
# Mapping and preliminary analysis of infrastructures, observation - data and human capacity building

WP 6 – Deliverable 6.1 24/01/2014

Project full title: **CSA Healthy and Productive Seas and Oceans**
Website: **www.jpi-oceans.eu**

Grant agreement no.: SCS2-GA-2012-314194-CSA Oceans
Project start date: 1st September 2012
Duration: 36 months
funding scheme: SP1 –Cooperation; Coordination and support action; Support actions FP7-SST-2012-RTD-1

Deliverable number: D6.1
Deliverable name: Mapping and preliminary analysis of infrastructures, observation/data and human capacity building

WP no: 6
Delivery date: January 2014

Lead Beneficiary: Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER)
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Nature: R

Dissemination Level: PU

**Cover images:**

Content

# 1. INTRODUCTION

Data collection and management, marine research infrastructures, and capacity building are fundamental to ensure that Europe benefit from knowledge and innovations possible with marine and maritime research.

Over the last years, many initiatives have been launched to better coordinate the marine research infrastructures' development and use at EU level with the aim to create sustainable cost-efficiency in marine and maritime data collection and management, use of the different research infrastructures, provision of appropriate capacity building services, supporting models for knowledge-based policy-decisions and development of the maritime economy. However, in Europe these initiatives have traditionally been fragmented leading to overlaps and duplication of efforts while important gaps are left unattended.

The overall aim of work package 6 of CSA Oceans is to draft optional solutions to overcome some of the major gaps, needs and bottlenecks related to marine research infrastructures, observations/data collection, human resources and capacity building. This will allow identification of where JPI Oceans can add value by providing a gaps and needs analysis as input to the development of the Strategic Research and Innovation Agenda (SRIA).

As a first step, WP6 has integrated mapping efforts conducted over the last years into one single repository, gathering all information on infrastructures related to marine and maritime research activities. This repository, developed in cooperation with EUROCEAN, will ensure the storage on a long-term perspective of all this information. As part of this mapping exercise, a broad stakeholders and public consultation was conducted in cooperation with WP3, WP4 and WP5 in order to collect input on potential needs/actions/tools to achieve the JPI Oceans goals.

Building on this mapping exercise, as well as on other existing initiatives (EURO-Argo, EMSO, EuroGOOS, EUROFLEETS, SEADATANET, JERICO, EuroSites, MyOcean, EMODNET, WISE Marine, Euromarine, SEAS-ERA etc.), WP6 conducted a preliminary analysis of marine research infrastructures and human capacity building. This preliminary analysis should be seen as an introduction to the needs and gaps analysis which will be delivered in a second phase of the project (Deliverable D6.2) in order to develop the SRIA of JPI Oceans.

The objective of this document is to report on the first phase of the project: the mapping and preliminary analysis of marine research infrastructures and human capacity building. Chapter 2 is dedicated to the work package methodology, Chapter 3 to the mapping a preliminary analysis of marine research infrastructures including a presentation of the repository and Chapter 4 to the mapping and preliminary analysis of marine human capacity building including a case study.

## 2. WORK PACKAGE METHODOLOGY

### 2.1 STAKEHOLDERS CONSULTATION AND WORKSHOPS

One of the aims of the CSA Oceans mapping exercise is to get information on: i) what issues could potentially be addressed by JPI Oceans to respond to its goals, ii) how those issues could be tackled and iii) how to do it efficiently. In order to collect views of stakeholders, CSA Oceans hosted a series of workshops during the summer of 2013. Over 60 stakeholders took part in 6 workshops relating to different stakeholders groups and interests. The participants were asked to fill in a pre-workshop questionnaire to prepare their input on potential needs/actions/tools to achieve the JPI Ocean goals. These input were discussed and debated during the workshops which allowed a number of commonalities between stakeholders' views to be highlighted. After the workshops, stakeholders were encouraged to elaborate on their responses through an online open consultation. The output of this consultation was used to feed in the mapping and preliminary analysis of marine research infrastructures and human capacity building and will be analysed further in the next phase of the project.

### 2.2 ONLINE PUBLIC CONSULTATION

The online open consultation allowed stakeholders from the marine and maritime community and general public to have an input into JPI Oceans' strategic research and innovation agenda including needs in the field of marine research infrastructure and human capacity building. The output of this consultation was used to feed into the mapping and preliminary analysis of marine research infrastructures and human capacity building and will be analysed further in the next phase of the project.

### 2.3 RESEARCH FUNDING AGENCIES CONSULTATION

Finally, a questionnaire was sent to the Research Funding Agencies and Ministries to identify the key challenges and opportunities for the future and to gather information on functioning and mapping of:

- national RTD and innovation systems
- science to policy mechanisms, and
- national research strategies and programmes

This part of the consultation was particularly important, not only to get the inputs of the Research Funding Agencies and ministries on the needs and gaps, but to feed as a baseline for assessment at a later stage if JPI Oceans contributes to aligning the European landscape in the long-term. The output of this consultation was used to feed into the preliminary analysis of marine research infrastructures and human capacity building and will be analysed further in the next phase of the project.

| Country | Responding organisation | Status |
|---|---|---|
| Finland | Academy of Finland<br>http://www.aka.fi/en-GB/A/ | Not final version |
| Ireland | Marine Institute<br>www.marine.ie | Final |
| Romania | Ministry of National Education<br>http://www.research.edu.ro/ | Final |
| UK | National Environmental Research Council<br>www.nerc.ac.uk | Interim response |
| Turkey | The Scientific and Technological Research Council of Turkey<br>www.tubitak.gov.tr | Final |
| Belgium | Belgian Science Policy Office<br>www.belspo.be | Final |
| Belgium | Fund for Scientific Research<br>www.frs-fnrs.be | Partial response |
| Poland | National Science Centre<br>www.ncn.gov.pl<br>National Centre for Research and Development<br>www.ncbir.pl | Final |
| Lithuania | Research Council of Lithuania<br>www.lmt.lt | Final |
| Portugal | Foundation for Science and Technology | Final |

| | | |
|---|---|---|
| | www.fct.pt | |
| Belgium | Flanders Marine Institute<br>http://www.vliz.be/en/ | Draft |
| Norway | | Form F only |
| Estonia | Ministry of the Environment<br>www.envir.ee | Final |

*Table of respondents to the regional funding agencies questionnaire (December 2013)*

### 2.4 DESK BASED RESEARCH

To fulfil the objectives of this deliverable, this report also includes substantial desk based research. While the consultation procedure has provided valuable information, it was also necessary to complement the findings with a certain level of desk-based research and experience based input. In addition, many initiatives have been launched in the past years to better coordinate marine research and a lot of information on needs and gaps is already available. It was therefore necessary to build on these initiatives. An indicative list of reference documents is available in Annex 5.

## 3. MAPPING AND PRELIMINARY ANALYSIS OF MARINE RESEARCH INFRASTRUCTURES LANDSCAPE IN EUROPE

### 3.1 OVERVIEW OF MARINE RESEARCH INFRASTRUCTURES IN EUROPE

The Marine Research Infrastructure (MRI) European landscape showcases a wide variety of facilities like research vessels and their underwater vehicles, *in situ* observation systems, satellites for ocean observation, *in lab* "…omics" equipment, experimental facilities for aquaculture or for ocean engineering, data storage and access services, etc. all together addressing the marine sciences and their multi-disciplinary nature.

It is a challenge as well as a necessity to describe this complex landscape to demonstrate to decision-makers, industry and the science community the consistencies and the complementary needs to which they respond. This overview will also help to identify infrastructures that require concerted efforts and commitment of member-states and associated countries to secure the delivery of knowledge, technologies and innovation necessary for understanding our ocean system and to enhance the excellence in marine and maritime research and experimentation.

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The proposed overview is based on the extensive one done by Seas-Era (Deliverable D4.1.1 and its annexes, published in October 2012), on latest developments (RI operators, ESFRI and I3 projects, dedicated workshops) as well as the EC's Expert group report on MRIs.

- **Infrastructure, facilities or equipment: how to name and define them?**

The starting point is to consider the "facilities" which are subject to an offer for a transnational access activity within the "I3 projects" and then by extension, to consider all similar facilities that may or could be integrated into these projects. That means «facilities » that are worth being open to national, regional or European researchers, i.e. beyond the limits of the research institutes which host and operate them.

- **Categories**

To overcome the complexity of the landscape, the agreed approach is to categorise these facilities by type of skills and jobs requested to design and operate them, i.e. by "horizontal" business lines which can eventually become operational as such, to be compared with scientific projects usually organised from experiments and data acquisition to knowledge dissemination ("vertical"), relying on different technical skills and related RI. These categories are in line with the vision of MRI as a cross-cutting issue for joint scientific activities. 6 categories / business line are therefore identified.

**Research vessels and their underwater vehicles**: for sea access and deep sea exploration/sampling.

**In situ data acquisition systems**: for seawater/seabed monitoring and observation.

**Satellites**: remote sensing for sea-surface monitoring.

**Marine data centres**: for data validation, storage and dissemination through web portals, incl. access to high computing facilities & generic modelling.

**Marine land-based facilities for engineering**: deep wave basins, water circulation canals, hyperbaric tanks, material behaviour in sea water testing laboratories, marine sensors calibration laboratories.

**Experimental facilities for biology and ecosystem studies:** marine genomics, blue biotechnology, aquaculture, mesocosms.

## RESEARCH VESSELS AND THEIR UNDERWATER VEHICLES

These RI are still essential for the sea access and the deep-sea exploration/sampling, (despite the development of new automated methods of data collection), as such they play a key role for the marine sciences. Moreover, they mobilise an important part of the marine research budget.

- **Class of vessels:**

*Figure of the different class of vessels: Global, Oceanic, Regional and Local/coastal vessels typically from 120 to 10 m long.*

The length of a research vessel is the main used characteristic even if it does not represent all of the ship sailing and operating capabilities. The length of research vessels could range typically from 10m to 120m, and it is used to call them local/coastal, regional, oceanic or global vessels depending of their size and their usual operating areas.

- **Class definition:**

The classification adopted by University National Oceanographic Laboratory System (UNOLS) for the US Research Vessel fleet is:

- L > 65 m: Global vessels are large and currently operate on an at least multi-Ocean scale,
- 55 m < L < 65 m: Ocean vessels are large enough to currently operate on an Ocean scale,
- 35 m < L < 55 m: Regional vessels currently operate generally on a Regional scale,

and

- 10 m < L < 35 m: Local and/or coastal vessels for local research only,

To simplify and also to avoid misunderstanding with the so-called “oceanic” and “regional” notion (a vessel having a length < 55 m could carry out some oceanic missions and on the other hand a vessel with a length > 55 m could be regional for a sea basin), these two categories are merged into one class: 65m < L< 35m: Ocean/Regional class

Furthermore, as regard European coordination and planning, it is worth considering the specificity of these 3 categories of fleets:

- Global class multipurpose vessels, which are operated at Ocean scale with typically more than 3 days of transit,

- Ocean/Regional class vessels. which are operated at Regional scale, with typically 1 to 3 days of transit,
- Local/coastal class vessels, which are operated locally within typically one day cruises,

- **Vessels operators:**

All the ships offering opportunities for scientific cruises are not strictly speaking “Research vessels” equipped as such, operated by a research organization and dedicated at 100% of their available time for scientific activities. To provide a complete and coherent mapping of the so-called “Research vessels”, we have chosen to retain those operated by or via a public entity and providing significant opportunities for scientific activities/cruises on a regular basis. "Operated" here means primarily to have the decision-making power on vessels and rare equipment planning and up-grading.

Corresponding operators could be:

- public research organisation,
- public administration (e.g. ships dedicated to monitoring activities like coastal waters surveillance or stock fish assessment, also offering opportunities of scientific activities on board),
- navy (e.g. ships dedicated to hydrography, also offering opportunities of scientific activities on board),
- Private operators offering chartering opportunities, but without any specific long-term agreement with a public research entity, are simply mentioned and corresponding vessels are not listed.

| | |
|---|---|
| Global vessels (L > 65 m) | 41 |
| Oc**ean/Regional vessels (35 m < L < 65 m)** | 57 |
| Local/coastal vessels (**10 m < L < 35 m)** | 137 |
| Total | 235 |

*Table of research vessels available in Europe per class of vessels (global, regional, coastal)*

These numbers of research vessels can give a false illusion of abundance, but the precise knowledge of two parameters is missing:

- the annual percentage of R/V real use at sea for scientific cruises,
- the degree of adaptation to the current scientific leading edge requirements,

For this second point, the age of R/V or underwater vehicles gives a significant indication, although biased because a right evaluation should also consider the age of; the on-board information, communication technology, of the embedded transducers and of the means for deployment of sophisticated underwater vehicles. All equipment which can be up to date after a consistent refit.

| Age or last refit (year one = 2013) | ≤ 5 years | 6 to 10 years | 11 to 15 years | 16 to 20 years | 21 to 25 years | 26 to 30 years | 30 to 35 years | ≥ 36 years | Not known |
|---|---|---|---|---|---|---|---|---|---|
| Global vessels (L > 65 m) | 4 | 8 | 8 | 5 | 4 | 4 | 3 | 5 | - |
| Ocean/Regional vessels (35 m < L < 65 m) | 5 | 3 | 7 | 5 | 12 | 7 | 4 | 14 | - |
| Local/coastal vessels (10 m < L < 35 m) | 10 | 13 | 21 | 9 | 19 | 11 | 17 | 22 | 15 |

*Table of age of research vessels for each class of vessels (global, regional, coastal)*

- **Underwater vehicles, unmanned surface vehicles, large exchangeable equipment:**

These devices are typically deployed from the rear decks of the research vessels which must be equipped accordingly. Exchange opportunities therefore require adapted vessels, this is the interoperability challenge.

