithium batteries (Saft LS14500) which, when removed from the MicroCAT, can be shipped via commercial aircraft. The pack provides sufficient internal battery capacity for more than 630,000 samples for a typical sampling scheme. Use of internal battery can be disabled. Moreover, usage of internal storage can be avoided by using real-time spoofing of data sent through an RS232 connection. This is also the case of INGV measurement campaigns.
Instrument resolutions per measured parameters are the following:

- Conductivity: 0.00001 S/m (0.0001 mS/cm)
- Temperature: 0.0001 °C
- Optional Pressure: 0.002% of full scale range

Measurement ranges per parameters are:

- Conductivity: 0 - 7 S/m (0 - 70 mS/cm)
- Temperature: -5 to 35 °C
- Optional Pressure: 20/100/350/600/1000/2000/3500/7000 (meters of deployment depth capability)

CTD is used in order to monitor possible variations of sea water masses in the area. Data are used in scientific papers after values are combined and compared. A time series comparison is usual.
CTD data could be useful to oceanographers, climate scientists, biologists, geochemists and all scientists who are indirectly interested in measuring sound propagation velocity in seawater, such as astrophysicists.
CTD data were already produced at many EMSO nodes, e.g., between June 10, 2012 and June 12, 2013 at western Ionian node, where sensor coordinates were 37.54765 N, 15.3975 E (in WGS84 standard). Sampling

rate was 1 sample/hour leading to 8,640 records corresponding to a periodical data size of about 500 KB/year. Originating platform was a fixed cabled benthic node, NEMO-SN1.

3.4.2 Description of Sensor Type #2: ADCP

The Acoustic Doppler Current Profiler measures the water velocity using the physical Doppler shift principle. The transducer generates a pulse of sound at a known frequency that travels through the water and is reflected in all directions by particulate matter (e.g., sediment, biological matter, bubbles). Some portion of the reflected energy travels back at the transducer where the processing electronics measure the change in frequency. The Doppler shift measured by the transducer reflects the velocity of the water along the axis of the acoustic beam. The ADCP operates using transducers (usually four) generating beams with different orientations relative to the water flow. The measured velocity by each ADCP transducer is the projection of the 3D velocity onto the axis of its acoustic beam.

This type of data were already produced in EMSO nodes, e.g., between June 10, 2012 and June 12, 2013 in the Western Ionian node by a Teledyne RDI WorkHorse Sentinel ADCP 600 kHz connected to the NEMO-SN1 observatory. Sensor coordinates were 37.54765 N, 15.3975 E (in WGS84 standard). The instrument sampling rate was changed several times during the campaign. From 11/19/2012 until the end it was set to acquire 1 profile every 5 minutes for the first 20 minutes of each hour (i.e. 4 profiles per hour with 40 minutes of silence) to a data size of about 100 MB/year.

3.4.3 Description of Sensor Type #5: Hydrophone.

Hydrophones allow the acquisition of acoustic signals in water at different frequency bands. Their scope of interest spans from ambient noise in the deep water, to sperm whale and cetaceans detections, to seismic signal acquisitions that may be tsunami precursors. The signal of interest affects the requirement on the band-pass of the instrument.
Acoustic data are already acquired in many EMSO nodes, e.g., between June 10, 2012 and June 12, 2013 at the Western Ionian node, by means of hydrophones connected to the NEMO-SN1 observatory. One of those hydrophones was the SMID DT-405D(V)1, whose coordinates were 37.54765 N, 15.3975 E (in WGS84 standard). It's a seismic hydrophone (frequency band 50mHz - 1kHz) sampled at 2 kHz. The hydroacoustic pressure signal is sampled at a 2kHz rate by two A/D converters (12 bit) which supply two data channels (with low, 30dB and high, 60 dB gain). Pressure data are stored in count units; 1 count corresponds to 0.546 Pa and 0.0172 Pa for the low and high gain channels respectively. Absolute time reference is available thanks to GPS data embedded in each packet of data and distributed from the land station to the seafloor. The dataset of that campaign contains 292.5 GB of data stored in 52560 files of ten minutes each and covers 8717.82 hours of acquisition (292.5 days) which was continuous during the mission, excluding some periods when acquisition was stopped for observatory maintenance and calibration. Physical data are represented as an “int” value in the proprietary binary format. Data are sent through a RS232-based serial protocol (115200 n,8,1).

