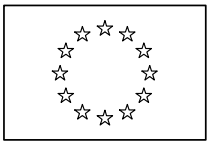

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Building a European marine knowledge infrastructure: Roadmap for a European Marine Observation and Data Network

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GLOSSARY AND ABBREVIATIONS

BEQUALM	The Biological Effects Quality Assurance in Monitoring Programmes ("BEQUALM") QA/QC programme is a system for objectively checking results from laboratories for three components of biological effects techniques - biomarkers, whole organism and benthic community analysis.
CDI	Common Data Index, a fine-grained inventory providing access to data, information and products.
CSR	Cruise Summary Reports, an inventory of oceanographic data collected on research vessels (originally developed by IOC)
ECOOP	Sixth Framework Programme 71-partner project aiming to build up a sustainable pan-European capacity in providing timely, quality assured marine service (including data, information products, knowledge and scientific advices) in European coastal-shelf seas
EDIOS	European Directory of the Ocean-Observing System covering observing systems operating repeatedly, regularly and routinely in European waters
EDMED	European Directory of Marine Environmental Datasets
EMODNET	The European Marine Observation and Data Network. An initiative to improve Europe's marine data infrastructure launched in the Commission's Green Paper. The word "network" indicates a desire to maintain the data in a distributed configuration.
EMBRC	Seventh Framework Programme Research Infrastructures project (Preparatory Phase) for a European Marine Biological Resource Centre. The project is included in the ESFRI roadmap and aims at creating a distributed RI which provides access to model marine organisms and related genomic resources.

EMSO	Seventh Framework Programme Research Infrastructures project (Preparatory Phase) for a European Multidisciplinary Seafloor Observatory. The project is included in the ESFRI roadmap and linked to ESONET network.
ESFRI	European Strategy Forum on Research Infrastructures to support a coherent and strategy-led approach to policy-making on new and existing pan-European and global research infrastructures. The main achievement is the ESFRI roadmap published in 2006 and updated in 2008.
ESONET	Sixth Framework Programme Network of Excellence which brings together European efforts on establishing a network of sea-floor observatories.
EURO-ARGO	Seventh Framework Programme Research Infrastructures project (Preparatory Phase) for a Global Ocean Observing Infrastructure. The project is included in the ESFRI roadmap and the objective is to provide a sustained European contribution to the international ARGO programme (global array of profiling floats).
EUROCEANS	Sixth Framework Programme Network of Excellence which is developing models for assessing and forecasting the impacts of climate and anthropogenic forcing on food-web dynamics (structure, functioning, diversity and stability) of pelagic ecosystems in the open ocean,
Eurogeosurveys	Eurogeosurveys is a non-profit association constituted by the national Geological Surveys of 32 European countries.
EuroGOOS	EuroGOOS is an Association of Agencies, founded in 1994, to further the goals of GOOS, and in particular the development of Operational Oceanography in the European Sea areas and adjacent oceans.
Framework Programme	The EU's research programme is conducted under Framework Programmes. The period 2007-2013 marks the Seventh Framework Programme

GEO	The Group on Earth Observations, a voluntary partnership of governments and international organizations, is coordinating efforts to build a Global Earth Observation System of Systems, or GEOSS.. GEO was launched in response to calls for action by the 2002 World Summit on Sustainable Development and by the G8 (Group of Eight) leading industrialized countries.
GEO-SEAS	Seventh Framework Programme Research Infrastructures project (e-Infrastructure) aiming at extending SeaDataNet infrastructures for marine and ocean geological and geophysical data (*under negotiation).*
GEOSS	Global Earth Observation System of Systems, is envisioned as a large national and international cooperative effort to bring together existing and new hardware and software for observing the planet
GOOS	Global Ocean Observing System
GMES	Global Monitoring for Environment and Security
HORIZON 2020	Initiative by Euro-Mediterranean governments aim to tackle the top sources of Mediterranean pollution by the year 2020
ICES	International Council for the Exploration of the Seas. This intergovernmental organisation promotes and coordinates marine research in the North Atlantic. This includes adjacent seas such as the Baltic Sea and North Sea.
ICSU	International Council for Science
IHO	International Hydrographic Organisation
INSPIRE	Directive 2007/2/EC establishing an Infrastructure for Spatial Information in the European Community. EMODNET will comply to INSPIRE with respect to data sharing and adopt INSPIRE standards and, where appropriate, support the development of INSPIRE's specific marine standards;

IOC	Intergovernmental Oceanographic Commission Part of UNESCO, it was created in 1960 to promote international cooperation and coordinate programmes in research, sustainable development, protection of the marine environment, capacity-building for improved management, and decision-making.
IPR	Intellectual property rights
ISO19115	ISO 19115 defines how to describe geographical information and associated services, including contents, spatial-temporal purchases, data quality, access and rights to use. The standard defines more than 400 meta data elements, 20 core elements.
MARBEF	Sixth Framework Programme Network of Excellence which aims to integrate and disseminate knowledge and expertise on marine biodiversity
MarinERA	Sixth Framework Programme ERA-NET project aiming at the coordination of national and regional marine RTD programmes in Europe.
metadata	Data describing data. For instance it might include the time and date of an observation or its precision.
MODEG	Marine Observation and Data Expert Group. An independent body of scientists set up by the Commission to assist in preparing and monitoring EMODNET
MSFD	The aim of the Marine Strategy Framework Directive 2008/56/EC is to achieve good environmental status in marine waters by 2020
multibeam mapping	Multibeam echo-sounders are used to map large swaths of the ocean floor. They measure depth and roughness.
QUASH	Quality Assurance, Sampling and Sample Handling
QUASIMEME	active Community of Practice for Marine Environmental Measurements

SeaDataNet	SeaDataNet (2006-2011) is a Sixth Framework Programme Research Infrastructures project (I3) aiming to set up a standardized distributed system for managing the large and diverse data sets collected by oceanographic fleets and automatic observation systems; it integrates data resources from 40 National Oceanographic Data Centres and Satellite Data Centres.
SEIS	Shared Environmental Information System – a collaborative initiative of the European Commission and the European Environment Agency (EEA) to establish together with the Member States an integrated and shared EU-wide environmental information system, modernising and simplifying the collection, exchange and use of the data and information required for the design and implementation of environmental policy
SEPRISE	Sustained, Efficient Production of Required information Services) is a Specific Support Action funded by the 6th Framework Programme to further operational oceanographic services, in line with the priorities of the members of EuroGOOS.
UP-GRADE BS-SCENE	Seventh Framework Programme Research Infrastructures project (Integrating Activity) aiming at developing a distributed virtual data and information infrastructure, and improving the identification, access, exchange, quality indication and use of their data and information about the Black Sea.
Ur-EMODNET	Prelimary version of EMODNET encompassing the projects set up under preparatory actions.
WISE-Marine	WISE-Marine is the marine environmental component of the Shared Environmental Information System
XBT	The Expendable Bathythermograph (XBT) is an instrument to obtain information on the temperature structure of the ocean to depths of up to 1500 metres.

EXECUTIVE SUMMARY

The EU's Maritime Policy Blue Book[1], welcomed by the European Council in December 2007, undertook to take steps towards a European Marine Observation and Data Network that would improve availability of high quality data. This document clarifies the current European marine data infrastructure and what those steps will be.

Need for marine data

It is now well-known that the rhythms and cycles of the marine world influence human activity in a multitude of ways. For instance the abundance and diversity of marine life influences the provision of food; changes in coastal morphology influence erosion, flooding and transport infrastructure; and ocean circulation is a primary, if poorly-understood, influence on the terrestrial climate. Since the industrial revolution humans have, in return, begun to exert an increasing influence on the marine world. This circle of interdependence between the human and marine domains is accelerating. But the magnitude of future changes in oceanic systems, their impact on human activity and the feedbacks on the ocean from these changes in human behaviour cannot be forecast without understanding the way the system works now and how it worked in the past. Scientists, regulators and commercial bodies need reliable observations and data if they are to contribute towards a sustainable development of the maritime economy. Gaps in the record cannot be filled later.

It is equally well-known that each country's territorial or jurisdictional waters are part of a dynamic global system connected by shifting winds, seasonal currents and migrating species. Therefore analysing the processes that govern the present state and future behaviour of these waters cannot rely exclusively on data collected within that country's own jurisdiction. Cooperation across borders is needed. And since atmospheric processes influence ocean currents which influence the diversity and distribution of marine organisms which influences fishing practices which influence ecosystem health, scientists working in different disciplines need to access and understand data collected and distributed by scientists from other disciplines including marine and atmospheric chemistry, biology, physics, and marine geology. The value of a complete set of multidisciplinary interoperable marine data is much more than the sum of the parts.

At present most data collection is focused on meeting the needs of a single purpose - as part of a regulatory requirement, for operational purposes or to further scientific understanding. The challenge is to develop a system that will allow a better identification of what is being collected, that will facilitate access to coherent data sets, that will permit the recognition of data gaps and that will shape a data collection and monitoring infrastructure directly suited to multiple applications.

[1] COM(2007) 575 final

Current marine data infrastructure

A number of measures have already been taken at EU level - the INSPIRE Directive[2] obliges Member States to adopt measures for the sharing of data sets and services between its public authorities. These measures will enable the public authorities to gain access to the data and services, and to exchange and use for the purposes of public tasks that may have an impact on the environment and will preclude any restrictions likely to create practical obstacles at the point of use. The Environmental Information Directive[3] requires them to release the data when asked, the Public Sector Information Directive[4] facilitates the re-use of public data and the revised Data Collection Regulation[5] has improved the availability of fisheries data. Marine data catalogues and quality procedures for measurement laboratories have been developed through successive EU research programmes.

However in practice many of these data, collected largely by public institutions, are still fragmented, of uncertain quality and difficult to assemble into coherent pictures. EU legislation aiming to oblige governments to grant access to marine data and allow their re-use does not automatically apply to the large pools of data held by research institutions or other bodies with no formal role in government or public administration. The property rights of many data are unknown or restrictive in terms of re-use. Partnerships dissolve when projects end and contractual obligations to deliver cease.

Some data and value added products produced by public bodies - particularly meteorological, hydrographical and geological - are charged on a cost-recovery basis which is an inefficient way of generating government revenue and puts a brake on innovation. If the public body produces value added products itself as well as the raw data then serious issues of fair competition may arise under certain circumstances[6]. Private companies have been shown to be willing to contribute to the common pool of data but there are few mechanisms for them to do so. Common standards and nomenclature are still not agreed; there are many bodies setting standards for data but none is recognised as primus inter pares. Joining data from different sources together is a challenge: each country classifies marine sediments differently. Synonyms, duplicate species names, separation of former species complicate the coherence and practical use of inventories of organisms. Measurement units can differ for the same variables, or the same parameters can be measured with different methods.

In general there is only loose linkage between the different disciplines. Physical and biological data collected in the same cruise are processed by different teams and stored in different archives. It is not possible to assess the spatial and temporal coverage of most geological, physical, chemical, biological observations across national boundaries.

[2] Directive 2007/2/EC establishing an Infrastructure for Spatial Information in the European Community.
[3] 2003/4/EC
[4] 2003/98/EC
[5] Council regulation N° 199/2008/EC
[6] The commercial use of public information (CUPI) UK Office of Fair Trading, OFT861 December 2006

Setting up a European marine observation and data network

Aware of these difficulties the Commission proposed a new European Marine Observation and Data Network (EMODNET) in its Green Paper on maritime policy[7]. Following an overwhelmingly positive response from stakeholders to its proposal, the European Commission, in its EU's Maritime Policy Blue Book[8], adopted in October 2007 and welcomed by the European Council in December 2007, undertook to take steps towards EMODNET in order to improve availability of high quality data. The Commission undertook to prepare by 2009 an EU action plan to make progress in this area on the basis of a road map to be published in 2008. The present document is the roadmap that was proposed in the action plan.

Basic design principles of EMODNET have been formulated by the Commission together with a specially-constituted Expert Group[9]. These are

1. collect data once and use it many times

2. develop standards across disciplines as well as within them

3. process and validate data at different levels. Structures are already developing at national level but infrastructure at sea-basin and European level is needed

4. provide sustainable financing at an EU level so as to extract maximum value from the efforts of individual Member States

5. build on existing efforts where data communities have already organised themselves

6. develop a decision-making process for priorities that is user-driven

7. accompany data with statements on ownership, accuracy and precision and

8. recognise that marine data is a public good and discourage cost-recovery pricing from public bodies.

The "proof of concept" of EMODNET is being tested through preparatory actions. Portals for a number of maritime basins are being set up for hydrographic, geological, biological and chemical data as well as functional habitat maps. These portals will provide access to marine data of a standard format and known quality and identify gaps in coverage. The projects will identify the main challenges in moving from an ur-EMODNET to an operational EMODNET.

An impact assessment to be conducted in 2009 will assess options for moving towards a definitive EMODNET, both in the intermediate period 2011-2013 and in the long term after 2014. At the same time efforts will begin to integrate other funding mechanisms. Given that EMODNET is very much focused on a sea-basin scale and given the impetus accorded to territorial cohesion by the new Green Paper,

[7] COM(2006) 275 final
[8] COM(2007) 575 final
[9] http://ec.europa.eu/maritimeaffairs/eu-marine-observation-data-network_en.html

discussions will begin to determine whether cohesion funding could support the initiative. Moves will begin to integrate EMODNET with initiatives under the EU's Research Infrastructure actions and the Common Fisheries Policy Data Collection Regulation.

Costs and Benefits

The costs of enhanced access to quality marine data can be divided into two components - the cost of creating better access to data that exists already and the cost of an extended monitoring or observation programme. The impact assessment and preparatory actions will clarify the cost of opening up data to users and identify areas where observations are scarce. Extending the observation programme will depend on the priorities of users. For instance, it has been estimated that a complete high resolution mapping of sea-beds would cost €100 million for all of EU Member States deep water and €900 to €2000 million for their continental shelf. These are clearly first approximations that will be clarified further as the EMODNET initiative progresses.

All sectors dealing with the marine domain will benefit from the creation of a better infrastructure for the distribution of standardized marine data. Researchers will be able to spend less time mining and assembling data and more time cross-checking and analysing them. Uncertainties in the behaviour of the marine world will be reduced with consequent improvement in the adaptation strategies -such as the designing building of sea defences to cope with rare catastrophic events. Public authorities at a local, national or sea-basin level will be able to assess impacts, develop marine spatial plans and meet reporting obligations. A data infrastructure that delivers better access to data, coherence across borders and known confidence limits will help Member States meet their obligations of the Marine Framework Strategy Directive[10].

Lastly a better marine data infrastructure will support the Lisbon objectives and drive economic change by promoting innovation and the development of innovative services based on the data.

Complementarity with other EU initiatives

EMODNET is complementary to other EU initiatives in the marine domain. The GMES/KOPERNIKUS initiative[11] aims to provide information services in the field of environment and security which will be developed on the basis of sustainable observation systems from satellites and from other sensors. Parameters made available through EMODNET will facilitate its marine core service which aims to deliver both short term and seasonal forecasts, hindcasts, nowcasts, time series and climate change scenario simulations of physical parameters describing open ocean state and dynamics and some primary ecosystem characteristics. EMODNET will provide the access to raw and processed data necessary to calculate the indicators that Member States will use for the Marine Strategy Framework Directive and are likely to provide through WISE-Marine. The European Atlas of the Seas proposed in

[10] 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
[11] COM(2008) 748 final

the EU's maritime policy action plan will obtain data from EMODNET to raise awareness of marine issues. Provision of coherent marine data will enable maritime spatial planning to take account of cross-border influences.