**Underwater vehicles: 66**

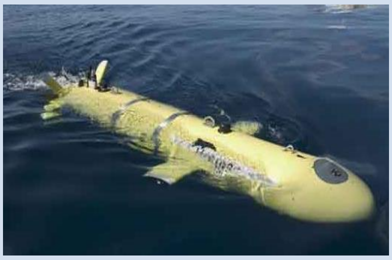
| | | |
|---|---|---|
|  **ROV (Remote Operated Vehicle)**<br>> 1000 m: 11<br>≤ 1000 m: 24 |  **Manned submersible**<br>> 1000 m: 1 *(Nautile 6000m)*<br>≤ 1000 m: 6 |  **AUV (Autonomous Unmanned Vehicle):**<br>> 1000 m: 8<br>≤ 1000 m: 15 |

*Table of underwater vehicles available in Europe and associated countries*

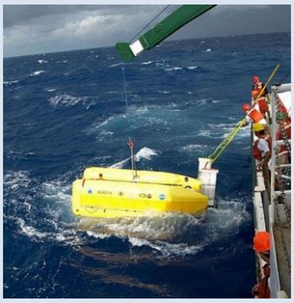
| | | |
|---|---|---|
| <br><br>**hybrid ROV-AUV:** 1 | <br><br>**USV (Unmanned surface vehicles):** 10 | <br><br>**e.g Sea-floor drilling equipment**<br><br>**Large exchangeable equipment: 21** (which can be listed as "exchangeable": Towed vehicle with payload (sensors, side scan sonar, camera, …), Corer, Plankton sampling equipment, Sea-floor drilling rig, Seismic instruments, Water sampler, 3D HDTV Camera |

*Table of hybrid ROV-AUV unmanned surface vehicles, large exchangeable equipment available in Europe and associated countries*

## IN SITU DATA ACQUISITION SYSTEMS

In situ automated acquisition systems with capabilities of long-term series of data and quasi real time data transmission have a rising role for; seawater/seabed monitoring and observation issues, for knowledge of climate change impacts, for alarm capability in the event of geo-hazards and last but not least for the necessary calibration of the remote sensing performed by satellites.

An automated measurement system can be both by water sampling in a regular way, carried out with various frequencies, and complemented by analysis that can be done in situ, or using directly in situ sensors immerged in the water column.

We define water sampling as high frequency as soon as the measurement is realized to have hourly or daily frequencies. Moreover the data transmission can also be automated, allowing a quasi-real time data service.

- **Measured parameters**

The parameters currently measured in high frequency are strongly conditioned by the environment and the nature of the site, by the performance of the sensors and the robustness of the measurement systems. The main physico-chemical parameters which can be measured in situ are usually:

- Temperature,
- Conductivity (=> salinity),
- Dissolved oxygen,

- Turbidity,
- Chlorophyll –a (through the fluorescence),
- Nutriments: ammonium, silicate, nitrate, phosphate.
- Sulphides, Total iron (II and III)

Among the parameters which are not presently able to be measured at high frequency and with the right resolution with existing technologies :

- $CO_2$ partial pressure (in direct relation with $CO_2$ uptake by Ocean issue)
- PH (in direct relation with ocean acidification issue)

Development is in progress for these two parameters within the WP12 of the FP7 NEXOS project.

- Chemical contaminants and heavy metals at traces level (traces level being a challenge because of the bio-accumulation effect by living species, for example Mercury traces as addressed in the FP7 GMOS project)

Development is in progress for automated passive samplers allowing in situ pre concentration, a first step towards the operational monitoring of these chemical parameters.

- **Instrumented platforms**

These sensors and their electronic & energy support devices should be themselves embedded on platforms, fixed or mobile, and able to carry out measurements at various sea levels from sea surface to deep-sea floor with the right degree of autonomy and reliability. Mature platform technology currently deployed includes:

- Oceanic moorings (> 1000 m waterdepth)
- Sea-floor stations
- Landers
- Oceanic profilers
- Gliders
- Drifters
- Ferry box on-board vessels
- Fixed coastal stations
- Coastal moorings (< 1000 m waterdepth)
- Coastal HF radars (Antennas are displaced along the coast. They receive the radio signal scattered off of the surface waves and use this information to measure current speed and direction )

This multitude of automated systems, both fixed and mobile platforms, allow quasi real-time data transmission. This does not masked the fact that all these recent developments rely on a small number of parameters, as listed above, for which *in situ* measurements in operational conditions are feasible. This means in-situ sensors with; the right resolution and precision (the very first condition), size, energy consumption and that function in an automated way without requiring frequent servicing for cleaning/recalibration purposes.

During the past two decades, the technology facilitated a lot of breakthroughs for the development of autonomous platforms and real time data transmission, and we are still in the cycle to make the best of these new technologies. On the other hand, progress to widen the range of in situ new sensors that are adapted to the operational oceanography constraints is low, in particular the development of chemical and biological in-situ sensors is still ahead.

| **Sub-category / type** | **Number** | **European countries involved** |
|---|---|---|
| Fixed point open ocean observatories / oceanic mooring | ~ 12 | 8 |
| Fixed point open ocean observatories / underwater observatory | ~ 19 | 12 |
| Mobile ocean observatories / oceanic profiler | ~ 185 to 205 deployed per year | 8 |
| Mobile ocean observatories / glider | ~ 67<br>(within ~ 13 fleets) | 8 |
| Mobile ocean observatories / sea surface drifter | ~100 in North Atlantic<br>~ 14 in Mediterranean Sea | Multinational<br>Italy |
| Mobile ocean observatories / Ferry box | ~20 | 10 |
| Fixed coastal observatories / instrumented station, buoy, mooring | ~175<br>(within ~ 45 networks) | 19 |
| Fixed coastal observatories / tide gauge, wave buoy | ~220<br>(within ~ 16 networks) | 10 |
| Fixed coastal observatories / HF Radar | ~14 | 8 |

*In-situ (automated) acquisition systems overview (as for Nov. 2013)*

## SATELLITES

- **History of satellites used for earth observation**

In the 1960's, the first satellites were for meteorological purposes (Tiros 1 on 1960), based on optical sensors of the visible spectra for cloud observation. The 1970s saw the first satellites used for the land observation which, for Europe, was the SPOT program launched in 1978 (France, Belgium, Sweden), which evolved from SPOT 1 (1986 - resolution 20 m) to SPOT 5 (2002 - resolution 2,5 m). Covered objectives mostly are:

- cartography, landscape,
- spatial planning,
- vegetation,
- anthropogenic impact.

This includes the first applications for the marine sciences: river mouths and coastline cartography, vegetation and observing anthropogenic impact.

In the early 1990's saw launch of the very first satellites specifically dedicated to Ocean observation: Topex-Poseidon (1992), a joint satellite mission between NASA, the U.S. and CNES. This is the birth of operational oceanography.

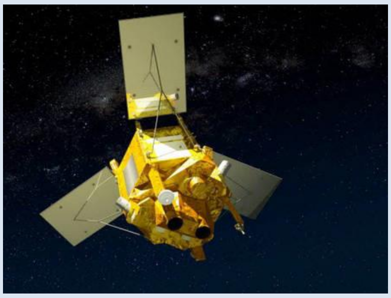
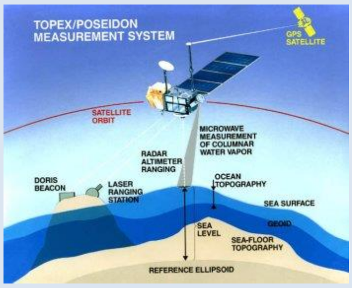
This satellite carried on board a radar altimeter allowing an accurate measure of the distance between the satellite and the ocean surface. Combined with the Doris system, it was capable of an accurate position of the satellite in the earth reference, it enabling mapping of the sea level with an unequalled "cm" accuracy. It was revolutionary for oceanographic research, revealing an unexpected and spectacular vision of the ocean with fine mapping of the waves of tide, revealing internal waves associated with the sea bed landscape; fine mapping of the oceanic currents, mesoscales vortex (few tens km in diameter) in the margins of the big oceanic currents also influenced by sea bed; and confirmation of sea level rise, an average 2-3 mm / year but with strong disparities from one place to another.

- **Current situation**

Two different types of earth observation satellites are used for and with marine sciences objectives:

**The « Coast watch » type:** satellites designed for landscape observation are based mainly on optical sensors (visible + infra-red sensors to observe despite clouds coverage) which could of course be used for the coast strip. On-board sensors, being focused on landscape observation, are more or less pertinent for some marine waters specific parameters. The very high resolution (< 1 m) which is worth for landscape fine description can be also useful for the coastal cartography and vegetation (including the foreshore areas at low tides), but is no longer a real requirement when the less expensive average resolution < 2,5 to 5 m is sufficient for non-coastal water areas then. Example: future constellation of 4 satellites on the same orbit, two (SPOT 6 and 7) with 1,5 m resolution and two (Pleiades-HR 1A and 1B) with 0,5 m one.

**The « Ocean watch » type:** satellites focused on ocean altimetry and observation can also be of some use for coastal waters, due to not prioritising very high spatial resolution: it is each parameter resolution which matters instead.

| | | |
|---|---|---|
|  **Spot 5 image** |  **New Spot 6 launched in Sept. 2012** |   **Topex/Poseidon** |

Both have a major role in remote sensing for; the coast line and adjacent waters, the sea-surface monitoring and the primary vegetation monitoring. Presently, about 17 satellites are involved directly or indirectly in the collection of marine data, 11 “Coast watch” type and 7 “Ocean watch” type:

| Satellite(s) | Launch date | Coast watch | Ocean watch |
|---|---|---|---|
| SPOT 5 | 2002 | X | |
| Cosmo-Skymed (4) | 2007 - 2010 | X | |
| GOCE | 2009 | | X |
| SMOS | 2009 | X | X |
| Cryosat 2 | 2010 | | X |
| TanDEM X (2) | 2010 | X | |
| Pleiades-HR 1A | Dec. 2011 | X | |
| SPOT 6 | Sept. 2012 | X | |
| METOP-B | Sept. 2012 | | X |
| Pleiades-HR 1B | Dec. 2012 | X | |
| Saral-Altika | Feb. 2013 | | X |

| | | | |
|---|---|---|---|
| Pleiades-HR 1B | Dec. 2012 | X | |
| Jason 3 | April 2013 | | X |

*Table of satellites involved directly or indirectly in the collection of marine data (11 "Coast watch" type and 7 "Ocean watch")*

| Satellite(s) | Launch date | Coast watch | Ocean watch |
|---|---|---|---|
| PAZ | 2013 | X | |
| SPOT 7 | 2014 | X | |
| INGENIO | 2014 | X | |
| Sentinel 2 (2) | 2014 | X | |
| Sentinel 3 (2) | 2014 | | X |
| EnMAP | 2015 | X | |
| METOP-C | 2016 | | X |

*Table of satellites planned to be launched between mid-2013 and 2016 (9 satellites)*

## MARINE DATA CENTRES

The local data centres constitute the elementary bricks for the data validation and core storage activities. The main issue is the organization of unique coordinated networks per family of parameters:

- data assembly by themes and by regions,
- standards,
- interfaces with digital models,
- implementation and maintenance of common portals for data access,

Some centres also offer access to generic digital modelling tools and other high computing facilities. All these data centres are the basic facilities playing a core role to archive and make available to everyone all the marine data reflecting the scientific efforts of observation and knowledge of the seas.

Several types of activity are necessary to make marine data available to all users of the seas (researchers, maritime and industrial sectors, policy-makers, public.):

- in situ and satellites data acquisition => needs a large scope of technology and specific RIs, as described in 2.2, 2.3 and 2.4 here before.
- data validation and storage => data banks
- data assembling and products manufacturing (maps, forecasts, …) => data computing
- access to high computing facilities & generic modelling => interface portals
- data dissemination (from raw data to information products) => data portals

These activities and services are carried out by software/computing people within local/regional data centres which act as marine data providers. Overview of the marine data providers in Europe:

**For the storage function:**

- ≥ 50 marine data providers in Europe, involving all maritime countries
- each data provider can be in charge of several thematic/regional data banks, up to 10 thematic data banks in some case, so elementary data banks (one family of parameters, one local region or ocean area) are few hundreds,
- ~ 90% of the data providers are public research institutes

**For the access function:**

- based on this basic infrastructure of data providers: data assembling, numerical modelling, data access are proposed via web portals both by the data providers themselves and by overarching European projects like Seadatanet, My Ocean and Emodnet.

## MARINE LAND-BASED FACILITIES FOR ENGINEERING

These land-based testing facilities first of all are used for maritime and ocean engineering purposes:

- ship design and optimisation,
- offshore oil & gas platforms , their moorings and their risers,
- ocean energy converters and their floating structures,
- port, estuarine and coast line structures,

But they are also necessary and useful for marine sciences for the design, testing and qualification of any instrumentation systems and underwater vehicles before deployment for oceanographic campaigns or as autonomous instrumented platform. Two main functions:

- Design, qualification and calibration of sensors and robotics components, in hyper baric + basin conditions,
- Test and qualification of instrumentation systems and underwater vehicles, in deep water basin,

In particular, they are the essential “back office” for all instrumentation systems requested for Ocean Observation.