3.4.4 Description of Sensor Type #6: Pressure Gauge.

This sensor measures the hydrostatic (water column) pressure exerted on the sensor resulting from the pressure of water above its position and the atmospheric air pressure acting on the sea surface. When it is not possible to use a vented reference to equalise the offset due to atmospheric pressure, the true water level is obtained from the PG by measuring and subtracting the atmospheric pressure at the sea surface from the PG measurement.
This type of data are already produced in many EMSO nodes, e.g., between June 10, 2012 and June 12, 2013 in Western Ionian node by the NEMO-SN1 observatory. The sensor was a Paroscientific Digiquartz Depth Sensor 8CB-4000-I. Data are sent by the sensor in ASCII format through a RS232-based serial protocol. The instrument is fully configurable. Measurement resolution increases as sampling rate decreases in instrument configuration. Sensor coordinates are 37.54765 N, 15.3975 E (in WGS84 standard). Sampling rate is 1 sample/15 sec. leading to 2,090,127 records corresponding to a data size of about 100 MB/year. For this campaign, a 15 s sampling period was chosen. In that case, pressure data was also used for tsunami detection: as an example, a tsunami detection algorithm runs on the NEMO-SN1 data acquisition system.

3.4.5 Description of Sensor Type #7: Turbidity Meter.

Turbidity meters have been used in order to monitor possible variations of sea water masses in areas of strong mixing of different water masses (e.g. Mediterranean and Atlantic waters). Turbidity measurements also provide information about possible resuspension of particles due to bottom currents.
Turbidity measurements were provided at some EMSO nodes by means of an auxiliary turbidity meter Wet Labs ECO-BB(RT)D connected to the CTD probe. One of the collection period ranges, for example, was from August 2007 through July 2008.

3.4.6 Description of Sensor Type #8: Oxygen Sensor.

The oxygen optode is designed to measure absolute oxygen concentration and % saturation. The optode can be used from streams to the deep sea, from fish farms to waste water and from polar ice areas to hydrothermal vents. The Aanderaa Optode 4330/4330F oxygen optodes are based on the ability of selected substances to act as dynamic fluorescence quenchers. The fluorescent indicator is a special platinum-porphyrin complex embedded in a gas permeable foil that is exposed to the surrounding water.

4. INFORMATION ON EMSODEV COMMUNITY-RELATED OBSERVATORIES

A detailed discussion on each observatory is out of the scope of this document. Such information can be easily found on EMSODEV Project DoA [R1] and Deliverable D2.1 [R2]. For reader's convenience, here follows a summary table.

Location (depth range)	Description	Status and Plans
Fram Straight, Arctic - Norwegian Sea - Atlantic (1000-5500 m)	• Stand-alone observatories • 17 permanent sampling sites • Moorings and long-term lander systems: Verankerungskette (Mooring Chain) and Hausgarten (House Garden)	• In operation since 1999 • New FRAM (Frontiers in Arctic Marine Monitoring) research platform will be expanded over a period of next five years • Will be supplemented with deep-sea robots, ice buoys, gliders and autonomously operating underwater robots • AWI and UniHB will contribute to EMSODEV by developing common standards and practices to support the operation of this node
Norwegian Margin, Atlantic (LoVe 255m, LOOME 1260m)	• Stand-alone and cabled observatories • **LOOME**: active gas emitting mud volcano covering the sequence of events before, during, and after an eruption; analysis of their effects on gas hydrate stability, seafloor morphology and the distribution and colonization patterns of benthic communities • **LoVe-Hovden**: cold water corals, cod spawning, benthic communities and environmental impact	• **LOOME** demonstration mission 2009-10 • **LoVe-Hovden** is up and running, online for real time data and historical data since September 2013
Koljoe Fjord, west Swedish coast, North Sea (0-42m)	• **Koljoe Fjord** cabled observatory and test bed, as well as stand-alone repeated sampling sites. • Both a testing facility and a coastal sampling site of a monthly monitoring program of the Swedish Meteorological and Hydrological Institute (SMHI) for T, S, and O2 measurements	• In continuous operation since April 2011 • New sensors/sensor systems for monitoring and field testing are now a part of routine observatory operation/maintenance procedures
Porcupine Abyssal Plain, Atlantic (0-4850 m)	• Stand-alone observatories • **Porcupine Abyssal Plain (PAP)** Sustained Observatory • Some data transmitted in near real-time by satellite. • Previous/recent activities: understanding the controls of biogeochemical fluxes in the open ocean to the deep seafloor and disentangling	• **Active** time-series sampling station since the 1980s. • Infrastructure at PAP since 1989 • Since 2002, this has included physical, biogeochemical and ecological measurements with sensors extending from surface to seafloor. • The PAP- Sustained Observatory