EMODNET will be complementary to current initiatives at EU level such as EMSO, EURO-ARGO or EMBRC, on the ESFRI roadmap, which are aiming at establishing a legal, financial and governance framework for new research infrastructures related to marine sciences. EMODNET will also, when relevant, build on current the Research Infrastructure project SeaDataNet which is integrating marine data in a standardised distributed system.

Timetable

By the end of 2009, preparatory actions, together with the European Atlas of the Seas, will have produced a prototype ur-EMODNET. Calls for tender for two new preparatory actions will supplement the coverage of parameters. The first will focus on human-activity data and how it can be used to improve maritime spatial planning. The second will focus on high resolution sea-bed mapping.

A study on the potential costs and benefits of EMODNET will report during 2009. The results will feed into an impact assessment that will analyse different options for moving forward. An Action Plan, based on this impact assessment, will set out the plans for the next four years – 2010-2013.

Discussions will begin on embedding EMODNET within other Community programmes – particularly, but not only, those in support of territorial cohesion of sea-basins and Research Infrastructures. A separate node for accessing fisheries data in one or more sea basins should be set up using the Data Collection Regulation Framework.

The ur-EMODNET will be operational throughout 2010 and 2011, collecting feedback from users on fitness for purpose and indicating how the definitive EMODNET might be set up. Should these prototypes prove to be successful, then efforts will be made to extend their geographic range in order to cover all of the waters of EU Member States for one or more sets of parameters through Community instruments for territorial cooperation. One final set of preparatory actions may be launched in 2010 to answer further questions not covered by the ongoing actions. Preparatory actions are designed to prepare proposals with a view to the adoption of future actions. Future actions will partly depend on the outcome of these preparatory actions.

The main priorities during 2012 and 2013 will be to maintain and extend the data communities and infrastructure that have been built up and to progressively develop the mechanisms to examine data coverage, feed-back user satisfaction and determine the priorities for extending the observation network. A secretariat might be set up,

Based on the knowledge gathered during this exploratory ur-EMODNET a strategy will be developed for moving ahead.

Monitoring and Feedback

During this period the Maritime Policy Member State Expert Group and the Marine Observation and Data Expert Group will monitor the initiative and determine how well it is achieving its objectives. Other stakeholders will be invited to present their views – through the internet and at maritime events. The Action Plan, to be presented at the end of 2009, will incorporate the lessons learned and insights gained during this initial period.

1 SCOPE

In its Blue Book for Maritime Policy[12] the European Commission undertook to take steps towards a European Marine Observation and Data Network in order to improve access to high quality data. It should improve the usefulness to European users for scientific, regulatory and commercial purposes of observations and the resulting marine data collected and held by European public and private bodies, wherever that data has been collected from.

The scope of this document is to indicate why the EU needs such a Network and to explain the steps that will be taken to set one up. It is not intended to be a blueprint but rather a framework with guiding principles, phases, timelines and an end objective. The details can be progressively modified as ongoing actions and assessments increase knowledge of what needs to done, what it is feasible to do and what the costs and benefits will be.

2 FITNESS FOR PURPOSE

The behaviour of seas and oceans is crucial to human life on this planet. For instance the abundance and diversity of marine life influences the provision of food and changes in coastal morphology influence erosion, flooding and maritime transport. Ocean circulation is a primary, if poorly-understood, influence on the terrestrial climate.

Since the industrial revolution humans have, in return, begun to exert an increasing influence on the marine world. This circle of interdependence between the human and marine domains is accelerating. But the magnitude of future changes in oceanic systems, their impact on human activity and the feedbacks on the ocean from these changes in human behaviour cannot be forecast without understanding the way the system works now and how it worked in the past. Scientists, regulators and commercial bodies need reliable observations and data if they are to contribute towards a sustainable development of the maritime economy. The importance of monitoring is highlighted in an editorial from Nature[13]

> *Monitoring the Earth system requires great expertise, not just to build the instruments but to use them properly and interpret their output (...) Testing hypotheses about how the world works requires not just information on the current state of the three-dimensional globe, but on its progress through the fourth dimension of time. Data on the colour of the seas that are not gathered today can never be gathered in the future — gaps left in the record cannot be filled. And continuous data sets are going to be vital to the validation of the ever more informative models of the Earth system that we need. This is why operational systems for data collection in which scientists play key roles are so important. Only they can give us multiscale and multifactor ways of seeing the*

[12] An Integrated Maritime Policy for the European Union ("The Blue Book") Brussels, 10.10.2007 COM(2007) 575 final

[13] Editorial Nature 450, 761 (6 December 2007)

world that are up to the challenges of the twenty-first century. When the expenditure needed to maintain these data flows conflicts with the funds needed to support fresh scientific research, researchers must acknowledge that there is a strong case for preferring continuous, operational monitoring. An accurate and reliable record of what is going on can trump any particular strategy for trying to understand it.

It is equally well-known that each country's territorial or jurisdictional waters are part of a dynamic global system connected by shifting winds, seasonal currents and migrating species. Therefore analysing the processes that govern the present state and future behaviour of these waters cannot rely exclusively on data collected within that country's own jurisdiction. Cooperation across borders is needed. And since atmospheric processes influence ocean currents which influence the diversity and distribution of marine organisms which influences fishing practices which influence ecosystem health, scientists working in different disciplines – need to access and understand data collected and distributed by scientists from a variety of disciplines including marine and atmospheric chemistry, biology, physics, and marine geology. The value of a complete set of multidisciplinary interoperable marine data is much more than the sum of the parts.

At present data collection is largely focused on meeting the needs of a single purpose - as part of a regulatory requirement, for operational purposes or to further scientific understanding. The challenge is to develop a system that will allow a better identification of what is being collected, that will facilitate access to seamless data sets, that will permit the recognition of data gaps and that will shape a data collection and monitoring infrastructure directly suited to multiple applications.

Because currently the full potential of marine data being collected is not being realised. The main reasons for this are:

1. Discovery of Data. It is difficult for potential users to obtain an overview of what data - biological, chemical, physical, geological - are available in a particular region.

2. Access to data. Those holding the data may not release them either because of confidentiality or security constraints, because they do not or cannot allocate sufficient resources for archiving and maintaining data (e.g. data stored on increasingly obsolete technological systems) or because they wish to retain a monopoly of products derived from the data.

3. Use of data. Even where data are available, their use or re-use may be limited by the data policy of the owner. The primary driver for data creation can limit their broader use.

4. Cost of data. The prices imposed by some data-owners reduces the uptake of these data by users.

5. Coherence of Data. Developing a complete picture in time and space over a sea-area using data collected by different bodies is complicated by fragmented standards, formats and nomenclature. This is particularly the case when there is a need to study cross-border areas or to use data stemming from

diverse expert communities.. Whether studying ocean circulation, fish stock populations or tsunamis, data from different sources are required.

6. Quality of Data. There are no universally-recognised measures of quality, precision or accuracy. Metadata documentation may be sparse or inadequate so potential users do not know what confidence to ascribe to the data.

7. Quantity of Data. At present there is not enough data being observed to meet many user requirements. There are serious gaps in coverage and range of data types.

This roadmap sets out what steps have been taken to resolve these difficulties already, summarises how well they are dealing with the issue and describes the shortcomings that remain. It indicates the opinions of stakeholders consulted and develops a set of principles, set of actions and a timeline for the design and implementation of a European Marine Observation and Data Network (EMODNET) that will progressively deliver a cost-effective solution for the organisation of marine data that meets the needs of their users.

3 CURRENT STATUS OF MARINE DATA INFRASTRUCTURE

3.1 Classification of data

Marine observation varies from real time monitoring of tides to assessing the biodiversity of cold water corals. The challenges of collecting, processing and distributing these data depend very much on the type of data we are considering so it is useful to consider each of these separately.

Although certain general principles for EMODNET are developed within this paper, it is clear that different types of data require different approaches. A number of classifications have been developed in the past. Early versions of the European Directory of Marine Environmental Datasets (EDMED) included overlapping terms - for instance it would be hard to know whether a certain dataset should be classified as "ocean composition" or "environmental quality/pollution". Other classifications - eg "data from space", "in-situ measurements" - focus on the way the data is collected from different types of observation platforms rather than the data themselves. EDMED has now adopted a discipline based system.

In line with this, this document considers data as being classified into five basic groups:

1. geology and hydrography - including sediments, bathymetry etc

2. physics - temperature, salinity, circulation, wind, waves, sea-level etc

3. chemistry - concentration and inputs of natural and anthropogenic substances in different marine matrices (biota, sediment and water)

4. biology - species abundance, population structure and diversity etc

5. human activity - shipping routes, fishing effort, gravel extraction etc

This has four main advantages. First it is relatively unambiguous - although there are grey areas such as fisheries where it is debatable whether fishing mortality should be considered as biological or human activity data; secondly these groups share certain similar characteristics in their data policies; and thirdly it looks at the data from the perspective of a user not the provider.

Finally, this breakdown is also useful in facilitating integration of different scientific disciplines. For instance the biological group includes both commercial fish species and all other species. Up to now these have been dealt with by entirely different groups of scientists who will now need to rely on each others' data to support the implementation of the ecosystem approach.

Similarly bathymetry and marine sediments are generally dealt with by different disciplines and different agencies - hydrographers on the one hand and geologists on the other. However both sets of scientists are now interpreting the results of multi-beam sonar measurements. Indeed the hydrographers and geologists of the Marine Observation and Data Expert Group (MODEG) felt that real synergies could be exploited by considering both activities together.

Whilst human activity data is within the scope of EMODNET in so far as they have an impact on the marine environment, socio-economic indicators such as employment or profits are not. The Commission's statistical service Eurostat is currently finalising a database of socio-economic indicators for maritime industries and coastal communities. Socio-economic data is also available within the framework of the Data Collection Regulation for fisheries[14].

3.2 Measures to improve infrastructure

3.2.1 Discovery, access and use

The EU has already adopted a number of measures that help prospective users find, access and use marine data. These measures as well as other relevant multilateral initiatives are more fully described in appendix 1. These include:

1. for discovery of data, the INSPIRE Directive 2007/2/EC which establishes an Infrastructure for Spatial Information in the European Community. Member States are obliged to establish networks allowing their spatial data holdings to be searched and displayed.

2. for access to data, the "Environmental Information Directive" 2003/4/EC, and the INSPIRE Directive 2007/2/EC (Article 17),

3. for re-use of data the Public Sector Information Directive 2003/98/EC

However these rules only apply to bodies exercising some public authority and therefore do not automatically apply to data owned by research bodies or universities. If the public authority holding the dataset is not the owner of the intellectual property rights (IPR) in the data, it will be unable to grant access to the

[14] Council Regulation (EC) No 199/2008[14]

data without the authorisation or consent of the rights holder[15]. A recent study[16] found that:

> *broadly speaking the study countries have correctly implemented the legislation at national level, while there are no particular legal problems as far as access to marine environmental data is concerned (in respect of data centres subject to the Environmental Information Directive), the question of use/re-use is governed in practice by the (..) implementation of individual data policies.. In other words there is not a problem of non-implementation of existing international and European rules in terms of access to, and the use/re-use of, marine environmental data, rather that those rules have a limited impact on IPR (and the data policies that determine how those IPR are exercised) and thus have a limited ability to facilitate flows of marine environmental data.*

This is the greatest difference with the United States. Their 1976 Copyright Act prohibits the federal government from claiming copyright protection of the information it produces. For instance all data authored or produced by the United States Geological Survey are considered to be in the public domain.

Confidentiality of data and/or the protection of personal data may also be valid reasons for refusing requests to access data. In some countries bathymetric data is considered as a military secret - either for the whole of that country's waters (eg. Finland) or some parts of them (eg France). Personal data can be connected with environmental data but these data can be properly protected without influencing the data's fitness for purpose. (see appendix 1).

The INSPIRE Directive strengthens the Environmental Information Directive by creating a general obligation upon public authorities to make "spatial data" accessible to all possible actors and share them across borders amongst Member States.

Data reported to the Commission under the Common Fisheries Policy Control Regulation – landings, effort, licences etc – in the framework of the Control Regulation is generally treated as confidential. However the EU separately provides financial support for the collection of fisheries data – landings, effort, discards, surveys etc - for scientific purposes. Access rules depend on the purpose for which the data is requested – management advice, public debate or scientific inquiry.

In general marine data from EU research projects have not always been made available – one of the aims of the EU's research programme being to encourage innovation and generate intellectual property for the partners. The Research Infrastructure is an exception. It aims to encourage open access at national and EU level. Under the Seventh Framework Programme, research contracts in the

[15]This is also reflected, to a certain extent, in the legal framework in relation to the access to environmental data and the re-use of public sector information (see below). For instance, under the legal regime governing the re-use of public sector information, if an applicant's request for re-use is refused based on the protection of the IPR of third parties, public sector bodies need to include a reference to the (natural or legal) person who is the holder of those rights (where known), or to the licensor from which the public sector body obtained the relevant material.

[16] Legal aspects of marine environmental data Framework Service Contract, No. FISH/2006/09 – LOT2, Final Report – October 2008

environment area will oblige consortia to release data to public bodies provided that it is not for commercial uses. Under the terms of the relevant special clause, Community institutions and bodies can oblige contractors to release data immediately to them if required for the purpose of developing, implementing and monitoring environmental policies.

In parallel with legislative moves to improve access to marine data, the community of data providers has itself been active.

A number of Member States have already made efforts to catalogue their national data holdings and to create on-line access to these catalogues. And there have also been a number of initiatives at a regional, European or global level to join these catalogues into seamless single catalogues. The EU Research Framework Programmes and organisations such as the International Council for the Exploration of the Seas (ICES) have been particularly active. More details of these are provided in Appendix 3.

Whilst the main thrust of this report is concerned with data held by public bodies, it is believed that most modern, high resolution marine geological data is owned by private companies concerned with activities such as petroleum exploration and exploitation, sand and gravel extraction,. pipeline laying or windfarm construction. These data are generally site specific rather than covering a region. As a rule of thumb these organisations consider sub-seabed information as confidential but are willing, in principle, to release data that concerns the seabed and above. However there are no sustainable mechanisms for them to do so.

3.2.2 Cost

The cost of marine data to users varies widely throughout Europe. A study[17], commissioned jointly by the UK Treasury and the Department for Business, Enterprise and Regulatory Reform (BERR) in July 2007, considered four basic charging policies for the public sector information provision.

1. Profit-maximizing: setting a price to maximize profit given the demand faced by the data owner. This is sometimes called `market-based pricing'

2. Cost-recovery pricing: setting a price equal to average long-run costs (including, for example, fixed costs related to data production).

3. Marginal-cost: setting a price equal to the marginal cost of supplying data (that is, simply the cost of actually transmitting the data to someone).

4. Zero-cost: setting a price equal to zero.

Although four different cost regimes for public sector data are in principle feasible, in practice it is worthwhile considering only two - cost recovery and zero cost. Profit-maximising for data collected with public funds is not widely used because, in the

[17] Newbery D. et al. Models of Public Sector Information Provision via Trading Funds, February 2008 Crown Copyright

absence of competition, it might result in monopoly pricing. And for digital products, the marginal costs of delivering data are practically zero.