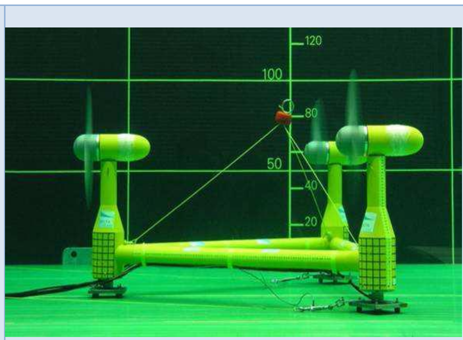
These facilities include:

- Deep wave basins, wave flumes, for both sea keeping tests and underwater functioning,
- Water circulation canal:  tests of devices in a current,
- Marine instrumentation testing facilities:  hyper baric tanks, shock and vibration generators, climatic room
- Material behaviour in sea water testing laboratories: mechanical tests,
- Marine sensors calibration laboratories
- In-situ testing sites, for the test of marine renewable energy system at scale one

To complement, facilities more focused on maritime research include:

- Long towing tanks with high speed carriage, dedicated for ship models
- Cavitation tunnels for ship propeller

**Deep wave basin**




**Water circulation canal**

**Hyper baric tank**

*Examples of three types of marine-land based facilities for engineering*

| Type of facilities | Number of facilities | European countries involved |
|---|---|---|
| Wave basins, wave flumes | **62** | **10** |
| Current and wave-current flumes | **15** | **7** |
| Other land-based facilities | **24** | **6** |
| In-situ test sites | **23** | **7** |

*Overview of land-based facilities and in-situ testing sites in Europe and associated countries*

## EXPERIMENTAL FACILITIES FOR BIOLOGY AND ECOSYSTEM STUDIES

This category of facilities should itself be split into 4 sub-categories according to their specific goals while sharing the same core skills in biology and marine life resources:

- Marine Genomics facilities
- Aquaculture experimental facilities
- Mesocosm facilities
- Ecosystems and biodiversity observatories

To note that marine genomics, ecosytems and biodiversity facilities are mostly for observation purposes, while aquaculture and mesocosm are mostly for experimental purposes.

## MARINE GENOMICS FACILITIES

As a direct consequence of the genomics revolution since 2000, marine genomics became a "must" in the marine biology toolkit, facilitated also by the relative cost/performance decline of such equipment. These facilities enable:

- exploration of marine biodiversity, , enabled by the knowledge of marine genomes and by novel molecular and imaging technologies => genes and new molecules mining for Health and Biotech
- novel knowledge on basic biological mechanisms and on complex disciplines such as neuroscience and developmental biology => knowledge basis for Fisheries and Aquaculture,
- an in depth knowledge of marine organisms will shed light on the role of these organisms in sustaining earth climate balance and global climate equilibrium.
- to foster integration of marine biology with other biological sciences, e.g., biomedicine.

Direct outputs of the experiments are:

- Molecular data
- Interpreted molecular data
- Gene functions
- Functional genomic
- Genome architecture
- Protein structures
- Metabolic pathways
- Molecular markers
- Regulation pathways
- Cellular, physiological, evolutionary or ecological knowledge

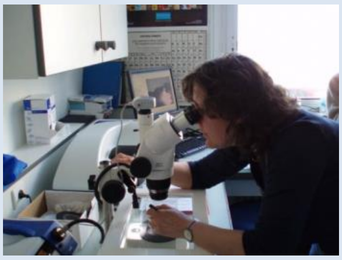
Challenges which make profit of these facilities are:

- Aquaculture,
- Fisheries & resources management,
- Marine environment & biodiversity,
- Blue biotechnology,

Marine genomics facilities are analytical platforms, i.e. « omics » equipment including bio informatics, animal-borne platforms, microscopy & imaging:

- genome => sequencing platform
- transcriptome => microarray
- proteome => 2D-gel electrophoresis
- metabolome => GC-MS ( Gas Chromatography & Mass Spectrometry)
- + crystallography, electronic microscope, diffractometer, etc.

In complement, such marine biology labs can offer an access to marine organisms models and their ecosystems, culture collections and databases => requires the culturing or raising of a variety of micro- and macro-organisms.

| | | |
|---|---|---|
|  Sequencing platform |  Cristallography |  Diffractometer |

*Example of different marine genomics facilities and equipment*

| Type of facilities | Number of facilities | European countries involved |
|---|---|---|
| Marine biology laboratories with genomics facilities | ~ 30 | 12 |
| Other marine biology laboratories | ~ 20 | 9 |

*Overview of marine biology labs with "omics" equipment in Europe and associated countries*

## AQUACULTURE EXPERIMENTAL FACILITIES

Aquaculture experimental facilities can allow experiments on:

- Reproduction / genetic
- larval rearing
- fish breeding
- nutrition / feeding
- health / pathology

Research is usually focused on commercial species:

- Sea bass
- Sea bream
- Cod
- Salmon
- Crustacean and Molluscs Etc.

| Land-based tanks | Sea-based cages |
|---|---|

*Aquaculture experimental facilities include mostly land-based tanks and sea-based cages.*

| Type of facilities | Number of facilities | European countries involved |
|---|---|---|
| Aquaculture research facilities | ~ 100 | 15 |

*Overview of Aquaculture experimental facilities in Europe. Nota: ~ 5% of these facilities are operated by the private sector*

## MARINE MESOCOSM FACILITIES

There is a rising concern about the environmental impact on the live resources and their biodiversity, that is why two quite new type of facilities have recently developed: Marine mesocosm facilities, ecosystem and biodiversity observatories.

A mesocosm is defined as a medium-scale experimental structure where real-life ecosystems are enclosed to allow manipulation of environmental factors. Tools and equipment involved for marine mesocosm experiments have similarities with the ones for aquaculture research (Pold system; Bag system; Pond system; Tank system) but the objectives are complementary. They are the adequate facilities to directly address the climate change and anthropogenic pressure effects on life resources via the marine environment factors of the experiments.

| Type of facilities | Number of facilities | European countries involved |
|---|---|---|
| <br>**Mesocosm facilities** | ~ 18 | 10 |

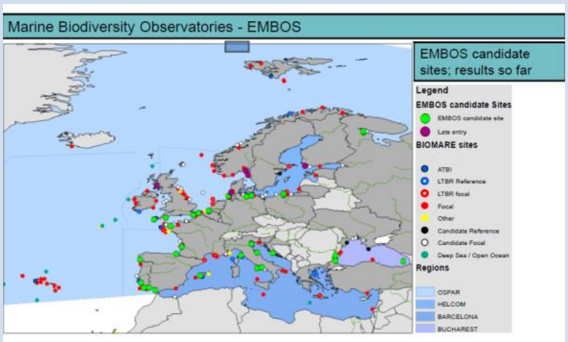
*Overview of marine mesocosm facilities in Europe and European countries involved*

Marine mesocosm systems are culture systems for fish larvae with a water volume ranging from 1 to 10,000 m³ typically. In these large enclosures a pelagic ecosystem can be developed, consisting of a multispecies, natural food chain of phytoplankton (diatoms, flagellates, Nannochloris...), zooplankton (tintinnid ciliates, Synchaeta and Brachionus rotifers, copepods,...) and predators (fish larvae). Intensification of mesocosms is determined by the initial load and by the level of exogenous compounds (fertilizer...).

## ECOSYSTEM AND BIODIVERSITY OBSERVATORIES

These specific observatories are used to monitor and assess long-term and large scale changes in aquatic (marine and freshwater) biodiversity and relate them to ecosystem functioning and the pressures and drivers on biodiversity change. They include a Network of stations committed to use a standardized and cost-effective set of methodologies for joint research on biodiversity, from genes to ecosystem functioning issues. Tools now exist that allow the analysis of these different levels, varying from metagenomics, indicator species and species communities to habitat mapping and ecosystem modelling.

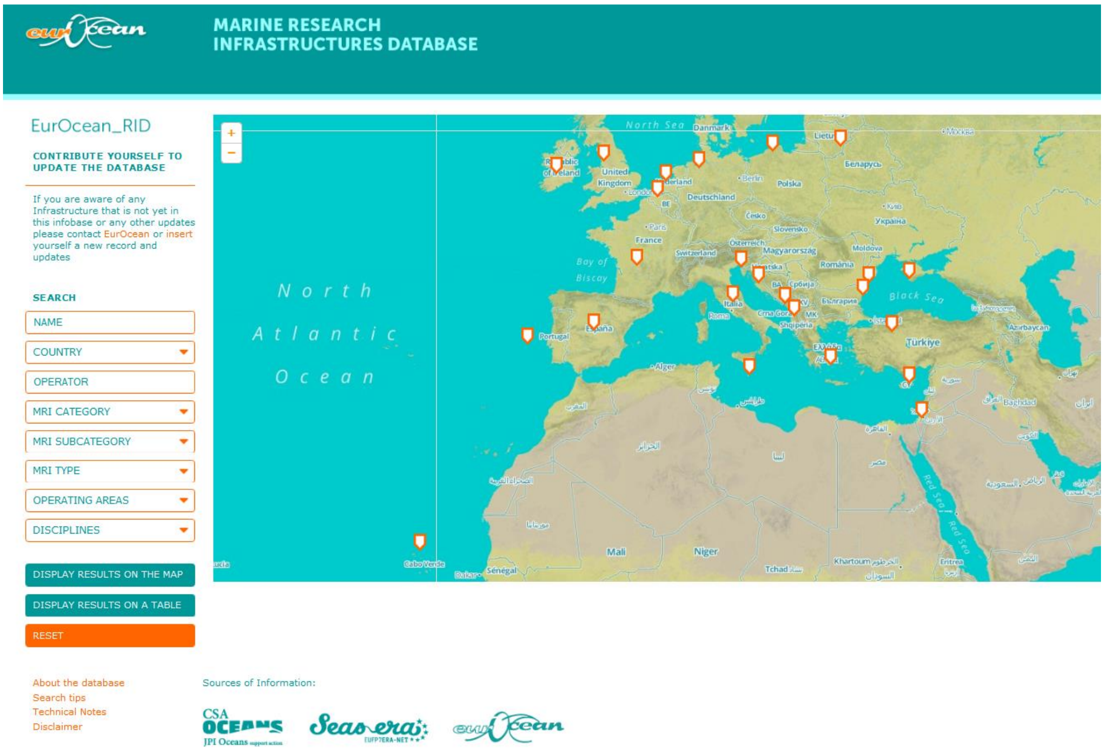
A complete mapping of the observatory which could be integrated in this network is under investigation, it should include more than 30 reference sites.



## 3.2 REPOSITORY AND INFOBASE OF MARINE RESEARCH INFRASTRUCTURES

### 3.2.1 REPOSITORY AND INFOBASE OBJECTIVES

In order to feed JPI Oceans' web platform, a repository[1] integrating the results of the mapping was created. EUROCEAN was contacted for the creation and the support of this InfoBase with a long-term perspective. Within their steering committee in November 2012, EUROCEAN members accepted the global objective and the InfoBase creation as part of their 2013 core activities. A complete specification has been established by EUROCEAN and, after iteration, agreed by the CSA Oceans project (7th march 2013). (See in Annex 6 the EUROCEAN specification and Annex 7 Terms of reference)




*Screenshot of the InfoBase of marine research infrastructure developed with EUROCEAN*

The specific objectives of building this repository are:

- to ensure storage with a long-term perspective of all the information which can be collected on marine research infrastructures in Europe, relying at first on the general overview made by Seas-Era (Deliverable D4.1.1 and its annexes, published in October 2012, available on http://www.seas-era.eu/np4/19.html ) and also taking into account all MRI news available since this date,
- to create a smart web interface for this repository allowing a targeted search using key words and location of the MRI on an interactive map,
- to allow the continuous updating of the repository via a permanent process, including access to MRI details provided and maintained by operators on their websites

[1] http://rid.eurocean.org/

The need for a "One-stop shop" portal was also expressed by stakeholders in the CSA Oceans stakeholders' consultation.

The proposed InfoBase includes both a "discovery" level of information for all facilities and the links and contact person for accessing more details. Ideally, all links and related sections of the database should be in direct correspondence with similar sections of the operator home page for each given facility: the updating of these sections under the same web link would automatically update the InfoBase itself.

This InfoBase covers all the European countries of the EU and the associated countries as listed for the EC framework programme as well as other countries which complete the perimeter of the Baltic Sea, the Mediterranean Sea and the Black Sea.

This InfoBase is intended for a whole range of users:

- Scientists; seeking the best suited infrastructure for their research,
- Operators; for the knowledge of similar facilities in European countries and for the best articulation of European projects in this field,
- Policy-makers; to have an overview and statistics on MRI landscape, to support the trans national access and to envision and optimize future investments,
- Industries; for the knowledge of access opportunities that could meet their needs, of the technologies involved and of the perspective of future development,
- Public, to discover marine sciences through all these facilities and their high-tech equipment,

For joint programming especially, an InfoBase based on a comprehensive and a continuously updated repository can be a common tool for scientists, operators and policy-makers to together optimize the relationship between:

- the scientific activities and their needs to properly address both leading-edge research and societal challenges,
- The facilities and services available, and their gaps if any.

### 3.2.2 INFOBASE ORGANISATION

The InfoBase is organised into two sections of information:

- ***"Facility information and contact"*** section, the « discovery » level of the facility with a set of general information, key words and links:
  - category, sub-category and type,
  - name, operator and contact person,
  - the main operating area(s),
  - the main scientific discipline(s) or issue(s) which can be addressed, etc. …

- **"Additional information"** section including complementary information and links to access more technical details:

  - Length (m") or "Max. operating depth" (m), when relevant,
  - Location: Latitude and Longitude,

As well as links to operator web page for:

- Services currently offered,
- Access conditions,
- Examples of scientific projects and data acquired,
- Photos gallery,
- Logo of operator,
- Technical details file,

For this additional information in particular, operators are proposed to adopt a common template for each facility entry page, within their usual web site, in English or with an English version, with description and links in correspondence with the similar sections in the database.

The InfoBase includes a capability to sort the facilities using search tips and an interactive map, allowing any targeted search of information for every type of request. Criteria such as: country, operator, category and sub-category, operating areas, main specific disciplines addressed, year built etc. can be selected.

All the available information should allow users to collect a first complete set of information on the facility(ies) before contacting the operator(s), which will relieve them of repeated requests.

For the continuous update of the InfoBase, a procedure is proposed to allow everyone to contribute to any correction or addition of information, by using functions "Insert" or "Contact EurOcean". Then the EurOcean office validates each submission in relation with the facility operator (see Annex 7 Terms of reference).