	climate driven trends from natural variability in the North Atlantic, biomass and community structure over time, C sequestration, remineralisation, estimates of respiration, understanding the effect of episodic events, trace pulse events from climate and surface ocean to seafloor influences, contribute *in situ* data to understanding of global change.	(SO) programme is expected to continue for the foreseeable future and forms one of the NERC core sustained observation programmes. • Improvements to the infrastructure in the future may include the significant upgrading of benthic sensing capability to bring it to a standard of the EGIM, as well as improvements to the existing sensor array in the surface mixed layer.
Galway Bay, Irish West Coast, Atlantic (23m)	• Cabled observatory and test bed. • National shared marine research, test and demonstration platform to catalyse and facilitate the commercial development of cutting-edge marine renewable energy and marine ICT products and services. • Have procured and are installing a fibre optic cable from shore to an underwater hub that links to the unique ¼-scale ocean-energy test facility in Galway Bay. • The instrument nodes and sensor packages are designed to contribute to a range of marine sectors including aquaculture, environmental monitoring, shipping, security and education. • An extension to the cabled test bed includes the deployment of a floating power system and platform that reduces operational costs and increases versatility of the power connection to the wave energy converters for research purposes.	• The Galway Bay **SmartBay** Coastal Observatory will be deployed in April 2015 using the *R.V. Celtic Explorer*. • The infrastructure includes a 4km fibre optic cable containing 12 fibres. The cable termination will contain one fully functional wet mate connector with both electrical and optical circuits and one purely optical wet mate connector. The Cable End Equipment (CEE) will provide 400V DC (3.5kW) to a series of sensors, floating power system and wave energy converters and 1Gb/sec Ethernet, upgradeable to 10Gb/sec in future expansions.
Iroise Sea - Molène Island, Brittany Coast, Atlantic (20m)	• **Molène** cabled observatory and test bed. • Testing base for long-term deployment of new instruments; qualification of electronics, software and mechanical components. • Monitoring of a Marine Protected Area (Parc Marin d'Iroise) including sea mammals, cooperation with a marine aquarium, Oceanopolis. • Array of sensors including acoustics, current meters, underwater HD cameras and environmental parameters.	• Launched June 2012 • The EMSO DEV generic instrumentation software package will be implemented for further technological research for instance in passive acoustics.
Azores Islands,	• Stand-alone observatories	• Node active for more than a