The same data may be subject to different data policies depending on who is requesting the data is the use to which it is put. For instance it is common for different policies to be applied to academic users, government users and commercial users. "Use for research" is frequently considered differently to "use for commercial gain".

Much of marine data collection is funded publicly (see appendix 2). An efficient cost regime for publicly funded data should maximise the benefit to the community for the minimum cost to the taxpayer. The proponents of cost recovery indicate that those who use the data should pay for it and that bodies currently collecting data would not be able to do so if they did not obtain an income from it.

However cost-recovery does have some drawbacks

1. It has been suggested that distortions and losses caused by taxes are minimised if taxes are applied to consumption rather than the resources needed for production[18]. In other words it is better for a government to offset the cost of collecting data by taxing the products deriving from data rather than the data themselves. On this basis a UK study[17] indicated that there would be a net social benefit of moving to zero cost for copyright licensing for the UK Hydrographic Office and wholesale data products for the UK Meteorological Office.

2. The State already pays most of the fixed costs of collecting data. A 2003 study[19] in the UK indicated that public bodies[20] revenue from marine data is negligible compared to the cost of collection.

3. The economic return on the investment of collecting data increases if it is used more. There is indisputable evidence that the demand for environmental data is highly elastic. When the United States Government charged higher prices for Landsat images, the demand from academic and independent researchers dried up[21].

4. Cheaper data will encourage users to innovate and produce new services based on the data. It is accepted that the flourishing market for added-value services based on meteorological data in the United States is a direct consequence of the less-restrictive data policies there.

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[18] Mirrles J and P. Diamond.1971, Optimal Taxation and Public Production I. American Economic Review 61:8-27

[19] Rayner R., J. Smallman, G. Cameron, C. Wallace, Achieving optimal value from publicly funded marine information resources A report prepared by the UK Marine Information Council Working Group on Data Access

[20] Centre for Environment, Fisheries & Aquaculture (CEFAS), Department of Agriculture and Rural Development Northern Ireland (DARDNI), Environment Agency (EA), Fisheries Research Service (FRS), UK Meteorological Office (UKMO), Natural Environment Research Council (NERC), Scottish Environmental Protection Agency (SEPA), UK Hydrographic Office (UKHO)

[21] Committee on Issues in the Transborder Flow of Scientific Data, National Research Council, 1997 Bits of Power. Issues in Global Access to Scientific Data ISBN-10: 0-309-05635-716

Analysis of the marine environment inevitably requires data from more than one discipline. Both the physics and chemistry subgroups of the Marine Observation and Data Expert Group flagged the cost of data from meteorological agencies as being a barrier to exploitation of marine data. Scientists and service providers often use meteorological data that is of lower quality than they would like in terms of resolution or timeliness in order to cut costs.

3.2.3 Coherence

Coherence allows different measurements in time and space to be assembled into a consistent picture in a painless and seamless manner.

The INSPIRE Directive 2007/2/EC as well as being the basic EU measure to regulate discovery and access to environmental data is also the main instrument to promote interoperability. It is intended over time to allow users to identify and access official spatial or geographical information from a wide range of sources in an interoperable way for a variety of uses. The actual implementing rules that set the standards and nomenclature are be developed through a collaborative effort of the Member States, international organisations, European agencies and the Commission and adopted as Community legal acts following the comitology procedure. They should take into account user requirements, existing initiatives, international standards, feasibility and cost-benefit considerations. In other words it will largely be the data communities themselves that develop these rules.

The coherence of scientific databases is also one of the main objectives in the Integrating Activities of the Research Infrastructure action, in which Research Infrastructures are working together in structuring the Research Infrastructures in a specific field. This includes work on standards, metadata, nomenclature, quality control, database interoperability etc.

3.2.4 Quality

As digital services develop it becomes necessary to develop, implement and maintain systematic procedures that will ensure and maintain the quality of the metadata, the functionality of the service, accessibility to a wide range of users and devices and interoperability with other services.

The metadata should include an explanation of the data quality assurance system, quality flags and peer review. Laboratories should be accredited.

In the same way as with marine catalogues, EU research projects have been the prime vehicle for introducing quality standards for measurements. These include QUASIMEME for chemical data, BEQUALM for biological and QUASH for sample handling. International bodies such as ICES and IOC have also developed guidelines covering the collection, processing, quality control and exchange of various types of physical oceanographic data (see appendix 4)

The quality of data includes the concepts of accuracy and precision. Accuracy is the degree of closeness of a measured or calculated quantity to its actual (true) value. Precision is the degree to which further measurements or calculations show the same or similar results.

Some marine data is already accompanied by an estimate of precision. Data collected for regulatory purposes, for instance in the Data Collection Regulation for fisheries, must be sampled to achieve a certain precision and the actual precision must be reported along with the data themselves.

Accuracy is much harder to estimate and report and can only be estimated through detailed knowledge of the way that the instrument makes the measurement or comparison with observations made in a different way.

3.2.5 Quantity

According to the European Science Foundation/Marine Board paper (see appendix 3)

> *there are huge gaps in data and observation provision also, either because the necessary measurements have not been made or because observing networks are inadequate. The variability of the sea surface is very evident from images captured from space, but there is huge physical, biological and chemical variability below the surface that is largely unobserved. These gaps must be filled.*

However, despite the many data catalogues described in appendix 3, fragmentation of knowledge on data coverage is such that there is as yet no overall view as to where these gaps are most limiting. There is no accurate description of the strengths and weaknesses of current monitoring networks and their resultant data. This is true for all disciplines - geology, physics, chemistry, biology and human activity:

3.3 Current Shortcomings

Whilst some progress has been made, appendix 5 identifies, for each of the main types of marine data, shortcomings of the present infrastructure. These lacks of coherence, quality or quantity of marine data limit the effectiveness with which researchers, governmental agencies or commercial companies can answer questions posed by customers.

The Marine Observation and Data Expert Group (MODEG) identified some of these difficulties. For example::

1. There is no agreed length of coastline of EU Member States and estimates of the area of their continental shelf vary considerably.

2. The European Environment Agency has access to good information over limited areas but cannot obtain sea-basin-scale data on chlorophyl, nutrients, marine mammals or oxygen concentrations.

3. The present limited coverage of biochemical measurement sites for dissolved oxygen, fluorescence, pH, nutrients and turbidity and the vulnerability of the sensor arrays to biofouling are challenges for Member States in meeting the obligations of the Water Framework Directive and the Marine Strategy Framework Directive.

4. It is known that the spatial and temporal distribution of zooplankton affects fisheries yields and that harmful algal blooms can damage the profitability of

aquaculture and the attractiveness of beaches. However the present monitoring, largely by optical remote sensing and isolated sampling campaigns from scientific institutions, is too infrequent and at too low resolution to feed into the management decision chain.

5. Detailed knowledge of past currents, waves and sediment movements are required if shorelines are to be protected, beaches managed and harbours maintained. Isolated wave and current measurements and infrequent monitoring of sediments increases uncertainty and raises the cost of dredging and shoreface nourishment.

6. The significance of reduced sea-ice cover and increasing methane emissions from permafrost thawing on the Arctic's ecosystem is universally acknowledged but it is hard to estimate the impact on the food web because of sparse and fragmented measurements.

Faced with these impediments, those who require better data, particularly when the area of interest spans the waters of several countries and particularly when data from different types is required, have no natural forum to voice their concerns.

3.4 Stakeholder Opinion

The impetus to create a more integrated and sustainable data infrastructure came up in discussions with many stakeholders in the period leading up to the Green Paper on Maritime Policy. The Commission accordingly included in its Green Paper a proposal for a Marine Observation and Data Network (EMODNET).

The 487 contributions to the year-long consultation that followed the Green Paper were largely in favour of the initiative - the most important messages being that it should build on existing efforts and that it should respect global standards. Following this encouraging response the Commission's Blue Book on an integrated maritime policy for the European Union[22] proposed to

> *take steps in 2008 towards a European Marine Observation and Data Network and promote the multi-dimensional mapping of Member States' waters, in order to improve access to high quality data.*

And, in the accompanying action plan for the integrated maritime policy[23], the Commission undertook to prepare by 2009 an EU action plan to make progress in this area on the basis of a road map to be published in 2008. The present document is the roadmap that was proposed in the action plan. Since many of the arguments for setting up such a Network and many of the steps to implement it are identical to what needs to be done for the mapping of seas, this document will cover both aspects.

Following the adoption of the Blue Book and the Commission's commitment to bring forward more concrete proposals, the Marine Board of the European Science

[22] An Integrated Maritime Policy for the European Union ("The Blue Book") Brussels, 10.10.2007 COM(2007) 575 final
[23] Action Plan Brussels, 10.10.2007 SEC(2007) 1278

Foundation and EuroGOOS joined forces to prepare a reaction[24]. They argued that the purpose of the Network was not only to provide access to existing data but to draw attention to gaps and hence encourage more monitoring.

The regional sea conventions around Europe, where the European Community, many of its Member States, and neighbouring countries cooperate on marine monitoring and assessment for their region, have expressed their interest in being closely associated with the EMODNET development[25]. The Commission will ensure that these bodies are fully informed and given the opportunity to contribute where appropriate.

The Commission has incorporated EMODNET in its new strategy for Marine and Maritime Research[26].

A further stakeholder consultation will take place as part of the impact assessment in 2009.

4 PREPARING EMODNET

4.1 Design Principles

Based on the lessons learned on the efforts so far, a number of conclusions can be drawn as to how a European Marine Observation and Data Network should be set up. Some of these reflect current orthodoxy in environmental data management, the legal framework of the European Union and the particular principles of the Commission's Communication on a Shared Environmental Information System (SEIS)[27]. Others reflect the peculiarities of the maritime world.

4.1.1 Collect data once and share it many times.

The aim is to move from collecting data for a specific purpose to a multipurpose data infrastructure. Since, as we have seen, it is largely public money that is funding the collection of data, then collecting the same data twice is not good practice. This does not of course obviate the need for confirmatory measurements.

4.1.2 Develop Interoperable Standards

EMODNET should develop and contribute to standards that are interoperable between different disciplines as well as within communities. Naturally, these will have to respect the provisions of pertinent INSPIRE implementation rules. Standards will cover formats (metadata, data, data products), quality control methods, quality control flag scales, vocabularies and services.

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[24] EMODNET The European Marine Observation and Data Network - Marine Board - Eurogoos perspective, 25 September 2008,http://www.esf.org/publications.html

[25] Letter from HELCOM, OSPAR, Commission on the Protection of the Black Sea Against Pollution and UNEP-MAP, 6 October 2008

[26] A European Strategy for Marine and Maritime Research A coherent European Research Area framework in support of a sustainable use of oceans and seas, Brussels 3 September 2008 COM (2008) 534

[27] COM (2008) 46 final of 1 February 2008
[http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52008DC0046:EN:HTML]

4.1.3 Process and validate at different levels

There have been long debates as to the whether it is better to maintain the data at source where it is collected or to gather it all in national or European mega-databases. The answer is "neither". The processing, archival and distribution of marine data needs to be a multi-level process. Different types of data require different approaches.

4.1.3.1 Laboratory level

Environmental data should be well managed at source in line with current standards, where they exist, and best practice. There are advantages in terms of data remaining close to the expertise of the originator and less risk of data duplication. SEPRISE is an example of a European project where data is gathered from individual laboratories and assembled in real time to provide pan-European information.

However a balance needs to be struck as it may not be efficient (in terms of accessing data from a number of sources in a variety of formats) or wise in terms of resource available and local priorities) for each university department, consultancy company, research laboratory, etc., to maintain develop and maintain an infrastructure for storing, cataloguing and distributing their own data.

4.1.3.2 Local level

Data may need to be assembled for specific areas such as estuaries or for specific purposes such as dredging. In general a local laboratory would take the lead in establishing the necessary infrastructure.

4.1.3.3 National level

Since data collection is largely funded from national government there needs to be a structure at national level to ensure that the taxpayers' money is spent in the most efficient way. Furthermore some parameters are best maintained in national databases. Many countries have National Oceanographic Data Centres. The UK's marine environmental data and information network is working to establish a national framework for marine data management in the UK, in order to guarantee secure long-term curation of key data sets. To this end it has developed a set of best practice standards to be met by marine "data archive centres" wishing to become part of this national framework.

4.1.3.4 Sea-basin level

At the same time an oversight at regional sea-basin level is essential. Ecosystems do not respect national boundaries and coherence between the different adjoining data streams must be ensured. Although, of course, all European marine data needs to be interoperable, experience suggests that, for most types of data, verification for all Europe's basins simultaneously is not feasible. A validation at a maritime-basin level is more appropriate.

These basins should correspond to the regions and sub-regions defined within the European Marine Strategy Directive. Some parameters may be better collated at a regional level and some at a sub-regional level. Member States also collect marine

data for waters outside the areas defined by the Marine Strategy Directive - for instance the polar regions. In these cases appropriate boundaries need to be chosen.

These regional sea basin nodes of the network might include gateways to data stored in Member States but in many cases will need to process data themselves. Gridded or polygon data for sea basins cannot be constructed by a mere superposition of datasets from individual countries.

4.1.3.5 European level

An overview at a European level is also necessary. First to ensure interoperability and coherence between the different maritime basins, second so that lessons learned in one basin can be applied in another and third in order to develop a single entry point for discovering data.

It is expected that the main links in EMODNET will be between the European level and the sea-basin level on one hand and between the regional level and the national or laboratory level on the other. There will be fewer direct links between the European level and the national level although the regional nodes themselves may well be operated by national laboratories.

4.1.4 Provide sustainable support at an EU level

The vast bulk of marine data collection and processing has been funded at a national level and this will continue to be the case.

Providers and users of marine data have always recognised that a more coordinated approach was needed to bind these efforts more tightly. But national bodies do not have the mandate or resources to move forward on their own. Most initiatives to result in concrete progress at a sea-basin or European scale – marine catalogues, quality procedures, habitat maps - have been prompted and funded by the EU through its research or regional development programmes. And few of these initiatives continued after the end of the project. The lesson learned is that such an infrastructure cannot be set up by a single burst of activity and left to the marine community to maintain.

An impact assessment will assess options for the long-term sustainable support and funding required to achieve the objectives of EMODNET.

4.1.5 Build on Existing Efforts

In certain disciplines data providers have already developed groupings at a European or international level. For instance Eurogeosurveys links the national geological surveys and nearly all the EU's hydrographic offices are Members of the International Hydrographic Organisation. There are some efforts by regional sea conventions to collect pollution data on a maritime basin scale. EuroGOOS aims at establishing a concerted European approach to operational oceanography and the development of the needed scientific and technology systems required for this, including the promoting of common European operational data procedures and services, including data quality control and data management (for operational oceanography).

EMODNET should build on the existing pan-European network of National Oceanographic Data Centres and national marine data centres and ICSU World Data Centres related to oceanographic sciences. Most of these centres are part of major national marine research institutes. They manage and secure long term stewardship for large data holdings, including third party data, and have established working relations and networks with other institutes in their countries. Moreover the centres have participated and are participating as data managers in numerous European and International projects. Through EU Research projects, such as Sea-Search (2003 – 2005) and the present SeaDataNet (2006 – 2011), the centres are actively building a common infrastructure for discovery, management and delivery of marine data. marine data. New research projects should extend and adapt SeaDataNet architecture and services to other types of marine data; e.g. the Geo-Seas project, just selected under the last Seventh Framework Programme Research Infrastructures call (e-infrastructure) will extend SeaDataNet infrastructures for marine and ocean geological and geophysical data. Up-grade BlackSeaSCENE (seventhframework programme research Infrastructure Integrating Activity) are using the SeaDataNet architecture, making marine data from the Black Sea region available.