## 3.3 PRELIMINARY ANALYSIS OF MARINE RESEARCH INFRASTRUCTURES

The mapping exercise demonstrates that Europe benefits from a wide variety of research infrastructures existing or in construction, with a total of more than 900 facilities. Despite some geographical discrepancy, the most important issue is adequacy of these infrastructures to respond to societal challenges (i.e urgent need to equip oceanic profilers, gliders, oceanic moorings and the seafloor stations with sensors directly in line with the issue of CO2 and the ocean acidification), as well as coordination of these infrastructures in order to be able to develop an efficient integrated multidisciplinary ocean observing system.

In order to introduce the MRI needs and gaps issue in relation to the JPI goals and objectives, an issue that will be extensively developed in the following deliverable D6.2, this chapter presents some significant findings as well as a preliminary analysis based on the MRI mapping outputs and from previous vision documents. Additional sources of information for this preliminary analysis are listed in Annex 5.

This chapter include two sections: MRI for Ocean observation issue, through the European Ocean Observing System concept (EOOS) and MRI for other thematic issues.

### 3.3.1 MARINE RESEARCH INFRASTRUCTURES FOR OCEAN OBSERVATION

In this chapter, existing thoughts about EOOS (European Ocean Observing System) are presented. EOOS is a global concept that relies heavily on in situ observation technologies and their spectacular development since the 1990's.

Observing technologies have possibly paved the way for global monitoring of seas and oceans that could be useful for utilizing the sea beyond the specific requirements of leading edge research. Since 2009 (OceanObs'09 conference) and 2010 (EurOcean Conference), stakeholders from the marine and maritime communities have taken over this objective and are trying to shape a common vision. Therefore we will start with a presentation of thoughts concerning the need for a common global framework and a shared strategic vision of ocean monitoring that can determine the future observing systems and maybe the evolution of their governance.

The second part summarises the reflections about the EOOS concept and the MRI at stake for its implementation, the role of the technological development (which remains one of the strong drivers of the EOOS), of models and of data management, a crucial issue for the dissemination of collected data and knowledge for the benefit of all users of the sea.

The last part addresses ongoing reflections about EOOS governance so that EOOS could be more than a concept, but also an acting body with strategic and coordination remits.

#### 3.3.1.1 TOWARDS A COMMON MONITORING STRATEGY FOR SEAS AND OCEANS

##### ECONOMIC AND POLITICAL CONTEXT

Ocean observation is a key area that enables activity which underpins all marine and maritime activities and economy, including; Marine and Coastal Safety, Marine Resources, Shipping and Transport and Tourism.

The economic and social benefits currently derived from the marine environment will be short-lived unless management of this living biosphere is carefully planned in the context of global responsibility and a balance is reached between economic growth and environmental health. Historically marine and maritime sectors such as transport and shipping, offshore energy industries, tourism and fisheries and aquaculture and others have worked relatively independently. However, with careful observation derived from a common monitoring strategy, a management of the global Ocean is possible and can offer a real opportunity to people and industries now and into the future for years to come.

The Rio Ocean declaration (16 June 2012) called for an "integrated approach addressing the interlinked issues of oceans, climate change, and security" and for countries to "Establish the scientific capacity for marine environmental assessment, monitoring, and prediction, including the implementation of……the global ocean observing system". The need for such an integrated ocean observing system is particularly paramount in Europe because of the complexity and density of human activity in the European seas and oceans. Multiple approaches to defining marine boundaries are needed to satisfy different stakeholder requirements depending on the topic and scale of interest. For instance, in ocean science, regional discontinuities in the scientific approach for physical processes and associated biogeochemistry are often used to compartmentalize the oceans.

A common monitoring strategy should overcome discontinuities regarding scientific disciplines, societal concerns and geographical scales.

In the past decade with the success of global projects such as Argo (Array for Real-Time Geostrophic Oceanography) and the launch of inter-governmental initiatives such as GEOSS, ocean observation has become a higher priority on the worldwide environmental political agenda.

Ocean observation is for example a key component to the EU Strategy for Marine and Maritime Research, providing marine environmental datasets as a solid science base to support delivery of the societal needs specified in the Integrated Maritime Policy (IMP). The EU Data Collection Framework (DCF), a Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy (CFP), is another important historical asset for Europe. In addition, it is likely that marine legislation such as the Marine Strategy Framework Directive (MSFD) and its monitoring component (for the Good Environmental Status assessment) will become one of the most important policy drivers for MRIs development at a European EU scale in the coming decade.

However, oceans are broadly under-observed, with spatial, temporal and thematic gaps in marine data collection. JPI Oceans, as the only high-level strategic mechanism that exists at EU level aims to contribute to bridge some of those gaps. Observing offshore regions remains crucial not only because little is known of this vast environment, but because such open ocean systems drive many global oceanic processes and are likely to be increasingly exploited as commercial activities move further offshore into the future.

Furthermore, the high latitude oceans remain under-sampled. Monitoring of Polar Regions is becoming increasingly important, particularly regarding the high climate sensitivity and growing demand to exploit the increasing areas of international open waters resulting from Arctic sea-ice retreat. Scientific research through ocean observation will be crucial to provide data to understand the rapid changes in this dynamic system, to validate and constrain model predictions and to underpin informed decision making and future international agreements for polar maritime navigation and marine resource exploitation (e.g. commercial fishing, oil/gas exploration), particularly in off-shore regions. Other locations that will receive growing interest are biologically sensitive/resource rich regions such as the deep sea and hotspot areas of biological endemism. As observations reveal increasing areas of the global Ocean, such areas are likely to come under increasing pressure for exploitation of marine resources despite the current lack of knowledge about the ecosystem functions and the vulnerability of these vast and yet under-sampled regions. A thorough understanding of the ultra-deep water environment will be crucial to underpin effective management solutions as the bio-economy moves towards exploiting marine biological and mineral resources. At last, some sub-regions of the Mediterranean Sea (in particular its Southern border) and even more the Black sea are seriously under-observed seas.

## THE DUAL ROLE OF EXISTING MRI DEDICATED TO IN SITU ACQUISITION SYSTEMS, OBSERVATORIES AND RELATED DATA CENTRES

Historically developed for the sole research demand and its specifications, existing MRI have now to comply with the growing demand of seas and oceans systematic monitoring, as well as to continue contributing efficiently to new research frontiers on oceanic variability and marine ecosystems functioning. MRI are now evolving to face this dual role:

*In connection with societal challenges:*

- the development of recurrent data, indicators and regular assessments characterising marine waters quality are required by several European and National Directives;
- climate change detection, forecasts and expected impacts (temperature, sea water level, acidification, ice cap shrinking, dissolved $O_2$ depletion, …),
- data supply directly used by marine and maritime stakeholders: high resolution cartography, deep-sea geology, atmosphere-ocean data, stocks assessments for commercial species of fishes, sea-bed habitat mapping…

In connection with frontier research and the generation of new knowledge:

- Oceanic variability: the understanding and mapping of the thermocline circulation (surface and bottom deep sea currents), the mesoscale vortices, the ocean thermal balance, the ocean-atmosphere interaction, regional upwelling etc.,
- Marine ecosystems resilience with regard to environmental parameters variability.

Basic science is still a driver. As the demand for geospatial marine information grows, basic science through sustained observation will continue to serve an important purpose, pushing the boundaries of our knowledge of the temporal and spatial variability of the marine environment and driving new research frontiers leading to innovation and socio-economic benefits. Identifying science priorities, technological breakthroughs, critical parameters and geographical regions to observe now and into the future is the first step towards an Ocean Observing System that will serve societal needs and drive a new era of oceanography.

But indicators of change are also a powerful approach. Indicators of change, necessary for monitoring purposes and requiring a mastery of the variability based on a strong sustained observation infrastructure, are a powerful way to translate natural science datasets into ecological indicators to assess pressure-state relationships, exploitation impacts and trends for informed marine management and policy. The concept of Essential Ocean Variables (EOVs) should be developed for this purpose.

## THE MAIN ISSUES OF A COMMON MONITORING STRATEGY

The global Ocean is a dynamic system, facing multiple anthropogenic and natural stressors, marine ecosystems are increasingly vulnerable to exceeding tipping points which may lead to irreversible change. So science priorities/key variables of tomorrow are likely to be different or even include currently unknown phenomena. Natural science and a future ocean observing system should be adaptable and resilient to known and unknown future trends e.g. ocean warming, enhanced stratification and increase in mid-water oxygen minimum zones. Each of these trends would in turn influence the biogeochemical signatures of oceanic regions with implications for ocean productivity, nutrient cycling, carbon cycling, and marine habitat. Across European closed and semi-enclosed seas, these changes will potentially have a profound impact on the marine and maritime sectors including the sectors of tourism and aquaculture. Temporal and spatial variability challenge

Marine ecosystem dynamics are inherently non-linear and resolving temporal and spatial variability in the oceans remains notoriously difficult. Interpretation of ocean processes is often further hindered by a lack of multidisciplinary oceanographic time-series datasets at high enough resolution or from specific locations of interest. The non-linearity means that perceived trends in ecosystem indicators can be short-lived and variables often display a delayed response time to pressures and larger-scale climate drivers. Indeed, studies have shown that statistically robust trend analysis requires long-term time-series datasets and that a high variance of ecological indicators reducing the statistical power for detecting trends in series less than 10 years.

- New perspective for rates and fluxes

Whilst many of the key oceanic variables can now be monitored autonomously, the next level of complexity, rates and fluxes, remains less well constrained. Advancements in monitoring fluxes in real-time e.g. ocean-atmosphere gas exchanges, and fluxes of particulate inorganic and organic carbon are set to revolutionize our understanding of fundamental oceanic processes including atmosphere-land-ocean interactions, elemental cycling and connections with larger climate indices such as the North Atlantic Oscillation (NAO).

- A new era in biological and biodiversity observations

The past decade has seen a huge drive for marine observations to address biogeochemical cycling and ecosystem services. As the infrastructures for biological observation grow, how will these be coordinated into an integrated and sustained system? The question is raised also for biodiversity, with international initiatives such as the Census of Marine Life engaging a global effort to address marine biodiversity observations: how much detail is required to monitor marine biodiversity and what are the “sentinel” species or taxa that can be monitored?

- Regional approach relevance

Frequently adjacent countries share the same sea basin waters, and thus it is relevant to seek regional agreements in order to take a basin-scale approach to interface science and governance: there is a real need for member states and third countries to share a collective responsibility for the delivery of healthy seas through common monitoring. Furthermore, agreements should include plans for rapid and coordinated responses to monitor and understand rare / unexpected events e.g. environmental disaster (oil spill), natural hazards (e.g. storm surge, earthquake/tsunami, and volcano) or biological responses (e.g. Harmful Algal Bloom).

- Parameters and spatial coverage

At last, a common monitoring strategy must deal with overall objectives regarding parameters versus needs and spatial coverage versus gaps.

There is a need to identify parameters for both multi-disciplinary research and societal needs, and priority for new sensors development. There is also a need to identify gaps in the spatial coverage and priority for new platforms deployment. The different issues need to be addressed: continuity of sea region, continuity from the ocean to the shelf seas, continuity from the sea surface to the sea-floor, continuity of the coastal waters monitoring, how to sustain the automated systems (continuity of the funding). Finally, there is a need to identify gaps in terms of temporal frequency and of long time-series of data, and priority for new data logging and transmission. Another issue to address is gaps in data assembling per sea basin, priority for data storage, exchanges, and access for this goal.

#### 3.3.1.2 THE EOOS CONCEPT

Over the past 10 years, several elements of a multidisciplinary and multiplatform observing systems have been developed through national investments and EU projects as demonstrated in the mapping exercise (see 3.1 MRI mapping and here after European RI projects).

These existing pre-operational initiatives should now be coordinated into a real European system with long-term planning and support as well as an appropriate governance scheme, for filling the identified gaps and for upgrading to meet emerging needs.

*With regards to ocean observation:*

To face the change of paradigm in the observation of our oceans and coasts observation has to evolve from being centred on a unique platform, the oceanographic ships with data availability being delayed in time, to observation based on multi-platform and integrated systems (using buoys, satellites, ships, autonomous underwater vehicles, HF radar, ARGO profilers, etc.), also assuring quasi real time, quality controlled data availability for both researchers and society.

*With regards to coastal observation:*

Coastal observation is historically focused on: bathymetry survey (marine maps), tidal measurements (tidal, forecasts), marine biology coastal stations (water sampling and in-lab analysis).

Nowadays, around European coastal seas, the number of marine observing systems is quickly increasingly under pressure from both monitoring requirements and oceanographic research needing reliable, high-quality and comprehensive observations from automated platforms and sensors systems with long periods of autonomy.

*In-situ* data collected and combined with remote sensing and models output contribute to detection, understanding and forecasting of the most crucial ocean and coastal processes over extensive areas within the various national and regional marine environment.

This observation paradigm shift is very important and moreover now requires the ability to address three key factors: (1) science priorities, (2) response capacity to society needs, (3) technology development.

To comply with this new paradigm, an EOOS concept (European Ocean Observing System) was proposed at the EurOcean conference 2010, and adopted by all stakeholders within the “Ostend declaration”: “Support the development of a truly integrated and sustainably funded “European Ocean Observing System” to (i) re-establish Europe’s global leading role in marine science and technology; (ii) respond to societal needs by supporting major policy initiatives such as the Integrated Maritime Policy and the Marine Strategy Framework Directive; and (iii) support European contributions to global observing systems. This could be achieved through better coordination of national capabilities with appropriate new investments, in coordination with relevant initiatives (e.g. ESFRI, EMODNET, GMES) and the engagement of end-users."

## EOOS / RATIONALE

A future European Ocean Observing System (EOOS), as shown in "Navigating the future IV" Marine Board position paper, should be a fully end-to-end system of systems with clear drivers and constant feedback to enable each stage to inform, drive and deliver high quality, relevant and timely environmental products and services for society.