Atlantic (1700 m)	• The EMSO Azores observatory is centred on Lucky Strike hydrothermal vent of **MoMAR** (Monitoring Mid Atlantic Ridge) is devoted to the integrated study of mid-ocean ridge processes, from the subseafloor to the water column. It is set atop an active volcano, which hosts one of the largest active ridge hydrothermal vent sites. The main scientific objectives are: 1- to study hydrothermal heat and chemical fluxes to the ocean in relation with seismicity, volcanic activity and ground deformation at a diverging plate boundary, 2- to study the impact of telluric, climatic and anthropogenic changes on deep seafloor ecosystems and hydrothermal communities, 3- to study the dynamics of water masses in relation to the steep axial valley topography, and their impact on the dispersion of hydrothermal effluents.	decade • Two stand-alone acoustic observatories and their transmission buoy operating since ESONET demo mission in 2010. • Yearly maintenance is scheduled for the next 5 years. • A new generation of stand-alone observatory with station specific instruments is planned for 2016 with full interoperability with EMSODEV generic developments. EGIM will provide : • reference observations in the vicinity of the hydrothermal activity, especially currents. • first example of base line time series in a context of potential exploitation of mineral resources in similar environment. • subject to funding availability, potential to expand offshore of Faial Island to monitor Condor seamount site • EMSODEV will provide complementary measurements at water column level and stimulate research on water column/benthos interactions
Canary Islands, Atlantic (50-3670m)	• Cabled and stand-alone observatories • **ESTOC/PLOCAN** - European Station for time-series on the ocean • Over 20 years of continuous surface and mid-water monitoring of several variables such as- Atmosphere: wind, temperature, humidity, pressure, solar radiation; Ocean-air interface: pH, CO2, Chl-a, salinity, temperature, dissolved oxygen; Water column, Salinity, temperature, nutrient, and currents	• Operating since 1994 • One planned stand-alone seafloor observatory at **PLOCAN/ESTOC** for 2015-2016 whose operational sustainability is guaranteed until 2023 • One cabled observatory starting with **PLOCAN** offshore platform test area at 100m in a first phase (2017) then daisy chaining to greater depths. Following standardisation and interoperability procedures proposed by ESONET NOE and stimulated by EMSODEV
Iberian Margin, Atlantic (3000 m)	• Stand-alone observatory • **GEOSTAR** - Geophysical and Oceanographic Station for Abyssal Research	• Data collection 2007-2008 and from 2009-2010 • Installation of a stand-alone observatory in 2015 (sensors:

	• Area of geophysical activity near Eurasian and African plate boundary off Portuguese coast • Mud volcanoes, pockmarks, mud diapirs, carbonate chimneys, hydrocarbon venting and faulting; passive acoustics related to marine mammals and anthropogenic noise; relationship between gas seepage and earthquake occurrence; pore pressure, bubble detection • Sensors: seismometer, gravity meter, absolute pressure sensor (prototype tsunami meter), CTD, triaxial current meter • Near real-time data transmission through acoustic link from seafloor observatory to surface buoy and through satellite link from buoy to shore.	seismic, pressure) • EMSODEV generic instrumentation module tests in 2016 and installation in 2017 or 2018 • Observatory Integration with the seismic and tsunami network of IPMA • Dissemination of data through EMSO-ERIC
Spanish Coast, North-western Mediterranean (25 m)	• OBSEA is a cabled observatory and test site off the coast of UPC- Vilanova i la Geltrú (Barcelona, Spain) • Connected through 4 km of optical fibre to the coast at a depth of 20m in a fishing protected area • Maintenance operations are done by scuba divers and small boats • Permanent instruments are: CTD, Hydrophone, Seismometer, Video Camera, AWAC, and a Meteo Station. • Quality controlled data available in real time.	• Operating since 2009 • Data available in real time
Ligurian Sea, Mediterranean (50, 1000, 2350, 2500 m)	• Cabled and stand-alone observatories • East Ligurian sea: a) **DYFAMED** – DYnamics of Atmospheric Fluxes in the MEDiterranean Sea), b) Nice slope monitoring of Geohazards, c) Standalone observatory in Var canyon. • West Ligurian Sea – **ANTARES** – Earth-Sea science extension of astrophysics underwater telescope (Astronomy with a Neutrino Telescope and Abyss environmental RESearch). • Characterized by coastal upwelling, particle plumes, nutrient benthic exchange, bottom boundary layer processes, seismic monitoring	• **DYFAMED** deep sea mooring array since 1988 • Cabled extension of Antares cable neutrino telescope since 2010, replaced by new cabled neutrino telescope **MEUST** in 2015-2016 • Cabled observatory at Nice in 2015 for land-slide geohazard process monitoring • The use of EMSODEV standards is important for this new extension and further relation of EMSO ERIC with KM3Net.
Western Ionian Sea, Mediterranean	• Cabled observatories • **NEMO-SN1** and **OnDE** seafloor	• Operating in real time since 2005. • Further implementation adding