Within the frame of SeaDataNet, standards and tools have been developed and adopted by all centres for formats (metadata, data, data products), common vocabularies, operation and maintenance of metadata catalogues, data access, analysis and presentation. EMODNET will consider adopting these standards and extending them towards other data disciplines.

Building on these existing agreements will allow EMODNET to profit from the expertise that has been developed, avoid duplication and simplify administration.

4.1.6 User driven

EMODNET is targeted at users from specialist marine laboratories and private bodies who will process the data to meet their own needs for scientific analysis and those of their clients – both public and private. In many cases providers of data will also be users.

However moving from a single-user system of data collection to a multi-user infrastructure risks disrupting provider-client relationships. Maintaining this contact is essential if the data provider is to understand how well the service provided meets expectations and to adjust it accordingly.

Furthermore there is an infinite amount of data to be collected so priorities and realistic targets are set – both for those providing data and for those who process it into useful products. These priorities and targets need to be set by those who require the data. It is the users who must decide where EMODNET can provide added-value to what exists already and direct effort accordingly.

4.1.7 Clarify ownership, accuracy and precision.

All data should be accompanied by a statement concerning ownership, rights of use, precision and accuracy. This benefits the provider whose work is acknowledged and the user who must assign confidence to the products derived from the data. The ISO

19115 description of legal restrictions (see appendix 2) is not adequate for this and an alternative needs to be developed.

4.1.8 Freedom of Use

Whilst the rights of data owners to establish their own data policy will be respected, the Commission remains committed to a free access data policy for marine data that has been gathered using public funding.

A number of organisations in the public domain – particularly in geology and hydrography - are concerned that the loss of income from data sales might limit their ability to process and archive data. It is not an EMODNET objective to harm the effectiveness with which these bodies operate. Nevertheless the charging for data for commercial use is a brake on innovation without bringing a net gain in benefits for society (see section 3.2.2). In all cases competition rules must be complied with at each stage of the process.

This has been recognised by the Irish administration that has not only developed the largest integrated programme of multibeam sea-bed mapping in the EU, spending €33 million in the first phase and committing to €4 million a year afterwards[28], but it has the most enlightened data policy. Data are delivered free of charge and free of restriction on use.

4.2 Preparatory Actions

4.2.1 Objectives

In June 2008 the Commission issued two calls for tender for preparatory actions that would test the "proof of concept" of EMODNET based on the design principles outlined above.

The first call was divided into four lots - hydrography, geology, chemistry and biology. The projects defined by each lot will last for two years with a third year dedicated to maintenance. Their objectives are to:

1. collate existing data from public and private organisations relating to the state of maritime basins; processing them into interoperable formats which includes agreed standards, common baselines or reference conditions; assessing their accuracy and precision and assembling them into common datasets;

2. develop, test, operate and maintain a portal allowing public access and viewing of these data

3. monitor and report on the effectiveness of the system in meeting the needs of users in terms of ease of use, quality of information and fitness for purpose of the products delivered;

[28] INFOMAR programme http://www.marine.ie/home/services/surveys/seabed/

4. analyse what further steps need to be taken to improve the accuracy, precision, coverage and ease of use of the data, including a scheme for sustainable quality assurance and control of the data delivered to the system, both in this preparatory action and in the future larger system.

5. analyse the necessary requirements to maintain the components built up in each lot as a sustainable infrastructure

6. keep the portal operational afterwards and be prepared to transfer to the Commission.

Each lot should cover two or more maritime basins or sub-basins as defined in the Marine Framework Strategy directive.

The second project is concerned with setting up an agreed common classification for marine habitats as a first step towards a European sea-bed map. The project will:

1. review and analyse existing broad-scale marine habitat mapping efforts in terms of methods used, data requirements and applications.

2. prepare a broad-scale digital seabed habitat map using common functional mapping methods for the Baltic, North Sea, Celtic Seas and Western Mediterranean. This should include both the constituent layers (features) used to derive the functional units as well as the final classified layers.

3. make the digital map layers available to stakeholders and develop an on-line mapping tool to display the layers incorporating a site to make the data available to the public.

4. assess the benefits and constraints of using broad scale categories of the EUNIS marine habitat types, in comparison to the use of other regional variations and what shortcomings could be addressed by more accuracy and higher resolution.

5. contribute towards INSPIRE implementation standards.

6. determine the effort required to develop a complete broad-scale coverage of waters surrounding the European continent and that required to provide a more accurate, higher resolution survey-based mapping.

7. maintain the map layers.

Both projects will start in early 2009.

4.2.2 Meeting requirements

The preparatory actions will be the primary vehicle for assessing whether the design principles outlined above are sound

4.2.2.1 Discovery

Each project of the preparatory action will develop a portal indicating for selected parameters where the measurement points are in two or more sea basins and what their temporal range is. With five different portals it will be possible to assess different approaches to discovering marine data.

4.2.2.2 Access and use

The access and restrictions of all data assembled within the preparatory action portals will be clarified. The standard ISO19115 nomenclature to describe data policy has been shown to be inadequate and more meaningful descriptions will be developed. This snapshot on data access will identify where to focus efforts on improving access – academic institutions, national data centres etc

At the same time certain basic data for complete maritime basins will for the first time be made publicly available for all uses. This will include bathymetric or sediment maps at a higher resolution than has been publicly available before. The Commission has been able to specify that this be the case because the preparatory actions, unlike research grants, are implemented through procurement contracts and are paid entirely by the EU. Experience gained from the Research Infrastructures Integrating Activities (I3 model) on the access and use of data by the scientific community will of course be taken into account.

4.2.2.3 Cost

The output of the preparatory actions will be free of use to the public. However users will be asked to indicate their intended use in order to better assess the market for data and the potential benefits of extending the coverage of cost-free data.

4.2.2.4 Coherence, quality and quantity

The preparatory actions will provide an assessment of the effort needed to create coherent picture of a maritime basin. A number of parameters will for the first time be available on a regional sea basin scale complete with information as to their quality. This will be the first step in identifying gaps in technology, procedures and skills.

4.3 Finance

Even if the level of funding of preparatory actions were enough to set up a full-scale operational EMODNET (which it is not), it could not provide the long term sustainable funding solution required by EMODNET design principle number 4. Preparatory Actions can only last for up to three years and must be followed by a proposal for further action.

In the meantime other sources of funding will be actively sought. It may be that a coordination between existing mechanisms would be needed. Four mechanisms will be actively explored:

4.3.1 Territorial Cohesion

€8.7 billion, or 2.5% of the total 2007-13 allocation for the EU's cohesion policy, is allocated to "territorial cooperation". Cooperation is an objective of territorial cohesion described in the recent Green Paper[29] as "harmonious development" and "making sure that their citizens are able to make the most of inherent features of these places".

Maritime basins are an obvious area where cooperation or cohesion can yield benefits for all the littoral regions. The EMODNET design principles explicitly require a strong maritime basin component for assembling and processing data and this is reflected in the definition of the preparatory actions.

Some work has already been done within INTERREG projects to provide data on a maritime basin level. Indeed the preparatory action on habitat mapping (section 4.2) consolidates what has been done within separate INTERREG projects in the North West Europe and the Baltic and extends the methodology to the Western Mediterranean.

The challenge is to move from a set of finite and unrelated projects to a long-term sustainable infrastructure with a coordinated approach building on the EMODNET design principles.

4.3.2 European Neighbourhood Policy

The European Neighbourhood Policy (ENP) was developed in 2004, with the objective of avoiding the emergence of new dividing lines between the enlarged EU and its neighbours and instead strengthening the prosperity, stability and security of all concerned. One of the seven objectives of the EU strategy, set out in 2006[30], is to enhance regional cooperation. Most of the financial mechanisms for implementing this policy benefit individual countries rather than regional consortia. The Mediterranean and Black Sea are specifically mentioned as priority areas and working together to develop a common resource that will support economic development would appear to be a worthy contribution to the aims of this policy.

Some of the regional programmes are especially active in the field of marine data collection – for instance transport in the Black and Mediterranean Seas. These efforts will continue and fall under the EODNET umbrella as far as data standards are concerned.

4.3.3 Common Fisheries Policy

The Commission already funds the collection of fisheries data to the tune of about €40 million per year. Efforts will continue to ensure a seamless interoperability between these data and data made available through EMODNET.

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[29] Green Paper on Territorial Cohesion Turning territorial diversity into strength Brussels, 6.10.2008 COM(2008) 616 final

30 Communication from the Commission to the Council and the European Parliament on Strengthening The European Neighbourhood Policy Brussels, 4 December 2006 COM(2006)726 final

4.4 Nodes of Network

The preparatory actions are a user-driven ur-EMODNET. They have been defined according to a perception of user needs as perceived by a group of Directorates General of the Commission.

For a definitive EMODNET this process needs to be refined in order that the users can progressively understand what has been done already and express their needs for the future. Part of the structure already exists. The Marine Policy Expert Group expresses the opinion of Member States and the Marine Observation and Data Expert Group provides advice from a cross-section of the marine disciplines – hydrography, geology, physics, chemistry and biology.

Furthermore, whilst the ur-EMODNET will consist of a set of separate portals processing and collecting data on a thematic or regional sea-basin scale, there will need to be a central portal directing users towards data in these separate portals. In the first instance the European Atlas of the Seas will provide this overview although its central purpose will be awareness-raising and education rather than a service for users of marine data.

These tasks - gathering users' needs, distributing funding according to these needs, managing contracts and maintaining a central portal – may require a secretariat. This need not be large – nearly all the data would be processed, quality-controlled and prepared by thematic or sea-basin consortia - but it should be sufficient to guarantee an uninterrupted service.

The secretariat would prepare contracts for organisations or consortia to manage a certain set of data – defined parameters over a defined sea-basin or set of sea-basins in similar way to the preparatory actions. These organisations or consortia would be the principal nodes of the Network and would themselves communicate with the secondary nodes of the Network – national institutes.

The secretariat would report the performance of these nodes to a representative group of users who would judge whether the consortia are managing the right set of data and whether they are managing them in the right way. In this way the contracts for following years can be adjusted.

A secretariat would need from 5 to 10 people to function efficiently. Funding a secretariat or office with preparatory actions is out of the question.

Options for the secretariat, including within existing institutional arrangements, will be analysed as part of the impact assessment.

4.5 Impact Assessment

All significant Commission initiatives are formally subject to impact assessments. This is a process aimed at structuring and supporting the development of policies. It assesses the problem at stake and identifies the main options for achieving the desired objective through an analysis of their likely economic, environmental and social impacts. It outlines advantages and disadvantages of each option and examines possible synergies and trade-offs.

Work has already begun on collecting the relevant information, some of which has been reported in this roadmap. The formal impact assessment will be launched at the beginning of 2009 and last for six months. It will aim to quantify current spending in the EU on marine data and observation, identify the difficulties faced by those using the data and indicate the potential benefits of a better marine data infrastructure. The costs of no action in terms of duplication and time spent searching for data will be assessed. Efforts will be made to be more precise about the benefits summarised in section 5.1 of this report. For instance it will aim to identify what the savings to local authorities might be if confidence levels in sea-level rise predictions could be improved.

5 COSTS AND BENEFITS OF IMPROVEMENT IN EUROPE'S MARINE DATA AND OBSERVATION INFRASTRUCTURE

5.1 Benefits

The Commission's background paper on data[31], published together with the Green Paper already listed some of the benefits that improved access to marine data would bring.

The first and most obvious benefit is that users of marine data will be able to do what they already do more quickly and more cheaply because they are able to assemble data for an application more easily. This will have an impact on all sectors. Researchers will be able to spend less time assembling data and more time analysing them, consultants producing impact assessments will be able to charge less and still make the same profit, and public authorities will be able to meet their statutory requirements for a lower cost. Those responsible for setting up national monitoring will understand better where the gaps and priorities are.

However an improved access to marine data would also improve the quality of the services based on these data. It will benefit scientists, public authorities and industry.

1. Scientists will be able to compare their data with those of other scientists and integrate data from other disciplines. Uncertainties in the behaviour of the marine world will be reduced. The Stern Review[32] estimated that the additional costs of making new infrastructure and buildings resilient to climate change in OECD countries could be $15 – 150 billion each year (0.05 – 0.5% of GDP). The job of designing and building sea defences to cope with the one in a thousand year event will be facilitated if scientists are able to calculate the magnitude of that event more precisely.

2. Public authorities at a local, national or sea-basin level will be able to assess impacts, develop marine spatial plans and meet reporting obligations. Under the new Marine Framework Strategy Directive, Member States are obliged to work together at a marine basin or sub-

[31] Background Paper No. 4a On The European Marine Observation And Data Network, 2006, http://ec.europa.eu/maritimeaffairs/suppdoc_en.html
[32] Stern Review on the Economics of Climate Change, Cambridge University Press, ISBN 0-521-70080-9

basin level to develop a strategy for achieving good environmental status. A data infrastructure that delivers better access to data, coherence across borders and known confidence limits is a sine qua non for this task.

3. Lastly it is clear that the Lisbon objective of innovation as a driver for economic change is not going to happen for commercial services based on marine data if these commercial services are denied access or charged unreasonable fees for data collected by public bodies. An old but still valid study[33] in 2000 on behalf of the European Commission's Directorate General for Information Society indicated that Europe invested €9.5 billion per year on public information services of which a significant proportion (37% in France and 57% in the UK) was in geographical information - mapping, land registration, meteorological services, environmental data and hydrographical services. The economic value of this activity (that part of national income attributable to industries and activities built on the exploitation of public sector information) was estimated at between €28 billion per annum and €134 billion per annum. The study suggested that the corresponding exploitation of public information in the United States was much higher with an annual turnover of nearly €800 billion with the key industries posting annual growth rates ranging from 11 to 37 % in the previous six years. It concluded that the priority given to public access to information in the United States and the higher investment (approximately double the EU level) in its production have contributed to this flourishing information industry.

A soon–to-be-published study commissioned by the Irish government suggests that the economic benefits of their sea-bed mapping project are five or six times greater than the cost.

The role of government in a digital age has been analysed by Stiglitz et al.[34]. This study suggests that public information and data are fundamentally a public good[35] and that governments should therefore seek to make as much public information and data available on-line as is prudently possible. However, governments should exercise increasing caution as they provide more and more raw data or information since the assembly and maintenance of the data is not costless, the benefits of additional data are diminishing.

[33] Commercial exploitation of Europe's public sector information Pira International Ltd., University of East Anglia and KnowledgeView Ltd., 20 September 2000

[34] Joseph E. Stiglitz, Peter R. Orszag, Jonathan M. Orszag, 2000. "The Role Of Government In A Digital Age" Commissioned by the Computer & Communications Industry Association. October 2000.

[35] A public good is a good that is non-rivaled and non-excludable. This means, respectively, that consumption of the good by one individual does not reduce availability of the good for consumption by others; and that no one can be effectively excluded from using the good

5.2 Costs

The costs of enhanced access to quality marine data can be divided into two components - the cost of creating better access to data that exists already and the cost of an extended monitoring or observation programme.