As explained in "Navigating the future IV", within a circular, inter-dependent system, four pillars drive the system, namely Stakeholders, Infrastructure, Data services and Outputs (products and services). These four pillars are all crucial to provide relevant and timely products for society in areas including Stewardship of the marine environment, understanding the ocean/climate, supporting the marine economy and marine safety (see also EC MRI expert group report, section IV). The system should be inherently open to adaptation and innovation ensuring enhancements can be made to each component that drive innovation, growth and knowledge across the whole system e.g. to the observation network or to the harmonization of data management protocols or centralization of data portals.

A future EOOS should build on the wealth of existing infrastructure capabilities and multi-platform assets already in use across European waters. Infrastructure are the foundation for an Ocean Observing System, providing the platforms and services to deliver environmental data, information and knowledge.

Essential components of EOOS include both the hardware and core resources including people, institutions (mostly research institutes), data and e-infrastructures that maintain and sustain operations. Four infrastructure fields are involved, namely (i) research fleets; (ii) observing and monitoring systems; (iii) land-based infrastructures e.g. marine stations; (iv) Data management. The ocean observing and monitoring systems include established networks of space-based, airborne, and *in situ* platforms and sensors, and the data management includes e-infrastructure components. This is maintained by experienced operators including technical experts, scientists and computing power for maintaining these systems and delivering data, knowledge and services.

A future EOOS will need to further integrate marine observations from the coast to the open ocean and from surface to deep sea, promote multi-stakeholder partnerships for funding observing systems and sharing of data and align with global efforts within a coherent Framework to engage all countries and work towards a truly integrated global ocean observing system (see IFSOO report).

In reality, the future EOOS will be a system of systems, linking existing and future infrastructures and funding opportunities. The EOOS should be smart, resilient and adaptable, driven by scientific excellence, societal and other stakeholders' needs, and technological innovation, to fill the real need for cross-disciplinary research and multi-stakeholder engagement.

## EOOS / EXISTING INFRASTRUCTURES

Many European projects have been launched, mostly since 2007, covering all categories of MRI skills with the aim to install an operational coordination, ultimately an integration with a centralized governance. These on-going projects have already given evidence of their operational functioning, they are the infrastructures on which the EOOS can be built. EOOS infrastructure should therefore rely on existing ESFRI or I3 consortia or equivalent integrating initiatives like:

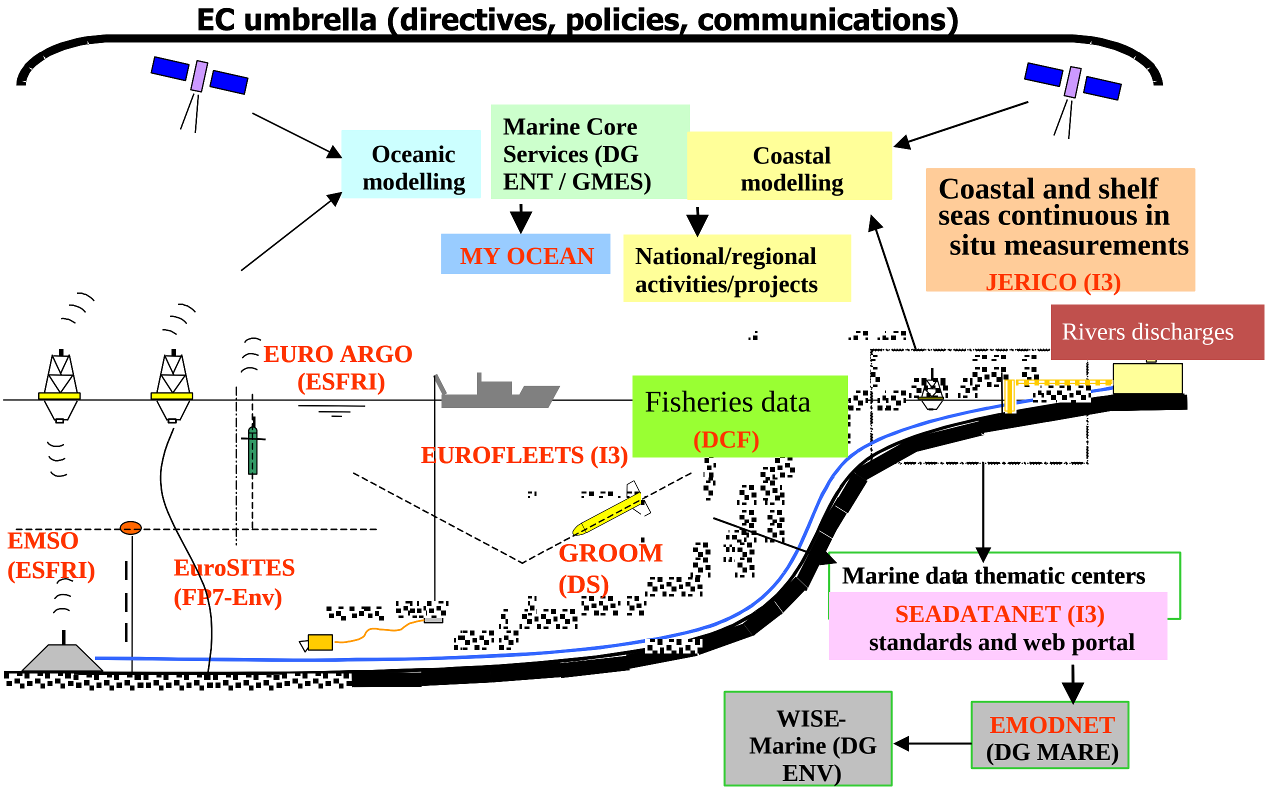
- for open ocean mobile platforms (EURO ARGO, GROOM) http://www.euro-argo.eu/ ; http://www.groom-fp7.eu/doku.php
- for open ocean fixed point observatories (EMSO, FIXO3) http://www.emso-eu.org/management / ; http://www.fixo3.eu/
- for ocean research drilling (ECORD) http://www.ecord.org/
- for other open ocean in situ measurements (CORIOLIS Centre) http://www.coriolis.eu.org/
- for sea and sub-sea access through research vessels and underwater vehicles (EUROFLEETS) http://www.eurofleets.eu/np4/home.html
- for satellites (Copernicus core service My Ocean) http://www.myocean.eu
- for costal/shelf seas observatories (JERICO) http://www.jerico-fp7.eu
- for data storage and standards (SEADATANET) http://www.seadatanet.org
- for data assembling, mining, access (SEADATANET, CORIOLIS, My Ocean, EMODNET, WISE Marine, i-Marine), (see specific section 3.3.1.5 here after.)

Most of these European research infrastructures projects started during the 2007-2012 period. It is an evolution which seems irreversible because:

- the need for European coordination seems more and more obvious due to the investment and running costs of up to date installations required to be at the leading edge of the knowledge,
- partnerships bearing these projects usually group all the European existing skills in each domain and thus have a vocation to be engaged for a long-life cycle,
- as already mentioned, MRI needs to now go beyond the academic research specific requirements: societal challenges emerging during the 2007-2013 period request seas and

oceans monitoring activities and data services, so mobilizing these existing research infrastructures as well as pressing on their future evolution (incl. for governance issues),

These projects showcase a wide variety of infrastructures, which are open to the trans national access or subject of networking activities or collaborative projects for their design, procurement and operation.




The mapping of existing infrastructures highlights the need for a common strategic vision and overarching coordination to make the concept of EOOS a reality

## EOOS / PRIVATE INFRASTRUCTURES AND PUBLIC-PRIVATE PARTNERSHIP

Private infrastructures like ferries, ships of opportunity, oil & gas offshore platforms, etc. can provide a lot of additional platforms to extend the spatial coverage of the *in situ* data acquisition. Among the main objectives of collecting data by using private infrastructures, the most pointed out is "validation of satellite data" and related numerical models (from interpolation purpose to more sophisticated forecasting). The issue is an important one, mainly for long-term operational oceanography furniture for regular, near real time data. Considering the costly maintenance and renovation of *in situ* observatories, automatic instruments and sensors needed for the validation process, the collaboration with the private sector allows more sustainable sampling.

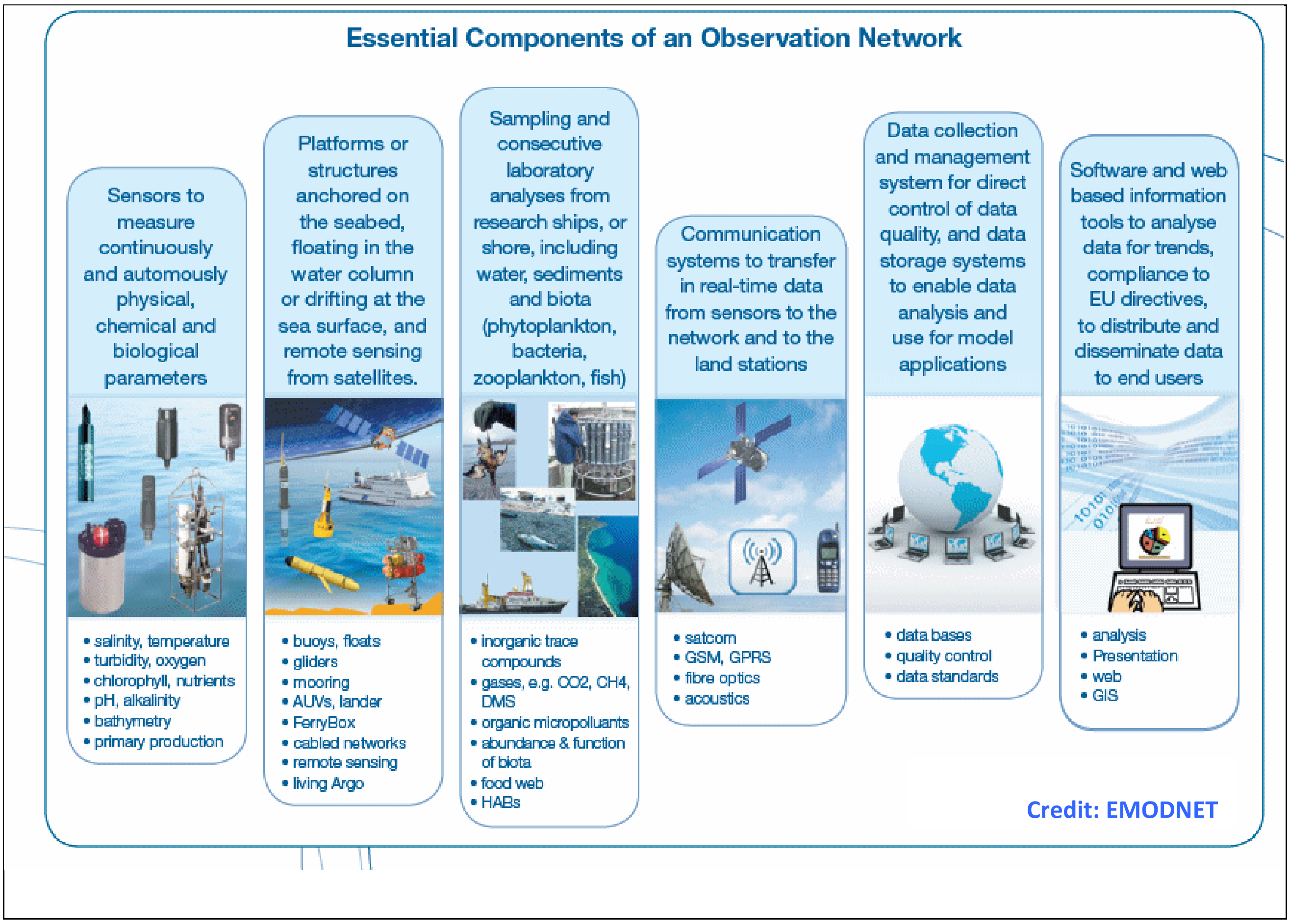
Parameters usually measured by taking advantage of private infrastructures are mostly related to physical oceanography, biogeochemistry, meteorology (sea/atmosphere interface). For "standard" monitoring purposes, private RI can offer a low cost solution; the use of dedicated (emerging) technologies (e.g. ROVs, AUVs, USVs, Lidars, telecom submarine cables, satellite/imaging/acoustic technologies) fitted for mutual p-p purposes can be an advantage, in some cases even a requirement, for improving the samples.

The foreseen scientific challenges of mutual public-private interest are referred mainly to environment monitoring (including early warning) and protection (e.g. sea-water quality, seabed changes, coastal erosion, oil-spills, underwater noise, effects of climate change on marine ecosystems), ocean exploitation, renewable energies, fisheries and aquaculture sustainable management, marine and maritime technologies.

An active role of EU Directives (e.g. MSFD) is to force an environmental monitoring that would open a new market for companies in the instrumentation sector.

### 3.3.1.3 DEVELOPMENT AND INTEGRATION OF NEW TECHNOLOGIES

Observing technologies are at the heart of the EOOS and the development and integration of new technologies still play a major role in the progress of the EOOS, together with the other two drivers "Strategic societal needs" and "Scientific priority".



The pace of innovation in ocean observation technologies has been very high in the past two decades, a lot of progress has been made in the development of automated instrumented platforms (like oceanic profilers or gliders or sea-floor stations) and for data transmission (via satellites). The drive for ocean observation in the 1990's led to a huge technological advancement in automated sensors for monitoring physical variables e.g. temperature, salinity and currents. Moreover, combined in situ and remote sensing techniques (e.g. ocean altime try, ocean colour radiometry) have revolutionized our understanding of surface processes.

The progress will continue for; *in situ* sensors, embedded electronics and energy (for data logging), data transmission (incl. by underwater acoustic when necessary), and for fixed or mobile platforms that can carry out instrumentation with autonomy and reliability.