(2000m)	observatories cabled to laboratory in harbour of Catania by 30km of electro-optical cable. • Geohazards, tsunami, climate change, bioacoustics and ambient noise • Integrated with land-based geohazard networks by transmitting real- time data to National Seismological Service Centre in Rome. • Test site for the underwater neutrino telescope.	water column and data management in the period 2013-2015. • Additional node under construction off Capo Passero: 100-km cable.
Hellenic Arc, Mediterranean (0-4500m)	• Cabled and stand-alone observatories: **Poseidon Pylos** and **Poseidon E1-M3A** (35o66'N, 24o99'E) • Poseidon-Pylos stand-alone observatory includes a seabed platform with acoustic connection to a surface. Seabed Cabled observatory (fibre optic cable) from the town of Methoni to the Poseidon Pylos is under construction • Off SW Peloponnese: Implementation of a new cabled observatory within the frame of EMSO (EMSO-Hellenic) near the Poseidon-Pylos node (about 15km from shore and in 1650m depth) with equipment according to ESONET standards.	• Stand-alone Poseidon Pylos observatory in operation since 2008 • Cabled connection to Poseidon Pylos under construction 2012-15 • Tender for construction of seabed platform completed. Seabed observatory platform under construction. New international tender of cable construction and deployment completed. • EMSODEV EGIM will be capable to interface to cabled, acoustic stand-alone or inductive stand-alone types of observatories.
Marmara Sea 1) 167m, 2) 380m, 3) 670m)	• Cabled and stand-alone observatories. • Earthquake research, and environmental monitoring of deep sea • 1) **SN4** Observatory: seismometer, current meter, CTD, turbidity meter, methane sensors, oxygen sensor; • Planned for 2) and 3) piezometer, OBS, CTD, oxygen and methane sensors, accelerometer, time-lapse camera. • Five **KOERI** cabled observatories include seismometers, accelerometers, current-meters and temperature sensors.	• Data for **SN4** since 2009, Data from **KOERI** stations since 2011 • Three sites were planned for cabled observatories, a proposal (MARDEP) was prepared and submitted to Turkish authorities in 2011, but not funded. The proposal is expected to be resubmitted in the future. • Research cruises in the EMSO and MARSITE (2014) context are devoted to experimental monthly or yearly observations. The results are strengthening arguments for the long-term observatory.
Black Sea, Western basin (15-100m)	• Stand-alone observatories • **EUXINUS** - Black Sea Security System - monitors the western Black Sea regarding geohazard events, environment, and offshore seismic activity through state of the art equipment.	• Operating since 2013 • The **EUXINUS** network will be integrated into the other international geohazard structures, to increase the monitoring capacity and complement GNSS land based

	• Marine information (meteo, physicochemical water parameters, pressure in the water column – tsunamimeters) are sent, in real time, to the on-shore centres (GeoEcoMar, Constanta, Romania; IO-BAS, Varna, Bulgaria).	measurements.

Table 10 - Summary table on Observatories related to EMSODEV Scientific Community.

5. FINAL CONSIDERATIONS

The present document contributes to frame the Data Policy EMSODEV in agreement to the parallel on-going work in the context of the EMSO ERIC constitution. This document has to be therefore considered as a living document and will evolve together with the day-by-day progress of EMSODEV. Moreover, the final Data Policy will reflect common goals of the EMSODEV scientific community in the upcoming landscape of Big Data management.

6. REFERENCES

[R1] "Guidelines on Data Management in Horizon 2020" ver. 2.0, HORIZON 2020, http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-data-mgt_en.pdf.

[R2] DMP online tool, Digital Curation Centre, https://dmponline.dcc.ac.uk/.

[R3] EMSODEV Project Description of Action.

[R4] EMSODEV Project Deliverable D2.1. "REPORT ON WORKSHOP ON SCIENTIFIC REQUIREMENTS"

[R5] "Technology readiness levels (TRL)" (PDF). European Commission, G. Technology readiness levels (TRL), HORIZON 2020 – WORK PROGRAMME 2014-2015 General Annexes, Extract from Part 19 - Commission Decision C(2014)4995.