5.2.1 Improved Access

Providing better access to data will incur both investment costs and running costs. The investment cost of moving an existing data infrastructure to a more interoperable one will depend on the heterogeneity of the current system. However the process is not starting from zero. It will be able to build on existing national infrastructure and previous European projects. The challenge is to develop a system that is simple to maintain and robust enough to provide high levels of service availability.

The obligation to provide extensive metadata (date, time and place of measurement, access conditions, precision etc) and on-line access might result in higher running costs where this has not already been standard practice. But the standardisation of these metadata will reduce costs in the long-term as it will provide an economically-viable market for those who develop tools to facilitate the process.

Collecting data at a sea-basin scale will be an ongoing running cost. The work will involve checking data quality, processing them (for instance to interpolate between measurements or to set up a gridded dataset) and providing a window that allows users to discover what data is there and access what is needed. It will require alerting data providers when their data is inconsistent or when the communication network breaks down.

Finally there will need to be secretariat (discussed in section 4.4) to provide an overall picture.

It is expected that the preparatory actions (section 4.2) will be the main source of information in quantifying the investment needed for an operational EMODNET.

5.2.2 More Observation

The present fragmented nature of marine data, the lack of adequate feedback mechanisms between those who use the data and those who provide the data are all major barriers to determining whether the present marine observation network is fit for purpose and what further observations and data would be needed to improve matters. The opinion of scientists[24] is that the present infrastructure is not adequate.

5.2.2.1 geology/hydrography

Indeed, for the specific data required to produce a seabed map, the maritime policy action plan[23] specifically indicated that in the second half of 2008 the Commission would

> *propose a programme for the development of mutually compatible and multi-dimensional mapping of seas in Member States' waters*

A group of European marine laboratories[36] have estimated what this might cost for waters of the EU Member States[37].

Modern multibeam sonar mapping from ships can provide unprecedented information on the seabed including both the depth and roughness. This allows a strong indication of the seabed geology, particularly when integrated with shallow seismic data.

The resolution of multibeam data decreases linearly with depth of water. Objects of approximately 2 metres can be detected in 200 metres but at 2000 metres the resolution reduces to 20 metres. Modification of the beam array and speed of survey can improve the resolution. The swath width, or area covered by each survey, increases with depth so deep water can be covered quicker and for a lower cost than shallow water. Where water clarity is high, very shallow waters may also be surveyed using penetrative LIDAR[38]. In deep water, the use of multibeam equipment mounted on remotely operated vehicles or autonomous underwater vehicles can provide higher resolution data.

The Irish National Seabed Survey programme of 1999-2005 mapped 432,000 km² of their deeper waters (greater than 200 metres depth) at a cost of €33 million.

The group[36] estimated that the area within the 200 mile limit or, in the case of the Mediterranean up to the median line, was 2,500,000 km^2 of continental shelf[39] and 7,200,000 km^2 of deep water. The cost was estimated from €60 million to €120 millions for the deep sea and from €900 million to €2,000 million for the shallow sea. Some of the Marine Observation and Data Expert Group felt that this calculation requires some further checking but it is a useful ball-park figure.

6 RELATIONSHIP WITH OTHER INITIATIVES

6.1 Global Earth Observation System of Systems (GEO/GEOSS)

The purpose of Global Earth Observation System of Systems, GEOSS[40] is to achieve comprehensive, coordinated and sustained observations of the Earth system, in order to improve monitoring of the state of the Earth, increase understanding of Earth processes, and enhance prediction of the behaviour of the Earth system. Its 10-year implementation plan will link together existing and planned observing systems around the world and support the development of new systems where gaps currently exist. It will also promote common technical standards so that data from the thousands of different instruments can be combined into coherent data sets. In order to provide global coverage GEOSS will promote capacity building in earth observation.

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[36] IFN-GEOMAR (Leibniz Institute of marine sciences), IFREMER (Institut français de rechereche pour l'expoitation de la mer) and NOCS National Oceanographic Centre Southampton)

[37] This area includes the Azores, Greenland and Madeira but should not be considered a definitive value of the European continental shelf. Others have come up with different numbers.

[38] Light Detection and Ranging

[39] This estimate should not be used as a reference. Other, significantly different, estimates have been made.

[40] http://www.earthobservations.org/

EMODNET should respect the same principles of openness and interoperability as the Global Earth Observation System of Systems and thus become one of its component systems.

6.2 Global Monitoring for Environment and Security

The Global Monitoring for Environment and Security (GMES/KOPERNIKUS) initiative seeks to provide services in support of the implementation of EU environment and security policies as well as meeting the needs of other users including national authorites and agencies, researchers, private companies, and the citizen. GMES/KOPERNIKUS will consist of two major components, services and observation infrastructure, and be driven by user demand and available resources.

By providing fully and openly accessible services, GMES/KOPERNIKUS is intended to promote the widest possible use and sharing of earth observation information, according to the principles of the European Shared Environmental Information System (SEIS) and the Global Earth Observation (GEO) initiatives.

These aspirations are clearly consistent also with the aims of the EMODNET. Indeed, EMODNET and GMES/KOPERNIKUS are mutually synergistic, as a better overview and availability of observation data achievable through EMODNET will help to meet GMES/KOPERNIKUS requirements for input data, and GMES/KOPERNIKUS on the other hand constitutes a powerful driver for

1. achieving sustainability for existing observation systems,

2. for making the case for needed observations,

3. funding to address relevant gaps in observation systems, especially for transboundary and global networks.

GMES/KOPERNIKUS has global aspirations and will need to rely on international cooperation, e.g. within the context of GOOS, GEO/GEOSS, to fulfill its observation needs to adequately address the observation of global changes. In this way, the scope of available information through the EMODNET would also be expanded.

6.2.1 Marine core service

The GMES/KOPERNIKUS Marine Core Service (MCS) will deliver two categories of products: satellite observations (sea level, ocean colour. sea-surface temperature, wind) and short term and seasonal forecasts, time series and climate change scenario simulations of physical parameters describing open ocean state and dynamics. The forecasts will be available for the global ocean and the Baltic, Mediterranean, North Sea, North East Atlantic Sea, Black Sea. The Marine Core Services will, in the period 2009-2011, be provided by a Seventh Framework Programme thematic project, MyOcean. As well as satellite data the marine core service relies heavily on networks for in-situ data that are collected and processed by many institutions. Particularly important for the MCS are drifting Argo-floats for the measurement of temperature and salinity but measurements from fixed gauges and ships are also highly significant.

EMODNET will contribute to sustaining and integrating these in-situ observation networks. Up to the present time none of the EMODNET preparatory actions concern physical data but it is intended that an action in 2010 should identify how an EU contribution to the present in-situ network could best meet the needs of GMES.

6.3 SEIS

In announcing the Shared Environmental Information System SEIS[41] , the Commission set out an approach to modernise and simplify the collection, exchange and use of the data and information required for the design and implementation of environmental policy, according to which the current, mostly centralised systems for reporting are progressively replaced by systems based on access, sharing and interoperability. The overall aim is to maintain and improve the quality and availability of information required for environmental policy, in line with better regulation, while keeping the associated administrative burdens to a minimum. This means that SEIS aims to move away from paper-based environmental reporting to a system where information is managed as close as possible to its source and made available to users in an open and transparent way.

A basic principle of SEIS is that data and information already held (in databases and other information systems) by Community institutions should not be duplicated but accessed and used in the new applications under development. This is completely along the lines of EMODNET.

The observations and data in EMODNET will contribute to SEIS, which is the overarching framework which will over time hold all environmental information together. The data available through EMODNET should meet the requirements of SEIS.

It is possible that the legal implementation of SEIS will provide regulatory powers relevant to EMODNET, and the project will need to be closely engaged with their development.

6.3.1 WISE-Marine

WISE-marine is the marine environmental component of SEIS. During the period 2008-2012 Commission services will be preparing for the implementation of the reporting obligations of the Marine Strategy Framework Directive 2008/56/EC. The main platform for exchanging and sharing information and underlying data for this purpose will be an extension of the current Water Information System for Europe (WISE) system towards the marine environment beyond the near coastal waters which are already covered by the Water Framework Directive. Both WISE, WISE-Marine and EMODNET are in line with the INSPIRE Directive and contributing to its implementation. EMODNET focuses on making observations and data available to the Community. WISE-Marine on the other hand intends to derive a maximum of data from EMODNET, but will concentrate on the processing and presentation of derived data products for use in the MSFD perspective or marine environmental management generally. The WISE-Marine user communities will to different degrees

[41] Towards a Shared Environmental Information System (SEIS) COM(2008) 46 final Brussels, 1 February 2008

have direct relations with EMODNET, depending on how much they require 'raw' data. The comparative qualities of the two systems are shown in Table 2.

Table 1 The intended comparative qualities of EMODNET and WISE-Marine

EMODNET	WISE-Marine
Networking facility for maximizing added value from potentially any marine observation and data, supporting the 'services' dimensions of maritime sectors and the knowledge base of the maritime policy	European portal for marine environmental information, in line with SEIS; Streamlined official reporting channel, reference centre for thematic marine environmental information
Focus on becoming a 'data warehouse' for marine observations for all types of users.	Focus on becoming a 'common reporting and information sharing' facility for communities in the sphere of marine environmental policy.
Regionally coherent, streamlined, raw data sets accessible to all potential users. Discovery, viewing, retrieving. Extensive post-processing (into information products) not intended.	Prioritized entry levels in WISE-Marine are: 1. Indicators and thematic assessments 2. Access to underlying data 3. Interpretation in order to derive environmental meaning from data.

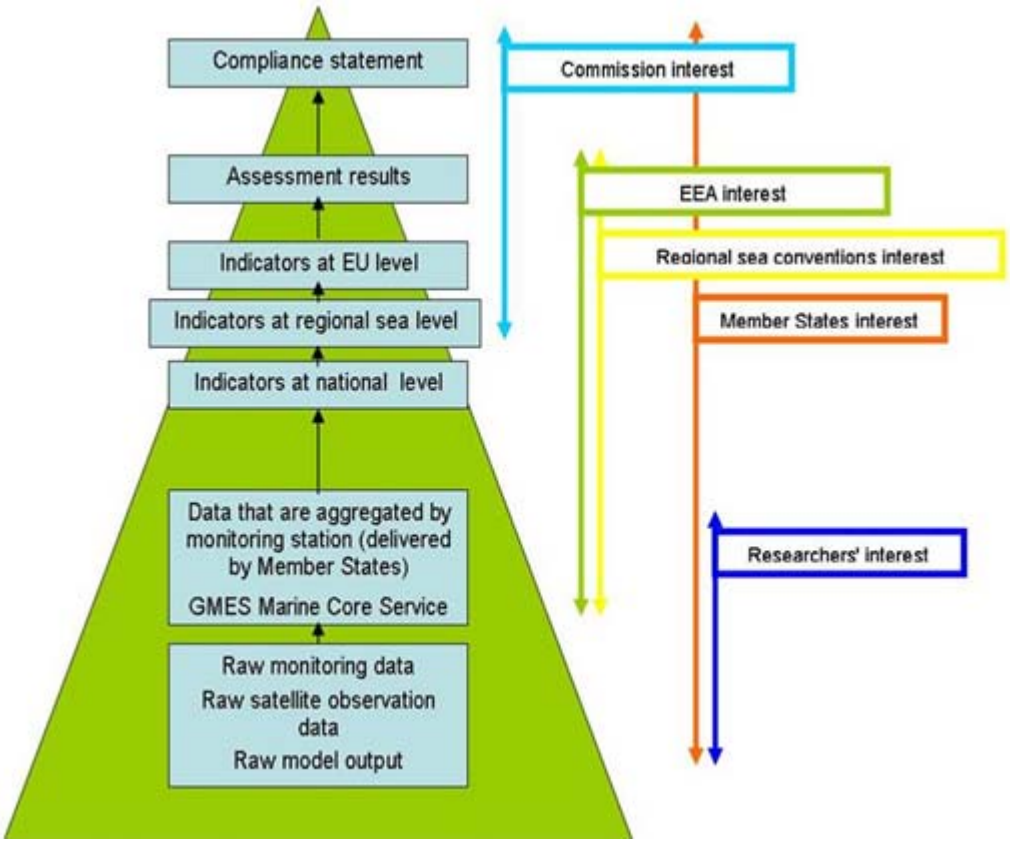


Figure 1 shows construction of indicators at different levels

Two of the ongoing EMODNET preparatory actions, that on biology and that on chemistry have been specifically tailored to meet the needs of the Marine Strategy Framework Directive and hence WISE-marine.

6.4 European Atlas of the Seas

During 2009 the European Commission will publish a prototype "European Atlas of the Seas". The primary purpose is to raise awareness of Europe's maritime heritage, of opportunities in the maritime economy and the fragility of the marine environment. The Atlas is still in the design phase but some of the on-line map layers will be sourced from the EMODNET preparatory actions and it will provide a window on the ocean indicators calculated through the Shared Environmental Information System process. It will provide a summary, in map form, of the progress of EMODNET. Formats and nomenclature will be identical in all these initiatives.

6.5 Networks of Excellence

The Sixth Framework Programme introduced Networks of Excellence with the aim of bringing about the long lasting and durable integration of leading institutions and their research programmes on critical or strategically-important themes. Particularly relevant to EMODNET are EUROCEANS which is developing models for assessing and forecasting the impacts of climate and anthropogenic forcing on food-web dynamics (structure, functioning, diversity and stability) of pelagic ecosystems in the open ocean, MARBEF which aims to integrate and disseminate knowledge and

expertise on marine biodiversity and ESONET which brings together European efforts on establishing a network of sea-floor observatories.

EMODNET will support these communities by providing the means by which they can assess what data are available from other disciplines and then access to the data. In some cases these Networks have developed information systems for particular types of data that could be eligible for further development and funding as nodes of EMODNET.

6.6 Research Infrastructure

Research Infrastructures is a strategic action for the European capacity building and the European Research Area (ERA).

Support to existing infrastructures has been provided through successive RTD Framework Programmes. The I3 model (Integrating Infrastructure Initiative) was introduced under the Sixth Framework Programme: it combines in a closely co-ordinated manner (i) Networking activities, (ii) Trans-national access and/or service activities and (iii) Joint Research activities to improve the services provided by the infrastructures. The Seventh Framework Programme Integrating Activities follows the I3 model. E-Infrastructures are also supported to build upon the ICT capabilities of existing infrastructures and development of "virtual research communities".

Extremely relevant to EMODNET is SeaDataNet, an I3 project which aims to an efficient distributed Pan-European Marine Data Management Infrastructure. Similarly, Geo-Seas, an e-Infrastructure project, will be an extension of SeaDataNet to marine geological and geophysical data. UP-GRADE BS-SCENE is an Integrating Activities project focusing to the Black Sea.

Support to new Research Infrastructures by the EU build on the strategic work of ESFRI (European Strategic Forum for Research Infrastructures[42]). ESFRI has identified (through consultation with Member States and expert groups) a number of strategically important new projects for European Research Infrastructures.

The Commission has proposed[43] setting up of a new legal, financial and governance framework for their construction and long-term operation. An initiative such as EMODNET, that focuses on sea-basins might also benefit from a new legal instrument, the European Grouping for Territorial Cooperation[44], designed to facilitate cross-border, transnational and inter-regional cooperation.