From the cost point of view automated instrumentation is the best option, as it is able to provide long-time series and therefore large amounts of data. Such technologies for ocean observation are constantly evolving and innovation is an essential driver for science, engineering excellence and technological advancement.

On the other hand, some breakthroughs need to be made, for example; in situ sensors, platforms performance and intelligent sampling.

Presently, very few parameters are operational for automation and long-time series of data with regard to the wider range of parameters to monitor. It remains a critical issue for the development of new *in situ* sensors adapted for autonomous platforms and long-time series of data.

In terms of *in situ* ocean observation improvements to; sensitivity, accuracy, stability, resistance to oceanic conditions and depth rating, are key to ensuring high quality and sustained data.

In general, for the marine environment, biochemical sensors are less developed than physical sensors.

A technological leap is now required for biochemical monitoring to enable routine *in situ* measurements: from nitrate to methane, from marine genomics to alkalinity. This leap should include developments in nano electronics, photonics and software to reduce the size of sensors towards miniaturized lab-on-a-chip micro sensors, to minimize the pay load and energy demand and to enable multi-parametric observation from autonomous platforms.

Expected technological innovation should also address autonomous platforms capabilities (e.g. oceanic profilers able to cycle down to 3000 m water depth, gliders agility, sea-floor stations) and should include design of novel multi-platform observing systems.

For intelligent sampling, the technology already exists for **bi-directional communication with autonomous ocean sensors and samplers.** This allows sampling strategies (e.g. sampling resolution, multi-parameter sensor suites) to be changed remotely and is set to revolutionize ocean research by enabling quick response to events. Further integration of the ocean observation system would enhance the use of such intelligent sampling allowing information and alerts from one observing system to inform other systems, with the added advantage of low energy consumption.

New technologies now should allow **three-dimensional real time observations**, which combined with forecasting numerical models and data assimilation it could lead to a major quantitative jump in scientific knowledge in areas like variability monitoring (physics and biology) at small scales (e.g. mesoscale/week), resolving the sub-basin/seasonal and inter-annual variability, establishing the decadal variability and budgets, understanding the associated biases and correcting them.

#### 3.3.1.4 DATA MANAGEMENT AND ACCESS

A complete monitoring system also implies a range of data services for the collection, storage and dissemination of a growing number of geo-referenced marine data, as well as interpolation and prediction services through the use of numerical modelling. Activities include:

- data validation and storage: data banks
- data assembling and products manufacturing (maps, forecasts, …): data computing
- access to high computing facilities & generic modelling: interface portals
- data dissemination (from raw data to information products, from quasi real time to delayed mode data): data portals

All this range of inter-linked functions are addressed by existing European projects:

| Project | Description | Website |
|---|---|---|
| SEADATANET | The open and operational network of all thematic/regional marine data centres. SEADATANET has developed a common lexicon for marine data across disciplines and applications and an open structure that can, with time, give access to an increasingly bigger number of data centres across sectors and countries, increasingly meeting the standards needed for INSPIRE compliance. | http://www.seadatanet.org/ |
| GEO-SEAS | network for the marine geological data, associated with SEADATANET | http://www.geo-seas.eu/ |
| CORIOLIS data centre | data collection, validation and distribution in real time and delayed mode, at global and regional scales, for ocean forecasting and monitoring systems of the operational oceanography, | http://www.coriolis.eu.org/ |
| MY OCEAN | the operational oceanography portal, developed as one of the Copernicus (ex GMES) core services, with 24h real time data service, forecast, an expected extension to shelf and coastal seas | http://www.myocean.eu/ |
| EMODNET (DG Mare) | A set of operational portals for a European public service of marine data, open and free of charge for all users. EMODNET must be developed from the pilot stage (2009-2013) to | https://webgate.ec.europa.eu/maritimeforum/content/3439 |

| | | |
|---|---|---|
| | the operational stage (2014-2020) by ensuring that it fits end-users' needs | |
| i-Marine | initiative to establish and operate an e-infrastructure supporting the principles of the Ecosystem Approach to fisheries management and conservation of marine living resources | http://www.i-marine.eu/Pages/Home.aspx |
| Wise Marine (DG Env.) | A comprehensive and shared European data and information management system for the marine environment which supports implementation of the Marine Strategy Framework Directive. | https://webgate.ec.europa.eu/maritimeforum/fr/category/554 |

This development of a European framework for marine data management should ensure compatibility with the INSPIRE directive (Infrastructure for Spatial Information in the European Community) and coherence with the global framework provided by International initiatives, the main ones being:

- **IODE:** International Oceanographic Data and Exchange, http://www.iode.org/
- **OBIS:** Ocean Biographic Information System, http://www.iobis.org/
- **GOOS:** Global Ocean Observing Systems, http://www.ioc-goos.org/

In addition to these projects, major consortia mentioned above and policy makers are concerned by the harmonisation of the marine data management, by the need of open exchanges and access to data, by the overlapping risks, and already initiated expert groups and propositions for a shared development. In complement, one can also mention:

| Project | Description | Website |
|---|---|---|
| MODEG (Marine Observation and Data Expert Group) | Group of experts, led by DG-Mare, for developing the EMODNET portals and undertaking supportive studies and activities, which together must result in a sustained and operational service from 2014 onwards. It is also an objective to identify data gaps and arguments why these gaps should be filled in future monitoring. Further efforts are being made to extend the geographic range in order to cover all of the waters of EU Member States as well as to extend the thematic coverage with more sets of parameters. | https://webgate.ec.europa.eu/maritimeforum/category/161 |

| | | |
|---|---|---|
| MSFD WG-DIKE(Data, Information and Knowledge Exchange) | A specific working group lead by DG Environment for the implementation of the MSFD. WG-DIKE first meeting July 4th 2013 | http://projects.eionet.europa.eu/msfd-wg-dike-technical-group/library/first-wg-dike-meeting |
| EUROGOOS DATA-MEQ | (Data Management, Exchange and Quality working group) | http://www.eurogoos.org/content/documents.asp?menu=0050000_000015_000000 |

*Expert groups and propositions for a development of a European framework for marine data management*

- **Existing connections or agreements between projects**
    - Memorandum of Understanding My Ocean / SeaDataNet (Jan. 2010)

A Memorandum of Understanding has been signed on 13 January 2010 between MyOcean and SeaDataNet. It acknowledges these two projects are very complementary, expresses the strong will to collaborate and summarizes collaboration topics. In addition, this memorandum of understanding improves the links which SeaDataNet already established with EuroGoos and its regional organizations. A second document describes in more detail the Common vision on marine data flow and services between the two projects, the involved actors and the provided services by both projects.

- SEADATANET proposal to WG-DIKE (as for August 2011)

From the ongoing developments, achievements and installed relationships, it should be concluded that the SeaDataNet infrastructure (including the associated EurOBIS and ICES infrastructures as backbone for the data management component of the EMODNet infrastructure) are well qualified for organising, quality control and quality assurance, and providing harmonised access to ocean and marine data sets that has been acquired by multiple data providers in Europe.

This infrastructure could manage and provide the basic data sets that are input and used as reference for the GES reporting information that will be managed by the WISE-MARINE infrastructure. Exchange between EMODNet and WISE-MARINE could be organised by customising the machine-to-machine interfacing that is planned for development in the SeaDataNet II project. This could also establish the mechanisms of regional data pools for each of the Conventional regions.

SeaDataNet II will work on full INSPIRE compliance which will ensure that efforts undertaken by SeaDataNet data providers will make their data holdings also fit for INSPIRE. From the analysis it appears that further development, customisation and additional data population will be required for the infrastructure to be ready and fit for purpose for MSFD implementation.

The basic technical requirements will be largely covered by the SeaDataNet II project._For the MSFD customisation, getting more data and data providers into the infrastructure, getting a full European coverage, establishing the interfacing to WISE-MARINE and defining an organisational structure, data policy arrangements and future funding requirements in agreement with EEA, EU, Regional Conventions and Member States considerable additional work is required. This could be the scope of the Call for Tender that EU DG MARE is planning early 2012 for the next phase of the EMODNet Chemistry and Biology pilots and for which funding is already in place.

Therefore SEADATANET proposal to WG DIKE is:

1. To agree with adopting the wider SeaDataNet infrastructure as a mechanism for managing and giving access to basic data sets required for the MSFD implementation.

2. To agree to a further analysis and development of the infrastructure for MSFD purposes with cooperation between WISE-MARINE,SeaDataNet II and EMODNet Chemistry and Biology pilot teams with regular reporting to WG DIKE in the frame of the next EMODNet phase.

*SeaDataNet and EMODNET connection for data management and services:* http://www.emso-eu.org/management/images/documents/EMSO_Conference_13_15_November_2013/presentations/SeaDataNet%20and%20EMODnet%20Data%20Management%20and%20Services%20-%20Giuseppe%20Manzella.pdf

- **Oceanographic information in the new data age**

Next generation ocean observation will enable rapid and wide distribution of information (data, methods and products). However, real-time delivery of large, multivariate data sets, with increasing temporal and spatial resolution will demand a new approach to data stewardship from storage and open access, to integration and standardization. The field of information and communication technologies (ICT) will be an increasingly crucial component of the marine data management infrastructure.

> Future observing systems will need to be adaptable to new ICT approaches in order to embrace the exponential growth in multivariate data and the ongoing progression towards interoperable systems using agreed standards (e.g SeaDataNet).

This will lead to the requirement for a new bio-physical data framework to allow complex biogeochemical and biological datasets and their metadata components to be available alongside climatic and physical oceanographic datasets.

High performance computing facilities and e-infrastructure, including cloud computing and internet-enabled 'smart' infrastructures, may revolutionize data storage, accessibility and integration. A major challenge is the development of new methods for analysis of these complex spatio-temporal data types that yield information not just about the ocean state, but also the underlying dynamic processes.

#### 3.3.1.5 MODELLING EFFORT

Models are a key research tool for ocean observation, using datasets for retrospective analysis and constraining predictions of future scenarios to aid decision-making. However, models are almost inherently data limited, requiring observational data for model development (e.g., choosing parameterizations and parameter values), forcing, data assimilation and data-based evaluation (e.g. validation). The models continuity at the open ocean/shelf seas frontier is challenging.

> The operational availability of multidisciplinary ocean datasets will remain critical for the next generation ocean models, including multi-scale coupled and nested models for producing inter-disciplinary predictions of complex environments e.g. coastal marine hazard tracking. Reversely, environmental models and statistical data assimilation methods are tools for identifying gaps in the observing system.

Models are especially useful for the assessment of various components of an EOOS system: these would benefit from a strategic overview aided by observing system simulation experiments and data assimilation in models to assess the added value and complementarities of all assets (space and in situ) to ensure that the most cost-effective system is in place, that data management and services initiatives receive the optimum datasets in a timely manner.

#### 3.3.1.6 SOME PRELIMINARY CONSIDERATIONS ON GOVERNANCE FOR A EUROPEAN OCEAN OBSERVING SYSTEM

EOOS is viewed, with a broad consensus, as a powerful concept for a system of systems, but is not yet embodied as a structure. Three main missions could be envisaged for such a structure:

- To set up a common monitoring strategy (see 3.3.1.1 above) that can be shared by all stakeholders incl. MRI existing consortia
- To simplify the dialogue with funding organisations for this complex "multi-things" issue (multi disciplines, needs, users, sectors, technologies, areas, scales, etc.),
- To have some coordination remits at an overarching level on implementation actions, including; instrumentation deployment strategy, new technological developments, existing MRI articulation and interoperability, training, data access, etc.

Here after some preliminary considerations that could underpin the need of an EOOS as a governance body:

- EOOS for multiple end-users

The originality of the EOOS ambition is to go beyond the needs of the scientific community alone, it is also vital to secure the delivery of key environmental datasets that underpin societal products and services for society.

> A smart, integrated EOOS would empower European nations to take control of assessing marine environmental status, predicting future scenarios and making informed decisions about ocean governance that balances economic growth with environmental sustainability.

This would ultimately lead to new opportunities in many marine and maritime sectors. Such a system would also progress Europe's position as a worldwide science and technology leader and further establish Europe's contribution to global initiatives such as the GEOSS.

To achieve an effective uptake by policy makers, bi-directional discussions are required between scientists and policy makers to define the priority datasets required by society and stakeholders alongside the ones required by the scientific community. Targeted Initiatives such as "Marine Knowledge 2020", stakeholders position papers as "Navigating the future IV", and marine legislation such as the Marine Strategy Framework Directive (MSFD) and its monitoring component (for the Good Environmental Status assessment), the Data Collection Fisheries (DCF), … provide a framework for EOOS.

- Sustain EOOS operations on a long term perspective

Long time-series of data and observation are required to meet the (societal) monitoring needs and are the core products of the EOOS. High investment is often required both for the hardware itself and the maintenance and operation of observing systems with a long-term perspective, on the other hand **funding is often short-term and difficult to secure, as they are granted within a public research framework instead of a public service one**. Although preparatory actions for pan European marine research infrastructures, networking and integration activities are funded by the European Commission through EU Research funds, infrastructure costs (capital and operating expenses) are predominantly funded by Member States and require improved coordination which could be achieved through JPI Oceans.

New models of governance and funding opportunities should be discussed to ensure sustainable operation of ocean observing systems, taking also into account an evaluation of the socio-economic impact and of the environmental contributions of such marine research infrastructures.

- The cost effectiveness demand

EOOS is also expected in the field of shared marine research infrastructure use (multi-annual planning), investment (new equipment) and maintenance (including the full life cycle of infrastructures), as well as to offer the scientists access to the best adapted and leading edge facilities. It should (and could) aim ultimately, at a sea basin or ocean scale:

- To reduce functioning costs of available facilities and of related technical skills involved,
- To optimize capital costs of new facilities which should be decided at least in the framework, for each MRI category, of a shared European vision,
- To seek cooperation and interoperability of EOOS with private industry observing networks (such as operated for the international oil & gas industry),
- To promote mutually beneficial public-private partnerships for new observing systems that support the development of marine industries sector (such as ocean renewable energy or off-shore aquaculture).