[R6] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:164:0019:0040:EN:PDF

[R7] FixO^3 Project Deliverable D4.1 "Common FixO^3 data policy MoU", http://www.fixo3.org/wp4.

[R8] ESONET Project Deliverable D68 "ESONET label definition" (ESONET label definition website)

[R9] GCOS Global Climate Observing System Essential Climate Variables (ECVs) definition, https://www.wmo.int/pages/prog/gcos/index.php?name=EssentialClimateVariables

[R10] RITMARE Project Data Policy definition, http://www.ritmare.it/area-download?download=187:data-policy-new

[R11] Milburn, H.B., A.I. Nakamura, and F.I. Gonzalez (1996): Real-time tsunami reporting from the deep ocean. Proceedings of the Oceans 96 MTS/IEEE Conference, 23-26 September 1996, Fort Lauderdale, FL, 390-394.

[R12] Mora C, Wei C-L, Rollo A, Amaro T, Baco AR, Billett D, et al. (2013) Biotic and Human Vulnerability to Projected Changes in Ocean Biogeochemistry over the 21st Century. PLoS Biol 11(10): e1001682. doi:10.1371/journal.pbio.1001682

[R13] Jones, D. O. B., Yool, A., Wei, C.-L., Henson, S. A., Ruhl, H. A., Watson, R. A. and Gehlen, M. (2014), Global reductions in seafloor biomass in response to climate change. Glob Change Biol, 20: 1861–1872. doi:10.1111/gcb.12480.

[R14] Santinelli C., Nannicini L., Seritt A. (2010) DOC dynamics in the meso and bathypelagic layers of the Mediterranean Sea. Deep-Sea Research II 57:1446-1459.

[R15] Heger A., King N., Wigham B.D., Jamieson A.J., Bagley P.M., Allan L., Pfannkuche O., Priede I.G. (2007) Benthic Bioluminescence in the bathyal North East Atlantic: Luminescent responses of *Vargula norvegica* (Ostracoda: Myodocopida) to predation by the deep water eel (*Synaphobranchus kaupii*). Marine Biology 151 (4): 1471-1478 DOI;10.1007/s00227-006-0587-7.

[R16] S. E. Hartman, Z.-P. Jiang, D. Turk, R. S. Lampitt, H. Frigstad, C. Ostle, and U. Schuster (2015) Biogeochemical variations at the Porcupine Abyssal Plain sustained Observatory in the northeast Atlantic Ocean, from weekly to inter-annual timescales. Biogeosciences, 12, 845–853

[R17] Jacopo Aguzzi , Antoni Mànuel , Fernando Condal Jorge Guillén Marc Nogueras Joaquin del Rio Corrado Costa Paolo Menesatti , Pere Puig, Francesc Sardà , Daniel Toma & Albert Palanques (2011) The New Seafloor Observatory (OBSEA) for Remote and Long-Term Coastal Ecosystem Monitoring. Sensors 11, 5850-5872; doi:10.3390/s110605850

[R18] van Haren, H., Laan M.,. Buijsman D.-J, Gostiaux L., Smit M. G., & Keijzer E. (2009), NIOZ3: independent temperature sensors sampling yearlong data at a rate of 1 Hz, Journal of Oceanic Engineering 34, 315–322, doi:10.1109/JOE.2009.2021237

[R19] Bett B.J. (2003) Time-Lapse Photography in the Deep Sea. UNDERWATER TECHNOLOGY THE INTERNATIONAL JOURNAL OF THE SOCIETY FOR UNDERWATER ·MARCH 2003 DOI: 10.3723/175605403783379741

[R20] Widder, E.; Robison, B.; Reisenbichler, K.; Haddock, S. (2005). "Using red light for in situ observations of deep-sea fishes". Deep Sea Research Part I: Oceanographic Research Papers 52 (11): 2077–2085. doi:10.1016/j.dsr.2005.06.007

[R21] Heger A., King N., Wigham B.D., Jamieson A.J., Bagley P.M., Allan L., Pfannkuche O., Priede I.G. (2007) Benthic Bioluminescence in the bathyal North East Atlantic: Luminescent responses of Vargula norvegica (Ostracoda: Myodocopida) to predation by the deep water eel (Synaphobranchus kaupii). Marine Biology 151 (4): 1471-1478 DOI;10.1007/s00227-006-0587-7