6.7 Maritime Spatial Planning

The new EU maritime policy launched three new activities whose cross-sectoral nature meant that they could not have been implemented under any single EU policy: maritime knowledge, maritime surveillance and maritime spatial planning.

[42] http://cordis.europa.eu/esfri/home.html

[43] A new legal instrument has been proposed by the EC and is currently being considered by the Council (COM(2008) 467 final).

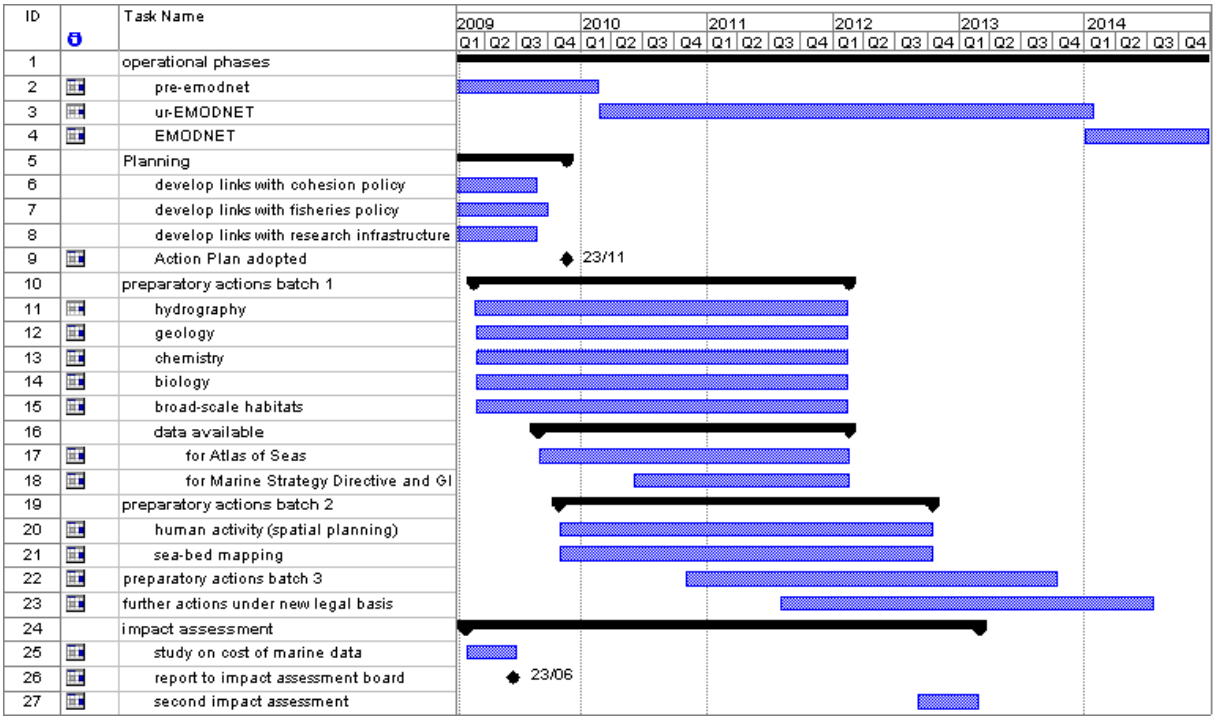
[44] Regulation (EC) No 1082/2006 of the European Parliament and of the Council of 5 July 2006 on a European grouping of territorial cooperation (EGTC)

EMODNET falls under the maritime knowledge heading. These three activities are themselves strongly coupled.

The Commission's recent Communication on the subject[45] confirms that Maritime Spatial Planning (MSP) is a key instrument for the integrated maritime policy. It helps public authorities and stakeholders to coordinate their action and optimises the use of marine space to benefit economic development and the marine environment. "A strong data and knowledge base" is seen as an essential element of maritime spatial planning and EMODNET will be a major EU's contribution towards the delivery of this knowledge to the authorities that need it.

During 2009 a maritime policy preparatory action will be launched to develop and test ways of presenting a picture of human activities on the sea to stakeholders and thus supporting a more efficient maritime spatial planning. These will build on data flowing from the EMODNET preparatory actions and aim to contribute towards a fully coherent and interoperable maritime knowledge infrastructure.

7 TIMETABLE



7.1 EMODNET

On the basis of present information, the following timetable is set out for EMODNET.

[45] COM/2008/0791 final

7.1.1 2009 setting up ur-EMODNET

The preparatory actions will start at the beginning of 2009 and be monitored by the Marine Observation and Data Expert Group. By the end of 2009, these actions, together with the European Atlas of the Seas, will have produced a prototype ur-EMODNET.

A follow-up preparatory action project to start later in 2009 will supplement the range of parameters encompassed by the ur-EMODNET One will focus on high resolution sea-bed mapping (see section 7.2). Other actions, to improve maritime spatial planning, will aim to use and extend the data infrastructure of EMODNET.

A new study will be launched on the potential costs and benefits of EMODNET. An impact assessment based partly on these results, will report by mid-2009. It will analyse different options for resolving the problems identified with the present marine data infrastructure.

Discussions will begin on embedding EMODNET within other Community programmes – particularly, but not only, those in support of territorial cohesion of sea-basins and research infrastructures. Discussions will begin with a view to creating a portal for fisheries data collected through the Data Collection regulation.

The Commission will prepare an Action Plan for adoption as a Communication at the end of 2009 that sets out this strategy.

Preparatory actions are designed to prepare proposals with a view to the adoption of future actions. Future actions will depend on the impact and the outcome of these preparatory actions.

7.1.2 2010-2011 operating ur-EMODNET

The ur-EMODNET will be operational throughout 2010 and 2011 collecting feedback from users on fitness for purpose and indicating how the definitive EMODNET might be set up.

It will provide better access to selected parameters for selected sea-basins. Should these prototypes prove to be successful and should discussions on embedding EMODNET within other Community programmes be fruitful, then efforts will be made to extend their geographic range in order to cover all of the waters of EU Member States. This can be done in 2010 through preparatory actions. Afterwards, provided that the impact assessment confirms the need for EU action, further actions can be launched under a new mechanism.

7.1.3 2012 consolidating ur-EMODNET

By 2012 the first set of preparatory actions will have run their course. The main priorities during the next two years will be to maintain and extend the data communities and infrastructure that have been built up and to progressively develop the mechanisms to examine data coverage, feed-back user satisfaction and determine the priorities for extending the observation network.

A report at the end of 2012 will summarise the lessons learned.

The secretariat may need to be set up in order to ensure coherence between the different thematic or regional activities and to consolidate user feedback.

7.1.4 2013-2014 Towards operationality

During 2013-2014, based on the outcome of the preparatory actions and another impact assessment, the Commission will be in position to assess what has been achieved and what the best option is for achieving the objective of a better marine data infrastructure.

7.2 Sea-bed mapping

The maritime policy action plan[23] includes a commitment by the Commission to present a programme for the mapping of sea-beds in 2008.

EMODNET will include data on sea beds and the eight basic design principles proposed for EMODNET (section 4.1) are identical to those for the production of seabed maps. Therefore this roadmap for EMODNET implicitly encompasses a programme for mapping seabeds. However in view of the Commission's commitment, and in view of the growing scientific and commercial interest in sea-beds, it is worthwhile spelling out explicitly how this sea-bed mapping will be achieved.

A preparatory action starting in early 2009 will develop a broad scale sea-bed habitat map based on existing data for the Baltic, the greater North Sea[46] and the Western Mediterranean using a common approach and a common classification system. This map will be assessed for fitness for purpose by stakeholders for applications ranging from siting of windfarms to setting up networks of marine protected areas. The process will therefore not only make significant progress towards full coverage with a broad scale habitat map but also help in understand where the priorities are for more detailed mapping.

A new preparatory action will be launched later in 2009. This will deliver a snapshot of how much has been covered already by high resolution multibeam mapping by hydrographic and geological agencies, scientific institutions and commercial companies. At the same time standards and processes will be agreed that will allow the merging, comparison and visualisation of different surveys. The end product will be a repository of metadata for this type of data and an indicator of progress towards a complete fine-scale mapping of European waters. This will be maintained and developed in the same way as the rest of the EMODNET infrastructure as described in section 7.1

8 MONITORING AND FEEDBACK

This roadmap is not a blueprint. Rather it outlines a set of principles, an approach and a timetable for reaching a desired end. The Maritime Policy Member State Expert Group and the Marine Observation and Data Expert Group will monitor the initiative and determine how well it is achieving its objectives. Other stakeholders

[46] As defined in the Marine Strategy Framework Directive

will be invited to present their views – through the internet and at maritime events. The Action Plan, to be presented at the end of 2009, will incorporate the lessons learned and insights gained during this initial period.

APPENDIX 1 LEGAL ASPECTS OF CURRENT MARINE DATA INFRASTRUCTURE

This appendix summarises the findings of a recently completed study carried out on behalf of the European Commission[47].

Discovery

Finding data will be facilitated by the INSPIRE Directive 2007/2/EC which establishes an Infrastructure for Spatial Information in the European Community. Member States are obliged to establish networks allowing their spatial data holdings to be searched and displayed. The Directive applies to spatial data held in electronic form by public authorities. By spatial data it means any data with a direct or indirect reference to a specific location or geographical area. However it should relate to an area where the Member State has jurisdictional rights and therefore does not cover high seas.

The intention is that INSPIRE should help public authorities exercise their function in support of EU policies that protect the environment. The appendixes list the types of data that are covered. It includes hydrography, geology, oceanographic currents habitats but not detailed species distributions.

However, INSPIRE does not address existing problems of data quality, comparability or timeliness.

Access

Environmental Data

The "Environmental Information Directive" 2003/4/EC seeks to align Member States' laws on access to environmental data with the Aarhus Convention[48] which aims to grant public rights and impose obligations upon public authorities regarding access to information and public participation and access to justice regarding environmental matters. Regulation 1367/2006/EC extends this to information held by Community institutions and bodies.

Nearly all marine data could be considered as environmental data. However Member States may refuse a request for environmental information if disclosure of the information would adversely affect:

a) *the confidentiality of the proceedings of public authorities, where such confidentiality is provided for by law;*

b) *international relations, public security or national defence;*

c) *the course of justice, the ability of any person to receive a fair trial or the ability of a public authority to conduct an enquiry of a criminal or disciplinary nature;*

[47] http://ec.europa.eu/maritimeaffairs/study_lamed_en.html
[48] 38 ILM (1999), 517.

d) the confidentiality of commercial or industrial information where such confidentiality is provided for by national or Community law to protect a legitimate economic interest, including the public interest in maintaining statistical confidentiality and tax secrecy;

e) intellectual property rights;

f) the confidentiality of personal data and/or files relating to a natural person where that person has not consented to the disclosure of the information to the public, where such confidentiality is provided for by national or Community law;

g) the interests or protection of any person who supplied the information requested on a voluntary basis without being under, or capable of being put under, a legal obligation to do so, unless that person has consented to the release of the information concerned;

h) the protection of the environment to which such information relates, such as the location of rare species[49]

If the request relates to emissions into the environment, Member States' authorities may not rely upon the refusal grounds listed under (a), (d), (f), (g) and (h).

In the case of marine data, the rule about intellectual property rights is certainly the one that is most restrictive. For practical purposes we can assume that some person or some body will hold intellectual property rights[50] of the marine dataset and can therefore control the access and use of the data. If the public authority holding the dataset is not the owner of the intellectual property rights in the data, it will be unable to grant access to the data without the authorisation or consent of the rights holder[51]

Ownership of the intellectual property rights may not even reside with those who have collected the data or those who are processing it. It may belong to the employer of the person or to the organisation that has paid for the data collection. Often consortia of institutions own the rights to acquired raw data whereas single laboratories or researchers hold the rights of data that they have processed. This will depend on the arrangements made amongst those persons or organisations. Data produced by public bodies is not exempt. This is the greatest difference with the United States. Their 1976 Copyright Act prohibits the federal government from claiming copyright protection of the information it produces. For instance all data

[49] In certain instances, there may be legitimate reasons to restrict access to data on the location of biological resources for the sake of conservation

[50] There are exceptions to this general rule, for instance for certain works produced by the Department of Commerce. Also, the US government can hold copyrights that are assigned to it (e.g. for works created by contractors). The fact that data is not copyright-protected does also not mean that the government may not restrict access to those data on the basis of other mechanisms (e.g. rules of secrecy or confidentiality).

[51] This is also reflected, to a certain extent, in the legal framework in relation to the access to environmental data and the re-use of public sector information (see below). For instance, under the legal regime governing the re-use of public sector information, if an applicant's request for re-use is refused based on the protection of the IPR of third parties, public sector bodies need to include a reference to the (natural or legal) person who is the holder of those rights (where known), or to the licensor from which the public sector body obtained the relevant material.

authored or produced by the United States Geological Survey are considered to be in the public domain.

Confidentiality of data and/or the protection of personal data may also be valid reasons for refusing requests to access data. Directive 95/46/EC of the European Parliament and of the Council on the protection of individuals with regard to the processing of personal data and on the free movement of such data (*the Data Protection Directive)* applies to the processing of personal data. "Processing" means any operation or set of operations performed on data. "Personal data" means any information relating to an identified or identifiable person. All other categories of data are governed by the provisions laid down in the Data Protection Directive to the extent that they include personal data as defined in that Directive.

In general this is not an issue for EMODNET. Data with information that can be traced back to a particular individual - for instance fishing vessel tracks - can generally be made anonymous with no loss of usefulness by removing those parts (eg. fishing vessel name) that may be connected to an individual or by aggregating data.

In some countries bathymetric data is considered as a military secret - either for the whole of that countries' waters (eg. Finland) or some parts of them (eg France). In these cases acquisition may be forbidden or there may be a restriction on the scale or resolution of the data that is made available.

In addition to guaranteeing the right of public access to environmental data, the Environmental Information Directive also requires the Member States to actively and systematically make available and disseminate environmental information to the public in the widest possible sense such as through electronic databases which are easily accessible to the public through public telecommunication networks.

The INSPIRE Directive strengthens the Environmental Information Directive by creating a general obligation upon public authorities to make "spatial data" accessible to all possible actors and share them across borders amongst Member States.

Fisheries Data

Data reported to the Commission under the Common Fisheries Policy Control Regulation – catch, effort, licences etc - is generally treated as confidential. The Commission maintains a database including more than 800 of such obligations. Although it is recognised that with respect to 'environmental information', the Environmental Information Directive applies, article 37(1) of the Regulation provides that 'Member States and the Commission shall take all necessary steps to ensure that the data received in the framework of the Control Regulation shall be treated in a confidential manner.

The EU also supports the collection of fisheries data – landings, effort, discards, surveys etc - for scientific purposes. It distinguishes 'detailed data' (data based on primary data in a form which does not allow natural persons or legal entities to be identified directly or indirectly) and aggregated data (the output resulting from

summarising the primary or detailed data for specific analytic purposes). According to the Council Regulation (EC) No 199/2008[52] referring to the Data Collection Regulation, Member States shall make detailed and aggregated data available to end-users to support scientific analysis:

a) as a basis for advice to fisheries management, including to Regional Advisory Councils;

b) in the interest of public debate and stakeholder participation in policy development;

c) for scientific publication.

Public debate and stakeholder participation has the lowest priority:

Where necessary, to ensure anonymity Member States may refuse to provide data on vessels' activity based on information from vessel satellite monitoring to end-users for the purposes referred to in paragraph 1(b).