- The cross-sectorial dialogue

The disparate nature of the disciplines, stakeholders, datasets and focused expertise of researchers and specialists mean that few studies are truly holistic, creating further issues for policy makers requiring synergistic summaries regarding the status of a research field.

The current lack of cross-sector communication makes it difficult to assess the full human footprint on an oceanic region and the likely trajectories for marine variables and indicators in the region based on economic growth models.

Innovation will also be driven by cross-collaborations between scientific disciplines and domains. EOOS could also be the platform that can deal with multi-disciplinary and cross-sectorial challenges and in particular facilitate the dialogue with the policy makers. Some existing organizations already play a similar supervision role for ocean observation in their scope:

- Euro-GOOS

Operational oceanography, as part of the Ocean observation, is already networked at pan-European level by EuroGOOS, within the framework of the Global Ocean Observing System (GOOS). http://www.eurogoos.org/

EuroGOOS has a key role for achieving scientific and technical coordination, defining activity areas, infrastructure needs and governance models in the area of operational oceanography. It provided a "short-term strategy for 2009-2013" (see sources of information). EuroGOOS recently evolved towards a legal entity, an AISBL (Non profit International association under Belgian law), for a more effective coordination of the implementation of sustained in-situ observing systems for the European regional seas and the global ocean. Today Euro-GOOS has 34 Members in 16 European countries, and a permanently staffed office coordinates its work. Euro-GOOS is established with full recognition of the importance of existing systems in research and operational oceanography in Europe at national and European scales. It provides a coordinated European approach and response to discussions and initiatives at a pan-European level, and to that extent it interacts with the European Commission and other international and intergovernmental entities. Members of Euro-GOOS are playing a leading role in all MRI projects and initiatives in Europe.

- ESONET - Vi (ESONET the Vision)

Previously called VISO (Virtual Institute of Scientific Users of Open Ocean Observatories), aims at defining a perennial integration at European level of scientists of the numerous laboratories using data collected by deep sea observatories, in relation with EMSO responsible for the implementation of these observatories. http://visobservatories.webs.com/

### 3.3.2 MARINE RESEARCH INFRASTRUCTURES FOR OTHER THEMATIC ISSUES

#### 3.3.2.1 RESEARCH VESSELS COORDINATION AT EU LEVEL, THE ISSUE OF THE REGIONAL FLEETS RENEWAL

##### RESEARCH VESSELS COORDINATION AT EU LEVEL

Oceanographic vessels will continue to be an essential component of the MRI landscape. The current situation is still strongly leaning toward national fleets, but with robust cooperation schemes at EU level. However, the development of sensors and of autonomous instrumented platforms (fixed and mobile) within the EOOS may change how ships will be used and how new ships could be designed.

There are 3 main initiatives for improving the coordination of European Marine Research fleets.

| Project | Description | Website |
|---|---|---|
| *FP7-EUROFLEETS* **(2009-2013) and its follow-up** *FP7-EUROFLEETS 2* **(2013-2016)** | This project aims to bring together the European marine research fleets to enhance their coordination and promote a more trans-national and cost-effective use of the vessels and their associated heavy equipment. Within EUROFLEETS 2, the next stage is pioneering, exploring and experimenting new integrating tools such as virtual joint fleet or shared scientific evaluation. | http://www.eurofleets.eu/np4/home.html |
| OFEG | The "Ocean Facilities Exchange Group" represents Europe's leading oceanographic research organisations and provides a forum to consider exchange and co-operation opportunities for the Global and Ocean Class research fleet. OFEG aims to maximise the overall scientific output of its partners, using its state-of-the-art facilities in support of the worldwide oceanographic community. OFEG still active to give flexibility to the sea cruises planning of global/ocean vessels and to foster operability of rare underwater equipment, but restricted to countries having similar vessels. | http://www.ofeg.org/ |
| ERVO | A network of European Research Vessel Operators, aims to promote the co-ordination of small to medium sized research vessel operators in Europe. The harmonisation of the | http://www.EurOcean.org/np4/63 |

European fleet is essential for facilitating international access to marine biodiversity and to remote/extreme ecosystems such as deep sea habitats, polar environments or the open ocean. These areas will surely provide numerous new species, novel molecules and biocatalysts for biotechnological applications. ERVO could evolve towards the advisory committee for regional vessels procurement strategy and implementation.

## THE RENEWAL OF REGIONAL FLEETS

A lot of regional and coastal vessels are becoming old, contrasting with a more balanced situation for the largest global vessels:

- For global vessels (L > 65 m), on 41 vessels in service, 16 (39%) are > 20 years old.
- For ocean/regional vessels (35 m < L < 65 m), on 57 vessels in service, 37 (65%) are > 20 years old (incl. 14 > 35 years old),
- For local/coastal vessels (10 m< L <35 m), on 137 vessels in service, about 87 (64%) are > 20 years old,

For local/coastal vessels, new or upgrading vessels is a priori a national affair, although some standardisation at EU level of on-board equipment and deployment capacity could be useful in the EOOS context.

For ocean/regional class vessels which are operated at the scale of regional seas and/or ocean openings by adjacent countries sharing the same scientific & monitoring concerns within sea cruises including typically 1 to 3 days of transit; **the renewal of the regional fleets is seen as a European issue.** The Seas-Era / *Eurofleets* joint symposium MSI2012 in Toulon (Nov. 2012) was an opportunity to analyse this issue:

## REGIONAL VESSELS AS AN OPPORTUNITY

- They are typically multi-purpose and can adapt to host variable payloads
- They can carry out reconnaissance work and hence prepare the ground to more targeted cruises by more specialised (and expensive) ships
- They allow the opportunity to share the same instrumentations in different regions through a shared schedule of activities
- They can respond rapidly to “events” both of natural or anthropogenic origin (in contrast to larger vessels that have complex schedules on global scale)

## REGIONAL VESSELS "LIMITATIONS"

- Vessels from different nations that have overlapping work areas may end up with unnecessary duplication of surveys
- Smaller Regional Vessels are more impacted by weather conditions. Cost is small compared to larger vessels but effectiveness of costs should be evaluated
- In some cases limitation to H24 use (peculiar agreements with owners; contracts that limit work on weekends)

## TOWARD AN EU NETWORK OF REGIONAL VESSELS

- Repeated surveys to observe inter-annual variability of a given oceanographic process
- Rapid Environmental Assessments (i.e.: a major oil spill faced by the vessel that is closer to the area)
- Maintain survey costs proportional to value of the instrumentation employed (i.e.: avoid using a major oceanic vessel just to shoot a 2D conventional chirp-sonar survey)

## REGIONAL VESSELS AS A KEY TO REDUCE GLOBAL COSTS OF MARINE OPERATIONS

- Trans-national use of vessels and reduction of transit costs
- Shared instrumentations among different vessels
- Shared expertise of crews, officers and technicians
- Assist observation networks at regional scale
- Help maintain fixed observing stations
- Help turn over of *ad hoc* mooring stations
- Assist deep-sea observing systems

## REGIONAL RESEARCH VESSELS AND SHARED PROTOCOLS

- Standardise choice/use of equivalent instruments on different ships (research teams find similar practical solutions on different ships)
- Multi-purpose host platforms with solid solutions for handling instruments from guest teams
- Construct a database of available vessels by main characteristics, main areas of work (both planned cruises and real time allocation) and by instrumentation that can be shared, and related teams.

**With the renewal of the regional research vessel fleet being costly, some innovative solutions need to be developed. An on-going example is the "Thalassa" scheme:**

Ifremer R/V Thalassa, second of the name, is the result of a cooperation between Ifremer and IEO initiated in 1991. This cooperation was introduced within the framework of the Eureka Halios project which sought a demonstrator of the technological developments it had financed.

French halieutic ship Thalassa, first one of the name, was then more than 30 years old and its replacement by a more economical and silent vessel was scheduled. Discussions were thus proposed by Ifremer to its Spanish counterpart IEO : the point was to obtain a Spanish minority co-financing (in the order of 20 % funded by the Spanish funds Pesca) of the construction costs for this new ship in exchange of an exclusive right by IEO teams to use Thalassa for one or two at-sea campaigns a year (approximately 60 days).

This vessel sails under the French flag with a 100 % French crew. Its hull carries both IEO and Ifremer logos. IEO pays off Ifremer for the operating costs according to a daily rate annually revaluated.

The first of a long series of at-sea Spanish campaign (PELACUS) took place in 1996 and was followed by numerous others (1 or 2 a year, according to IEO possibility of financing), a majority of halieutic missions, often dedicated to anchovy in the Biscay Gulf, and some physical oceanographic missions.

#### 3.3.2.2 MRI WITH "OMICS" AND BIO-INFORMATICS EQUIPMENT

As a direct consequence of the genomics revolution since 2000, Marine Genomics became a "must" in the marine biology usual tools, in particular it brings a lot of new facts and figures to the biodiversity full observation and understanding. Its development is facilitated by the relative cost/performance decline of such equipment, but also results in an avalanche of new data. So, due to and beyond the "omics" technics themselves, this leads to the development of Marine Bio-informatics infrastructures reflecting the integration between biological field data (gathered by marine stations/labs), environmental data and "omics" data produced by sequencing techniques and molecular methods.

No single institution can afford the full range of sampling equipment and technology needed to explore the marine biodiversity and no state has access to all ecosystems needed to understand coastal zone processes and connections between regional seas.

A European level of collaboration is necessary and was launched at first by a Network of Excellence, the FP6 "Marine Genomics", then relayed by an ESFRI project, **EMBRC (European Marine Biological Resource Centre)**, which aims to change the scale of resources available allowing world class science and impacts in this domain. EMBRC enables integrated multinational planning and operation of existing and novel national research infrastructures (equipment, platforms, and technologies, human resources) to optimize sustained service provision to European end users. EMBRC also contributes to a Pan-European standardisation of data collection and analysis which is needed to progress the science and constitutes an enormous Knowledge Exchange opportunity. A great variety of Ecosystems are accessible to EMBRC Marine Stations:  Fjords, Estuaries, Mud flats, Sea grass beds, Kelp forests, Volcanic seeps, Coral reefs, Megatidal seas, Deep sea environments and anthropogenically impacted sites.

EMBRC recently organised an Interaction and Collaboration Workshop (HCMR – Crete, Greece. 28-30 May 2013) to foster collaborations and minimise duplications between research infrastructure in Europe. The workshop addressed interoperability (sharing of facilities, training courses), Data sharing, standards, 'omics' data, historical datasets, e-infrastructure innovation issues (KTT, Intellectual Property, promotion & marketing) and user access. http://www.embrc.eu/index.php/announcements/285-embrc-workshop-on-research-infrastructure-collaboration.html

EMBRC itself is in relation with other on-going networks and projects dealing with biological, biodiversity and ecosystems information, standards and knowledge transfer. Main connections are:

- **FP7-EUROMARINE** "From genes to ecosystems in changing Oceans", an integration of European marine networks of excellence EUR-OCEANS, MarBEF & Marine Genomics Europe. http://www.euromarineconsortium.eu/

- **ESFRI project ELIXIR**:  this project wishes to construct and operate a sustainable infrastructure for biological information in Europe to support life science research and its translation to medicine and the environment, the bio-industries and society. ELIXIR should act as a long-term data repository for marine biological, environmental and genomic data gathered in particular in the framework of EMBRC. It should provide harmonised standards even between disciplines and ensure interoperability and public access. EMBRC and ELIXIR would provide the appropriate logistical and data storage / processing for coordinated site-based research with high volumes of sequencing. http://www.elixir-europe.org/

- **ESFRI project Lifewatch:**  a consortium of institutions and organisations acting on behalf of a number of European States and scientific networks, working towards establishing a distributed infrastructure that would support scientific research within the context of European strategies concerning biodiversity and eco-systems. http://www.lifewatch.eu/web/guest/home

- **The Genomics Standards Consortium (GSC)**: created in 2005, with the goal of promoting mechanisms that standardize the international description of genomes and the exchange and integration of genomic data. This work is being mainstreamed in marine genomics, internationally and in Europe. In September 2012, the GSC officially launched the international network of Genomic Observatories, which includes an increasing number of marine genomic observatories, among which coastal observatories participating in EMBRC. This development should facilitate the introduction of the standards proposed by the GSC into Marine Genomics and Monitoring. http://gensc.org/

- **FP7-MG4U (Marine Genomics for Users)**:  many business leaders and legislators are not yet aware of how marine genomics hold great potential for problem solving and industrial commercial advantage. Valuable knowledge needs to be made accessible and disseminated in user-friendly contexts. In this context, the EU coordination action (MG4U) aims to facilitate knowledge transfer, technology transfer, and technology translation between high-throughput marine genomics, industry and society. http://www.mg4u.eu/

### 3.3.2.3 RESEARCH INFRASTRUCTURES FOR MARINE BIOTECHNOLOGY

Nb: This specific chapter relies notably on the Marine Board position paper 15: "Marine Biotechnology: A New Vision and Strategy for Europe", Sept. 2010 (http://www.marine.ie/NR/rdonlyres/C076682C-2B32-437C-A781-B2EACBAA6B62/0/ESFMBmarine_biotechnology_paper15LR.pdf)

Research Infrastructures for marine biotechnology are directly in line with the previous ones using "omics" and bio-informatics equipment, as central to the understanding of the biotechnological potential of marine organisms is the assessment of their genetic capabilities, i.e. sequencing of their genome and annotation of the genes. The resulting marine bio-banks could be screened for biotechnological applications.

- What are the specific nature of research infrastructures for marine biotechnology?