[R22] UNFCCC UN Framework Convention on Climate Change, http://www.unfccc.int

[R23] IPCC, 2007a. Climate change 2007: the physical science basis. In: Solomon, S., Qin, D., Manning, M.,Chen, Z., Marquis, M., Averyt, K.B., Tignor, M., Miller, H.L. (Eds.), Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, http://www.ipcc.ch

[R24] IPCC, 2007b. Climate change 2007: impacts, adaption and vulnerability. In: Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J., Hanson, C.E. (Eds.), Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, http://www.ipcc.ch

ANNEX A. COMMON APPROACH TO DATA PRESERVATION

As far obtained as an outcome of several years-long research and analysis activities, later formalized through the SCIDIP-ES project (http://www.scidip-es.eu) implementation for long-term data preservation.
Digital data – and the associated knowledge that is needed to use it – undergo multiple threats when it comes to long-term data preservation. Technologies, hardware and software, semantics and ontologies, as well as international standards or even simply file formats, continuously change and evolve as time goes by. The risk is to actually have the data preserved but to lose the possibility to exploit it properly.
A data preservation infrastructure should consist of a set of services that are designed to help data managers in preserving their data – and associated knowledge – against threats. They are generic enough to allow its usage in different preservation environments (e.g. scientific, cultural, art, etc.).
Every time they are needed, those components should be tailored and used in the target domain.
For Oceanography, this was done and a 4-step data preservation process was put in place.
In the following, each step will be discussed in detail by describing outcomes of each phase in terms of documents.

Campaign Concept (CC) – see also "experiments"

Analysis of a large amount of data is considered necessary to reply to urgent questions on Earth changes at different spatial and temporal scales. As an example, the development and use of multiparametric seafloor observatories, enabling a multidisciplinary approach to investigate the processes with different time scales (from seconds to decades), has posed the need to collect, organise and maintain a variety of long time series.

Identifier	Type	Identification Objective	Description
CC 1.1	Document	Scientific Scenario and User Communities	Definition of: Campaign Requirements Campaign Objectives Continuous , long-term measurements Principal Investigators, Designated User Communities Campaign Assumptions and Constraints

Table 11 - Campaign Concept documents description table.

Sensor Campaign Definition (CDDescription, SCD)

Define sensor and instrument requirements for the Scenarios identified during CC phase.

Identifier	Type	Identification Scope	Description
CDSCD 1.21	Document	Sensor/Instrument requirement specification Campaign Design and Plan	The doc includes requirements, specifications/configurations of the sensor (transfer function, data format, other metadata)
CDSCD 1.2	Document	Sensor/Instrument calibration data and test results	Method of calibration including calibration datasheet
CD 1.3	Document	Processing algorithms and data format specification	Tutorial for the use of algorithms and description of the data format

Table 12 - Sensor Campaign Concept documents description table.

Sensor Campaign Implementation (CI)

Define products of Campaign Implementation activities.

Identifier	Type	Identification of Objective	Description
CISCI 1.1	Document	Detailed description of the deployment phase	Daily log-book of sea operations
CISCI 1.2	Document	Detailed Final deployment recap	Synthesis and publishable report on the deployment phase
CISCI 1.3	Document	Sensor Periodical Reports on operation	Description of the ordinary checking procedures and results
CISCI 1.4	Document	Report on eventual intervention	Description of the extraordinary checking procedures and results (including recovery phase)

Table 13 - Sensor Campaign Implementation documents description table.

Post Sensor Campaign Stage (PCS)

Define products of Post Sensor Campaign phase activities.

Identifier	Type	Identification of Objective	Description
PCSPSCS 1.1	Document	Data Sensor status report	Description of the sensor operating status and eventual diagnostics
PCSPSCS 1.2	Data	Consolidated Data integrity, QC/QA and validation report	Data integrity-check, QC/QA and results
PCSPSCS 1.3	Document	Data Reference publication	publications related to the data

Table 14 - Post Sensor Campaign Stage documents and data description table.