And for scientific publication Member States may:

in order to protect the professional interests of the data collectors, withhold data transmission to the end-users for a period of three years following the date of collection of the data. Member States shall inform the end-users and the Commission of any such decisions. In duly justified cases the Commission may authorise that period to be extended

Data on catches and landings are also transmitted by Member States to the Commission according to the Council Regulations (EEC) 3880/91[53], 2018/93[54], 2597/95[55] and to the Council and the European Parliament Regulation (EC) 1921/2006[56] while according to the Regulation (EC) N° 762/2008[57] of the European Parliament and of the Council, the Member States are required to submit statistics on aquaculture production and structure of the sector. These statistical data are less detailed than the data collected under the Data Collection Regulation. For instance they are not disaggregated by vessel type. However the data are free of any restrictions on use.

EU research projects

EU research projects are another special case. Up to and including the EU's Fourth Framework Programme, the intellectual property rights (IPR) set out within EU-RTD marine (MAST) contracts stated that data gathered by projects was part of the foreground information generated by the project and that this data had to be accessible for at least 10 years after termination of the contract. It was understood that MAST projects would meet these obligations if they made data publicly

[52] OJ L 60/1 of 25 February 2008
[53] OJ L365 of 31.12.1991
[54] OJ L186 of 28.07.1993
[55] OJ L270 of 13.11.1995
[56] OJ L403 of 31.12.2006
[57] OJ L218 of 13.08.2008

accessible at project termination. Access could be ensured by entrusting data to public data banks, or by publishing data on electronic media which could be archived. It was recommended that any moratorium period for public access should have been shorter than 6 months counted from the date of project termination.

However in the Fifth and Sixth Framework Programme there was a change in the rules for intellectual property rights and the Commission could no longer insist that the provisions used during the MAST Programme could be included into EC-funded research contracts. Hence access to EC funded marine research data could no longer be guaranteed.

Under the Seventh Framework Programme, research contracts in the environment area will oblige consortia to release data to public bodies, but not for commercial use. Under the terms of the relevant special clause, Community institutions and bodies can oblige contractors to release data immediately to them if required for the purpose of developing, implementing and monitoring environmental policies.

Using data

Public Sector Data

The objective of the Public Sector Information Directive 2003/98/EC is to lower the legal, economic and technical barriers which individuals or companies face while developing new cross-border information services and products based on public data resources. This may cover data accessed following requests through the mechanism of the Environmental Information Directive but is primarily aimed at data that the public authority makes available for other purposes or by other means - for instance on a web-site. The Directive refers to "document" which is defined as "any content whatever its medium (written on paper or stored in electronic form or as a sound, visual or audiovisual recording) or any part of such content". Marine data therefore falls under this regime provided it is held by public bodies.

This Directive does not cover exchange of documents by public bodies in pursuit of their public tasks but rather their re-use for other purposes - for instance by a commercial body. Licences granted by public bodies may address issues such as liability but should not be used to restrict competition. Exclusive rights to re-use information should only be granted in exceptional circumstances. The Directive constitutes a minimum requirement - Member States are free to apply a more liberal policy if they wish.

However, similar provisions on intellectual property rights apply as for the Environmental Information Directive. As such, marine environmental data will not be affected by the Public Sector Information Directive if third parties would have intellectual property rights in the data.

The Public Sector Information Directive does not apply to data held by public educational or research institutions.

Commission Decision 2006/291/EC/Euratom on the re-use of Commission information (the "Re-use Decision") applies to information held by the Commission. It contains largely similar definitions and re-use principles as the PSI Directive.

Fisheries Data

As we have seen, (section 5.2.2) fisheries data collected under the Data Collection Regulation is provided for specific purposes - scientific advice, public debate or research. There are also specific conditions on how it is used. End-users shall

a) *use the data only for the purpose stated in their request in accordance with Article 18 of (EC) No 199/2008;*

b) *duly acknowledge the data sources;*

c) *be responsible for correct and appropriate use of the data with regard to scientific ethics;*

d) *inform the Commission and the Member States concerned of any suspected problems with the data;*

e) *provide the Member States concerned and the Commission with references to the results of the use of the data;*

f) *not forward the requested data to third parties without consent with the Member State concerned;*

APPENDIX 2 TESTING THE ACCESS OF DATA

To determine how the legal framework works in practice a study, funded by the Commission[58], aimed to obtain a snapshot of the data holdings in a sample of European States - Bulgaria, France, Greece, Norway, Poland, Spain and the United Kingdom. They analysed the data policies of bodies holding the data and/or owning the intellectual property rights in the data.

The study confirmed the large number of organisations holding and owning marine data. Their sample of data was obviously not an exhaustive summary of marine holdings. Private organisations are almost certainly undersampled because they are under no obligation, legal or moral, to advertise their data holdings. For France[59] 5 organisations were identified as owning hydrographical data, 11 geological data, 10 physical oceanography data, 8 biology data (excluding fisheries), 4 fisheries data, 6 chemical data and 8 human activity data. There was similar fragmentation in other Member States

The data-owners were almost overwhelmingly in the public sector, partly for the reasons explained above, although few could automatically be considered "public authorities" within the meaning of the Environmental Information Directive or Public Sector Information Directive as most are not bodies fulfilling tasks of government or other public administration. A significant amount of data is owned by publicly-funded organisations that are required to raise part of their income through commercial activities (Table 1).

The study concluded that the ISO 19115 description of legal restrictions – patent, patentPending, trademark, license, intellectualPropertyRights, restricted, otherRestrictions - is not appropriate for describing data access conditions. An alternative needs to be found.

Table 2 Types of organisations owning marine data in Bulgaria, France, Greece, Norway, Spain, Poland and the United Kingdom. The numbers in the columns indicate discrete data sets. This table is not intended to provide a complete picture of marine data holdings in the countries concerned.

organisation	hydrography	geology	physics	biology	fisheries	chemistry	human activity	mixed	Total
academic	13	30	39	34	13	21	17	16	183
central government agency	18	32	16	7	7	5	33	13	131
commercial	0	2	6	0	1	2	6	3	20
local government	3	3	3	5	4	2	7	1	28

[58] http://ec.europa.eu/maritimeaffairs/study_lamed_en.html

[59] France is used as an example because the sample of data was checked by a member of the MODEG and can be considered more reliable than the other data collected within the study. The number quoted is a minimum. There may be other data that was not discovered during the study.

organisation	hydrography	geology	physics	biology	fisheries	chemistry	human activity	mixed	Total
multinational organisation	1	0	0	0	0	0	0	0	1
non-government organisation	0	1	0	7	2	0	2	1	13
other	7	7	2	4	4	2	4	1	31
publicly funded institution that is required to raise part of its income from commercial activities	22	33	68	25	15	18	22	14	217
publicly-funded institution	17	27	37	37	31	28	27	25	229
unknown	29	33	70	28	9	17	41	12	239
total	110	168	241	147	86	95	159	86	1092

The study group then selected a sample of data that was available free of charge and that had not been declared confidential and assessed how easy it was to access that data. It was concluded that for each type of data between 30 and 50% of datasets were provided immediately, between 20 and 30% within a few weeks and between 30 and 40% not at all. There was a strong correlation between fast arrival of data and an automatised internet-based delivery. In those cases where requests were sent via e-mail or where signed requests had to be prepared the whole process took longer. It is not clear whether this was because of the administrative procedure or whether the data themselves needed some preparation.

APPENDIX 3 MARINE CATALOGUES

Catalogues Developed through EU Research Projects

Marine data including geological, physical, chemical, biological and marine meteorological data are catalogued in the following following catalogues currently maintained under the SeaDataNet project:

- European Directory of the Ocean-Observing System (EDIOS): covering observing systems operating repeatedly, regularly and routinely in European waters
- European Directory of Marine Environmental Data (EDMED): covering marine data sets and their associated data holding centres
- Cruise Summary Reports (CSR): an inventory of oceanographic data collected on research vessels (originally developed by IOC)
- Common Data Index (CDI): a fine-grained inventory providing access to data, information and products.

Some of these go beyond metadata and actually provide access to data. This includes CDI from the SeaDataNet project and the SEPRISE project. The latter includes 385 stations producing 652 time series of physical parameters once every hour. EurOBIS, developed within the MARDEF network, is the European node of the global OBIS programme. It allows searching of multiple datasets simultaneously for biogeographic information on marine organisms. The ultimate goal of EurOBIS is to provide the end-user with a fully searchable biogeographic database, focused on three main parameters: taxonomy, temporal and geographical cover.

The projects EUROCORE (1998-2001), EUMARSIN (1998-2000) and EUROSEISMIC (2002-2004), SEISCAN[60] (1997-2000) and SEISCANX[61] (2001-2004) have developed and maintained a number of information systems for organising geological survey metadata. The obvious next step would be to move beyond metadata to real data and extend coverage to data held by third parties (academia, government and industry).

Catalogues Maintained by International Organisations

The International Council for the Exploration of the Sea (ICES) hold a number of regional data sets - largely focusing on those parameters contributing to marine pollution. In addition to the oceanographic database which covers primarily temperature, salinity and nutrient data collected by ICES member countries), ICES acts as a data centre for the marine conventions HELCOM and OSPAR. This activity includes data on contaminants observed in the water, sediment and biota of the marine environment, data resulting from biological monitoring (including biological

[60] http://www.noc.soton.ac.uk/CHD/seisweb/SEISCAN.html)
[61] http://www.noc.soton.ac.uk/gg/SEISCANEX/

effects monitoring), and data on nutrients and eutrophication effects resulting from the (OSPAR) Eutrophication Monitoring Programme. An agreement has also been reached whereby they hold data on fisheries surveys in northern and western waters (ie excluding the Mediterranean and Black Sea).

The World Data Center for Marine Environmental Sciences, Germany (WDC-MARE[62],) has supplied and is supplying data management services for European funded marine projects such as EUR-OCEANS, HERMES, EURODELTA, PROMESS, OASIS, OMARC, CENSOR). It holds a large inventory of oceanographic metadata including a direct Internet link to all related data and provides data to scientists in any country free of charge according to the ICSU WDC data policy.

The UNESCO Intergovernmental Oceanographic Commission (IOC), through its Harmful Algal Blooms Programme (HAB) is developing the Harmful Algal Event Information System (HAIS). This system is being built in cooperation with ICES, PICES, the World Register of Marine Organisms (WoRMS) and the International Society for the Study of Harmful Algal Blooms (ISSHA). When fully developed, this database will provide access to information on harmful algal events, harmful algae monitoring and management systems worldwide, current use of taxonomic names of harmful algae, and information on biogeography of harmful algal species. Supplementary components are an expert directory and a bibliography. One of the main components of HAIS is HAEDAT, a meta database containing records of harmful algal events, including records from the ICES area (North Atlantic) since 1985, and from the PICES area (North Pacific) since 2000. IOC Regional networks in South America and North Africa are preparing to contribute.

Hydrographic survey information can be found in the S-55[63]. publication of the International Hydrographic Organisation. It is a registry of reports from Member States which does not identify individual hydrographic surveys but gives a worldwide overview of coverage.

Marine Conventions

Whilst the northern and western Regional Seas Conventions use ICES as a data centre, the southern Regional Sea Conventions host their own databases for marine pollution. Until recently the UNEP/MAP-MEDPOL database for the Mediterranean was on-line.

A subset of the dataholdings from MED POL and the Black Sea Commission are freely available from European Environment Agency website as well as from the BlackSeaSCENE website.

Data from Private Bodies

Whilst the main thrust of this report is concerned with data held by public bodies, it is believed that most high resolution modern marine geological data is owned by private companies concerned with activities such as petroleum exploration and

[62] http://www.wdc-mare.org
[63] http://www.iho.shom.fr/PUBLICATIONS/S-55/S_55.htm

exploitation, sand and gravel extraction,. pipeline laying or windfarm construction. These data are generally site specific rather than covering a region..

According to the International Organisation of Oil and Gas Producers[64]

> *"Information on the seabed that is useful for the offshore oil and gas industry includes information on seabed morphology, chemistry and biology, seabed topography, seabed depth and geological sub-seabed profile as well as seabed geotechnical conditions.*

Clearly some data is commercially sensitive but there is much that is not. That there is no intrinsic resistance to sharing data is evidenced by the success of the SIMORC infrastructure, originally funded as an EU research project, which allows access to 1200 data sets from Shell, Total and BP and covers more than 1250 years of observations of winds, waves, currents and sea-levels.

[64]In consultation for Green Paper http://ec.europa.eu/maritimeaffairs/contributions_post/224.html

APPENDIX 4 QUALITY STANDARDS FOR MARINE DATA

A number of marine science communities have established quality standards. The QUASIMEME project, funded by the EU between 1993 and 1995 but since continued on a subscription basis, has developed a quality assurance program for marine chemical contamination monitoring information in Europe. The original project demonstrated that laboratories which followed on a regular basis the learning programmes and testing schemes improved the quality of their data. Laboratory performance studies have been established for most of the determinants measured in the marine environmental programs for both monitoring and research purposes. The BEQUALM project similarly began as an EU project in 1998 but deals with biological rather than chemical parameters. Standard procedures for sample handling before analyses (~normalization through sieving) and normalization with co-factors after analysis were developed within- QUASH (Quality Assurance of Sampling and Sample Handling) which ran from 1996 to 2000. Both inorganic and organic compounds from standard sediment samples and biota (mainly fish) were handled, analysed and compared between the test laboratories. A report with recommendations was written as a final product. The project did not consider the quality of sampling at sea.

The OSPAR marine convention monitoring programme specifies that QUASIMEME and BEQUALM be used for measurements used in compiling indicators on hazardous substances.

Standards for marine data are also the concern of international bodies such as ICES and IOC. For example, ICES has developed a number of guidelines covering the collection, processing, quality control and exchange of various types of (mainly) physical oceanographic data. In addition, IOC's International Oceanographic Data and Information Exchange (IODE) programme together with JCOMM has a programme to adopt a number of standards related to ocean data management and exchange, including data quality control.

APPENDIX 5 ISSUES FOR PARTICULAR TYPES OF MARINE DATA

Geology and Hydrography

Bathymetric data varies in quality. Data collected 100 years ago with a lead line was accurate with respect to the depth but density of soundings were poor and cannot compare with the detailed survey of a modern multibeam sonar

Multi-beam surveys providing water-depth and sea-bottom backscattering have the potential to answer many questions on habitat type or suitability for economic activity. A number of hydrographical institutes, geological surveys and commercial companies have collected these data but nobody has an overall picture of what is available and what remains to be done at a pan-European level.

Coherence is currently not assured when data from more than one country is required. There is no uniform classification for sea-bed sediments. There is no agreed length of the coastline of EU member States. Neither is there an agreed area of continental shelf.

Physics

There is certainly a need for interoperable data models and standards for physical oceanography. Many groups are concerned with the development of these standards - Eurogoos DATAMEQ, JCOMM, IOOS-DMAC, IOC: Initial Operating Capability, SIF: Standards and Interoperability Forum. However most are dealing with the same set of parameters and it is not clear which group takes precedence.

There are concerns whether the monitoring network is sufficient.

Salinity	lack of in situ data to validate the plumes for simulation. So far, for shelf seas, there are only few automated measurement stations moored in the estuaries + data from scientific or from episodic monitoring cruises. Initiatives like the deployment of coastal profiling floats or the instrumentation of fishing ships devices are still very limited and insufficient to provide interpolated maps with the required degree of confidence. Consequently, plumes extension are mainly determined through numerical simulation tools or, weather permitting, through water colour remote sensing as a proxy. Applications for sediment dynamics, bio-ecology, seabed habitats predictive mapping are then not provided with consistent enough salinity data, even when this parameter is expected to vary sharply in the plume zones.
Dissolved oxygen	O_2 monitoring must be seriously sustained on a highly spatial and frequent basis in order to cope

	with the eutrophication risk, especially when this one is high like in Baltic Sea. In many regions, this parameter is poorly measured, with the exception of some few scientific cruises. It is however an important factor for the pelagic and benthic ecosystems health, presently assessed on the basis of simulation poorly calibrated by in situ data. As for salinity, only few automated buoys moored very near the coast line provide time series of local data. Vast offshore areas, suspect of dissolved O_2 large variation (as the Grande Vasière area, in Biscay Gulf), are not covered.
Thermohaline circulation	Currently there are only based on ocean campaigns like Ovid. The same goes for the Mediterranean where the circulation in the eastern basin is even less well known

Chemistry

Despite the admirable work done on cataloguing marine data (for example the CDI database), it is still not possible to assess the spatial and temporal coverage of a particular parameter in a particular maritime basin or the data policy of the owner.

The Marine Framework Strategy Directive 2008/56/EC[65] obliges Member States to achieve good environmental status by 2020. The Directive includes a long list of chemical and biological parameters by which the environmental status will be assessed. The current data availability for these parameters is unclear although they may be clarified for certain sea-basins through EMODNET preparatory actions (section 4.2).

The European Environment Agency has a well established network with Member States who provide data to the EEA on chlorophyl, nutrients and in the future also oxygen concentrations on a voluntary basis. This data exchange has allowed comparable indicators for these variables to be developed in the four European Regional Seas, although the data coverage varies among countries due to variable national data policies. The EEA makes data and indicators publically available through their webpages. The EEA is also beginning to provide on-line access to information on bathing water quality which is a good first step in showing through an intuitive interface what data is available on a European scale.

The continued exploitation of new technologies to provide more chemical data (oceanography and environmental) is important to ensure adequate provision of data to monitoring programmes and MSFD compliance to adequately assess the state of the environment and ecosystem responses through models and observation systems.

[65]OJ L 164/19, 25 June 2008

Biology

The diversity of observational procedures and data sets means that standardisation is important in marine biology. However, standardisation is given little emphasis in funding mechanisms, although the peer review process should ensure that appropriate methods are generally used. International programmes such as the IGBP/SCOR Joint Global Ocean Flux Study (JGOFS) went to considerable lengths to recommend that key "Core Measurements" were made to particular defined standards. This standardisation ensured comparability of data sets collected by scientists from many different laboratories and proved to be crucial for modelling.

As biological oceanography develops, a further standards challenge is to adapt the convention of naming organisms (at species or lower taxonomical levels) using correct taxonomic scientific names. Synonyms, duplicate species names, separation of former species, and many other problems, complicate the coherence and practical use of inventories of organisms of almost all groups (but more often for plankton and all invertebrates). Several international initiatives tried to create standard nomenclature systems, compatible with modern applications but also preserving the historical naming approach (e.g. TSN, NSTC). To date, however, there is no universal system widely adopted as standard for species names for all organisms. Successful examples exist in the fields of genomics and molecular biology (e.g. enzymes) that could help in designing a similar system for whole organisms.

There is a wealth of data lying in files of researchers and students that could greatly improve our understanding of the marine biosphere if made available. Obliging those who publish to do this is already becoming common practice in some disciplines.

Fitting data together is a challenge. In general there is only loose linkage between the different disciplines. One school specializes in the identification of bacteria and another on production. Physical and biological data collected in the same cruise is processed by different teams and stored in different archives. Retrieving the physical conditions during a biological sampling can be difficult.

Useful fisheries data is generally not publicly available. Official landings figures are not a good estimate of extractions from the stock because they do not include illegal landings or discards. A considerable part of the effort involved in scientific stock assessments consists in assembling data from different sources.

Benthic data is available for the immediate coast but not much further. Cooperation with non-EU countries is essential - particularly in the Mediterranean where the situation is not good. Indeed the status of data in the Mediterranean is poorer than in other marine basins for nearly all biological data.

It is known that the spatial and temporal distribution of zooplankton impacts fisheries yields and that harmful algal blooms can damage the profitability of aquaculture and the attractiveness of beaches. However the present monitoring, largely by optical remote sensing and isolated sampling campaigns from scientific institutions, is too infrequent and at too low resolution to feed into the management decision chain

Better biological data will enable more efficient assessment of environmental impact, and enable the setting of reference points for depleted fish stocks. Spatial planning cannot be achieved without better data on our seas than we have at present. If we are going to implement the ecosystem approach to fisheries we will need more data on the impact of fisheries on the environment and on the environment's impact on fisheries.

APPENDIX 6 STAKEHOLDER OPINION

Green Paper

Once preparations were underway to develop an all-embracing European maritime policy, there was some reflection as to how a new approach to marine observation and data could improve the availability of good data to users. The Commission produced a reflection paper on the issue that was summarised in its Green Paper on Maritime Policy.

Better understanding of the competing uses of the ocean will require better data and information on maritime activities, be they social, economic or recreational, as well as on their impacts on the resource base. Good data are also of importance for maritime economic operators. However, there are still major problems of harmonisation and reliability of data, as well as insufficient and geographically imbalanced monitoring in EU marine regions. These gaps must be addressed if we are to devise a sound and sustainable EU Maritime Policy.

The EU could consider setting up a European Marine Observation and Data Network which would provide a sustainable focus for improving systematic observation (in situ and from space), interoperability and increasing access to data, based on robust, open and generic ICT solutions. Such a Network would allow for an EU integrated analysis of different types of data and meta-data assembled from various sources It would aim to provide a source of primary data for implementing in particular forecasting and monitoring services, to public authorities, maritime services and related industries and researchers, integrating existing, but fragmented initiatives.

The improvement and dissemination of marine data would also open up opportunities for high-technology commercial companies in the maritime sector and improve the efficiency of activities such as maritime surveillance, management of marine resources and marine research in European laboratories. It would also contribute significantly towards reducing the current uncertainty about the oceanic system and climate change, bringing accurate seasonal weather forecasting a step closer.

Creating such a network would require the EU to take legislative, institutional and financial steps. Legislation may be needed, for example, to facilitate better access to data from sources such as that of the Common Fisheries Policy and the Framework Programmes for Research. Institutional changes could include the strengthening of existing bodies at a national, regional and European level and the creation of a permanent secretariat with scientific and information technology expertise. Financial support should aim to be sustainable and long-term. Representatives of those who need the data - including Member States, the Commission, the European Environment Agency (EEA), the European Maritime Safety Agency (EMSA), the European Global Navigation Satellite System (GNSS) Supervisory Authority, the climate change community, industry and service providers should continually review priorities and set objectives.

The Commission then asked

> *How can a European Marine Observation and Data Network be set up, maintained and financed on a sustainable basis?*

Stakeholder Consultation

487 stakeholders replied to the consultation including all EU and European Economic Area coastal states, 105 regional administrations, representatives of industrial sectors and civil society. The Committee of the Regions considered that:

> *this Network should be used to integrate existing and new maritime data, thereby enabling a long-term monitoring and a high quality risk assessment process, particularly with respect to such issues as safety in maritime transport, natural resource exploration and exploitation and protection of the marine environment and its biodiversity.*

The Heads of the European Hydraulics Institutes declared

> *A common assumption in Europe is that open access to data means making data available to governments and the public but not commercial enterprise. The evidence from the US suggests that making the data openly (and freely) available not only creates additional jobs and revenue but also results in better products (notably with added value) to promote engagement with stakeholders and to inform the management process.*

International Association of Oil and Gas Production (OGP)

> *encourages the European Commission to create a common network out of the many existing observatory and data networks.*

BIMCO - the world's largest private shipping organisation considered that

> *The establishment of a European Marine Observation and Data Network as suggested in the Green Paper could have merit. A centralised collection and access to information may provide certain efficiencies that would be shared across the board. Many stakeholders - both public and private ---. agree that data is needed. BIMCO currently maintains databases and information gathering on many essential maritime topics. We are prepared to assist by providing information that would be useful to real and meaningful effort aimed at improving maritime safety, environmental protection and spatial planning.*

Nearly all national governments were in favour of creating such a Network - the most important messages being that it should build on existing efforts and that it should respect global standards. For instance:

> *The lack of data on underwater environments is a major problem for the production of good planning material and difficulties with mapping are much greater than on land. A whole-hearted effort needs to be made to develop a good system which has the full support of all Member States (Swedish government)*

The Netherlands does not advocate leaving the analysis of raw data to the EEA, for instance. The recommendations of the ICES, the EU body that advises on European fishery policy, are already used in an OSPAR context for the marine environment. Apart from that, specific attention should be paid to coordinating the aims and parameters of the various European directives, OSPAR and other frameworks. Much has already been achieved in the area of European cooperation on observation and data systems. That existing cooperation should be built on as much as possible. If properly validated, more data could lead to more knowledge. Standardising data could add specific value by enhancing member states' ability to exchange data, for example. And greater efficiency could be achieved by streamlining data collection and processing (Netherlands government)

The way the project is conceived and presented seems to be very exhaustive. The envisaged Atlas of EU waters could represent a basic and fundamental instrument which will help an aware and multi purpose system of spatial planning, ensuring a sustainable development of coastal regions and closely connected to planning mechanisms on lands (Italian government)

Ireland supports the establishment of the European Marine Observation and Data Network (EMODN) as outlined by the Commission (Background Paper No. 4a) and specifically that it: be based on existing national/regional infrastructures and data collection networks, integrating existing marine observation facilities, improving interoperability and access to data; builds on the data integration being developed by the SeaDataNet Project; be a source of primary and processed data that can serve both public institutions, including their researchers, and commercial providers; the data should be freely available with emphasis on the private sector developing commercial services and products; and supports the aims of the Global Monitoring for Environment and Security (GMES) initiative. In the context of the EMODN, Ireland would propose to expand this to include the ESFRI4 proposal for a European Multidisciplinary Seafloor Observatory (EMSO). (Government of Ireland)

The exception was the Government of the United Kingdom who considered

We are not persuaded that a new European Marine Observation and Data network is needed.

Although this was not the unanimous view of UK stakeholders. Indeed the subsequent House of Commons Science and Technology Committee report "Investigating the Oceans" considered

This position is difficult to understand as the network is not intended to act as a monitoring agency in its own right. Shared data sets will be critically important for managing transboundary waters (that is, everything that surrounds the UK). We recommend that the Government reconsider its opposition to discussions on a European Marine Observation and Data Network.

The most enthusiastic proponents of such a Network were those whose first-hand experience made them most aware of difficulties with the present arrangement. For

instance the French community of scientific oceanography, who themselves have made considerable efforts on a national scale, reckoned that

> *the complexity and cost involved in collecting and managing both environmental and economic data, call for European and international cooperation and the development of original, unifying governance structures. Successive Framework Programmmes have failed to meet this requirement and, generally speaking, the Member States themselves have not taken the necessary steps towards cooperation. A long-term structure, most likely a network to extend the framework of current conventions (e.g. OSPAR), needs to be set up to bring together the EC and the Member States*

Blue Book

Following this encouraging response the Commission's Blue Book on an integrated maritime policy for the European Union[66] to

> *take steps in 2008 towards a European Marine Observation and Data Network and promote the multi-dimensional mapping of Member States' waters, in order to improve access to high quality data.*

and in the accompanying Action Plan[67] to

> *prepare by 2009 an EU action plan to make progress in this area on the basis of a road map to be published in 2008. It will provide an overview of the main data and information service categories to be covered and some of their sources and uses, as well as examples of benefits and added value of better integration, and clarify how this initiative relates to other initiatives. In the second half of 2008 it will also propose a programme for the development of mutually compatible and multi-dimensional mapping of seas in Member States' waters.*

The present document is the roadmap that was proposed in the action plan. Since many of the arguments for setting up such a Network and many of the steps to implement it are identical to what needs to be done for the mapping of seas, this document will cover both aspects.

Reaction to Blue Book

Following the adoption of the Blue Book and the Commission's commitment to bring forward more concrete proposals, the Marine Board of the European Science Foundation and Eurogoos joined forces to prepare a reaction[68]. They recommended:

> *An evaluation of the costs and benefits of various observing system scenarios must be undertaken to determine the benefits to be derived from*

[66] An Integrated Maritime Policy for the European Union ("The Blue Book") Brussels, 10.10.2007 COM(2007) 575 final
[67] Action Plan Brussels, 10.10.2007 SEC(2007) 1278
[68] EMODNET The European Marine Observation and Data Network - Marine Board - Eurogoos perspective, 25 September 2008,http://www.esf.org/publications.html

implementation of EMODNET. This evaluation should consider the cost of no action.

The appropriate level of funding, responsibility and cooperation for investment to fill identified data gaps and the provision of data management must be determined among Member States and at EU level. There are good examples of networks and management activities which are best implemented by Member States, e.g. for the individual regional seas, and others, such as the EuroArgo initiative, which might be better organised at EU level.

In view of the improved collection and scientific use of data by Member States under existing EU agreements, directives or regulations, methods must be established to gain access to the data coming from, for example, the Water Information System for Europe (WISE), the Water Framework Directive (for transitional and coastal waters), the European Marine Strategy (for marine waters), the Data Collection Regulation (for fisheries), the Habitat Directive and Natura 2000 (for biodiversity). The prospective EU Shared European Information System will facilitate this action.

As far as possible, the data collected by military and industry (e.g. oil and gas, fishing, transport) should be included in the EMODNET. In the same way, data collected through networks operated by local authorities should be considered for inclusion.

Data collected via EMODNET should be used to contribute to the multidimensional mapping of Member State waters and to the production of a European Atlas of the Seas, outlined as a priority in the Action Plan of the European Integrated Maritime Policy.

Development of new technologies (e.g. deep sea observatories) and new sensors (e.g. oxygen sensors on Argo floats) should be encouraged by EU and Member States to help fill identified data gaps using for instance the European Maritime Research Strategy.

Indeed the Commission's new strategy for Marine and Maritime Research indicated that[69]

The Commission will coordinate the launching of a European marine observation and data network (EMODNet) in 2009 integrated with GEOSS and GMES

Marine Observation and Data Expert Group (MODEG)

An expert group of representatives of national governments provide feedback and guidance to the Commission's maritime policy.

In addition, in order to provide a more direct and specialised support on matters related to EMODNET, the Commission has selected a group of independent

[69] A European Strategy for Marine and Maritime Research A coherent European Research Area framework in support of a sustainable use of oceans and seas, Brussels 3 September 2008 COM (2008) 534

specialists in the collection, processing and application of marine data. This group, the Marine Observation and Data Expert Group (MODEG)[70], includes a broad cross-section of expertise in the different types of data - geological, physical, chemical, biological and the different maritime basins.

The MODEG Members do not represent the views of their national government but act independently. They have provided considerable advice to support the preparations to this Roadmap and will continue to play an active role in the definition of EMODNET.

[70] http://ec.europa.eu/maritimeaffairs/eu-marine-observation-data-network_en.html