They should be 'incubators' or marine biotechnological institutes, co-located with both marine laboratories where the scientific expertise, the resources and the technological platforms are established, and with new emerging marine biotechnology start-ups or companies. Reference example: the European Centre of Marine Biotechnology, based at the Scottish Association for Marine Sciences (SAMS) in Oban. http://www.ecmb.org/

To network such "incubators" within a European Marine Biotechnology Infrastructure (with permanent secretariat + key nodes in network), in order to capitalise the knowledge and experience gained in different Member States for further optimisation of nationally based projects, cooperative initiatives and funding. It should be charged with supporting Europe's Marine Biotechnology research capabilities through a range of collaborative services including: the provision of research leadership in Marine Biotechnology; establishing and operating a European Marine Biotechnology Portal; facilitating access to essential infrastructure to ensure that European Marine Biotechnology research remains competitive; training early stage scientists via a European Marine Biotechnology graduate development programme; operating a Marine Biotechnology resources centre and strengthening the awareness of Marine Biotechnology across European industry. Such an infrastructure would also contribute to securing adequate supplies of biological material and provide a basis for much stronger industry-academic collaborations and partnerships.

### 3.3.2.4 MARINE RESEARCH INFRASTRUCTURES FOR AQUACULTURE

Aquaculture is an important industrial sector in Europe that contributes substantially to a sustainable "blue growth". European aquaculture technology is one of the areas where Europe has the edge and can make a difference in the future. Nevertheless, the European aquaculture industry is facing increasing challenges due to a more demanding and selective market combined with competition from outside the EU.

> These complex challenges require technological solutions that can be solved with the contribution of the public research community relying on excellent experimental facilities, high level expertise in biology and in environmental constraints, alongside experienced professionals of the private sector.

At European level, **FP7-I3 AQUAEXCEL** (March 2011 – Feb. 2015) initiated a cooperation which provides the aquaculture research community with a platform of top class research infrastructures. AQUAEXCEL unites major aquaculture experimental facilities with capacity to undertake experimental trials on a selection of commercially important fish aquaculture species and system types. The facilities available cover the entire range of:

- Production systems (re-circulation, flow-through, cage, hatchery and pond systems); environments (freshwater and marine, cold, temperate and warm water);
- Scales (small, medium and industrial scale);
- Fish species (salmon, trout, sea bass, sea bream, cod, common carp etc.);
- Fields of expertise (nutrition, physiology, health and welfare, genetics, engineering, monitoring and management technologies).

The overall objective of the AQUAEXCEL project is to promote the coordinated use and development of these top class experimental facilities and encourage problem-based research and knowledge transfer to more effectively support the development of a sustainable European production of high quality seafood with reduced environmental impact. On a regular basis within its transnational access activity, AQUAEXCEL invites proposals from European research groups for scientific research that utilises the facilities of any of the participating Aquaculture Research Infrastructures. http://www.aquaexcel.eu/

**Future potential improvements within an AQUAEXCEL 2 perspective (1st call H2020 / Infrastructures):**

- Additional consortium infrastructures could comprise of those dedicated to new species with special requirements (e.g. Bluefin tuna which needs larger tanks/cages than any other species).
- It could also include disease challenge testing facilities which were not included in AQUAEXCEL because of overlap with the NADIR I3 project, although diseases are a major problem for aquaculture development.
- Another improvement expected from the present AQUAEXCEL project is that the Trans National Access (TNA) should include the possibility of a bench fee for basic analyses of the samples provided by the infrastructures, as this type of cost is generally not included in the operating cost of the infrastructures themselves and thus not taken into account in TNA (being more attached to labs related to the infrastructures). Nevertheless, basic processing (extraction, analytical devices, basic genotyping) is often needed to adequately valorise the biological samples obtained in the infrastructures.
- Links to *high throughput sequencing infrastructures* should also be considered as a new, powerful emerging tool for understanding biological mechanisms and their genetic basis in aquaculture (non model) species.
- For fostering cooperation within the project, *Trans National Access* between project partners should also be encouraged, especially *for students.*

AQUAEXCEL is in relation with other MRI networks and projects dealing with aquaculture, biology and environment. Main connections are:

- Nordic Network on Aquaculture Recirculating Systems: The aims are to co-ordinate and strengthen research and development of Recirculating Aquaculture Systems (RAS) in Nordic countries. The network is financed by the Nordic Council of Ministers, and was formally founded at a steering committee meeting in April 2011 with country representatives from Denmark, Norway, Sweden, Finland and Iceland. http://www.nordicras.net/

- ESFRI project EMBRC: European Marine Biological Resource Centre, already mentioned here above. http://www.embrc.eu/

- FP7-I3 MESOAQUA: the network of European marine mesocosm facilities to advance the studies of future aquatic ecosystems from the Arctic to the Mediterranean (Mesoaqua ended in Dec. 2012) http://mesoaqua.eu/

### 3.3.2.5 MRI FOR OCEAN ENGINEERING

MRI for Ocean Engineering are wave basins, water circulation canals, hyperbaric tanks, material behaviour in sea water testing facilities, marine sensors calibration laboratories, … including also in situ test bases. These land-based testing facilities first of all are used for maritime and ocean engineering purposes, including for the new emerging ocean energy challenge. But they are also necessary and useful for marine sciences, for design, tests and qualification of every instrumentation systems and underwater vehicles before their deployment for oceanographic campaigns or as autonomous instrumented platform. In this function, they are also part of the range of research infrastructures supporting the EOOS. European integration in this domain is mainly supported by two FP7-I3 projects:

- one networking Hydraulic/Hydrodynamic testing facilities for offshore engineering as for marine environment issues (***FP7-I3 HYDRALAB IV*****:** "More than water, Dealing with the complex interaction of water with environmental elements, sediment, structures and ice", 2011-2015) http://www.hydralab.eu/

- another one more focused on testing facilities for Marine Energy Converters (***FP7-I3 MARINET:*** **"**Marine Research Infrastructures Network for Energy Technologies", April 2011- march 2015). http://www.fp7-marinet.eu/

Both consortia gather very similar skills and could envisage common actions on issues like wave generation and water-current flumes.

Some marine sensors calibration labs are integrated in the FP7-I3 JERICO-Coastal Observatories. Some other important testing equipment, like hyperbaric tanks for sensors and instrumentation qualification, are not integrated in a European network up to now.

# 4. MAPPING AND PRELIMINARY ANALYSIS OF HUMAN CAPACITY BUILDING

One of the aims of WP6 is also to develop a Human Capacity Building (HCB) scenario for marine and maritime activities, including initiatives, and unbalances among the regions. To this end, firstly a mapping and preliminary analysis of the current landscape is presented. The next step will be to analyse needs, gaps and unbalances of HCB among sectors and Regions, in order to address appropriate mechanisms for supporting HCB and particularly personnel mobility. In line with general CSA-Oceans objective, critical inputs to the JPI-Oceans SRIA will be finally provided.

## 4.1 MAPPING OF HUMAN CAPACITY BUILDING PROGRAMMES AND SCHEMES

The update of HCB European schemes presented in the following paragraphs includes a preview of Horizon2020 news, with a focus on HCB associated to access to Research Infrastructure, and a tentative overview of non-academic training in marine and maritime sector with particular reference to HCB aspects in the framework of research support to industry and policy. The mapping is completed by a comparison among HCB actions in the framework of international marine projects.

### 4.1.1 EU INSTRUMENTS TO SUPPORT EDUCATION, TRAINING AND MOBILITY

Education, training and mobility of students and researchers are at the core in reaching the aims of Europe2020[2], the EU Strategy launched in 2010 to enable Europe to emerge from the economic crisis and turn the EU into a smart, sustainable and inclusive economy. Based on five key targets to be achieved by the EU in the fields of employment, education, R&D, social inclusion and poverty reduction, and climate/energy, Europe2020 entails seven ‘flagship initiatives’ providing a framework through which the EU and national authorities will mutually reinforce their efforts in areas supporting its priorities such as innovation, the digital economy, employment, youth, industrial policy, poverty, and resource efficiency.

In particular, three Flagship Initiatives - Innovation Union, Youth on the Move and The Agenda for new skills and jobs - will, through a number of specific commitments aimed at creating growth and jobs, support and stimulate actions to modernise higher education, to develop new curricula addressing innovation skills gaps, to promote attractive employment conditions in RDI, to remove remaining obstacles to transnational and intersectoral mobility and to increase Europe’s attractiveness for researchers.

The full realisation of the European Research Area (ERA) is a key condition to attain these objectives and the EC Communication of 18 July 2012 on "A Reinforced European Research Area Partnership"[3] urged structural changes across Europe and the adoption of concrete measures to increase the levels of excellence, efficiency and effectiveness of Europe's public research system.

A number of succeeding EU policies and actions in the field of education, training and human resources in S&T have been developed since the launch of the Lisbon Strategy in 2000, recognising that, in a knowledge-based society, high-quality education and training at all levels (pre-primary, primary,

[2] http://ec.europa.eu/europe2020/index_en.htm
[3] http://ec.europa.eu/euraxess/pdf/research_policies/era-communication_en.pdf COM(2012)392

secondary, higher and vocational education) and an open and competitive labour market for researchers are fundamental to Europe's success.

### 4.1.2 ERASMUS AND MARIE CURIE ACTIONS

In these fields the EU has a long-standing tradition in coordinating instruments at European level: the two most successful and renowned programmes in higher education are ERASMUS and the Marie Curie Actions, both having offered over decades structured training, exchange and mobility opportunities to young students, graduates, doctoral students and postdocs.

Established in 1987, ERASMUS is the EU flagship mobility programme in education and training and one of the best-known EU-level actions that has enabled more than 2 million students from across Europe to pursue enriching learning experiences in other countries by means of selected Joint Master and Doctoral Programmes and Scholarships of outstanding academic quality. In the last selection round alone of ERASMUS Mundus (2009-2013) 4 Master Courses and 2 Joint Doctorates were selected in the fields of Marine and Maritime Sciences[4].

The Marie Curie Actions (MCAs) boast a long-term and very successful tradition within EU RTD Framework Programmes since the early 1990's, and have developed their support from pure training and mobility into more structured actions aimed at also fostering career development, creating conditions for researchers to be mobile without obstacles and enhancing the status and attractiveness of a research career in Europe. They have proven to be one of the most popular, successful and more international programmes throughout EU FPs, leaving a reasonable amount of flexibility to respond to societal demands, and setting a valuable benchmark for researchers' working conditions and employment standards.

Within the FP7 People specific programme (2007-2013), the evolution of MCAs is the result of stock-taking and building on past experiences and successes, while at the same time focusing actions and instruments, and fine-tuning the programme's objectives with the changing strategic scenario and the new goals Europe has set. Strategic shifts and pilot initiatives (e.g. European Industrial Doctorates and Innovative Doctoral Programmes) have already been put in place in FP7 (People Work programmes 2012 and 2013), in order to bridge towards Horizon2020.

New opportunities in higher education and research will be offered in the next EU multiannual financial framework 2014-2020 by the ERASMUS FOR ALL programme and the Marie Skłodowska-Curie Actions (MSCA) in Horizon2020. Both coordinated by the European Commission for Education, and Culture, the two EU programmes will significantly increase the possibilities for students, researchers and staff to engage in European and international training, mobility and cooperation.

Organised in three key actions (mobility, cooperation for innovation and policy support), ERASMUS FOR ALL will support Scholarships for mobility (credit mobility; over 2 million students estimated)

[4] 2013 Selected Projects:
http://eacea.ec.europa.eu/erasmus_mundus/results_compendia/selected_projects_en.php. For Master Courses' and Joint Doctorates' best practices, consortium agreements and useful documents see http://eacea.ec.europa.eu/erasmus_mundus/tools/good_practices_en.php, http://eacea.ec.europa.eu/erasmus_mundus/beneficiaries/beneficiaries_action_1_en.php.

within both the EU and to non-EU countries, Joint Master Courses (degree mobility; expected about 34.000 Masters students) to obtain a joint international degree, as well as mobility for higher education staff to teach or get trained in another EU or non-EU country.

The programme will also foster and strengthen cooperation among universities, other education institutions, organisations and enterprises by means of strategic partnerships, Knowledge Alliances and Sector Skills Alliances in order to create new multidisciplinary curricula to promote entrepreneurship within education, to develop other transferable skills and to ensure that the educational systems better match the needs of the labour market.

Within Horizon2020, the Marie Skłodowska-Curie Actions (MSCA) will support Joint Doctorates as well as European Industrial Doctorates to encourage collaboration with the private sector, foster innovation and entrepreneurial spirit and improve career prospects of doctoral candidates (around 26.000 doctoral students foreseen).

The Horizon2020 MSCA streamlined activities (4 compared to 8 in FP7) will, through a bottom-up approach, encompass fostering new skills through excellent and innovative initial training of researchers (research training networks, Joint and Industrial doctorates), supporting transnational and intersectoral mobility, opening research careers at European and international level, enhancing business-academia collaboration and staff exchange, while continuing to ensure excellent employment and working conditions, in line with the EU Charter and Code for Researchers (Fig. 1).


*MSCA in Horizon2020*

### 4.1.3 HUMAN CAPACITY BUILDING AND RESEARCH INFRASTRUCTURES

Research infrastructures (RIs) play an increasingly important role in the advancement of science and technology and their exploitation, as they provide the conditions, critical mass of people, knowledge and investment required to carry out cutting-edge research and contribute to national, regional and European economic development. RIs are facilities, resources and services that are used by the research communities to conduct top-level research and foster innovation in their fields, by offering unique research services to users from different countries, by attracting young people to science and the best researchers from around the world, and by helping to shape and bridge scientific communities. RIs may be 'single-sited' (a single resource at a single location), 'distributed' (a network of distributed resources), or 'virtual' (the service is provided electronically).

RIs activities in Horizon2020 will support broader access to and deeper integration of European RIs, integrating and opening national and regional RIs of European interest, fostering the innovation potential of RIs and their human resources. The programme will also support the implementation, long-term sustainability and efficient operation of the new pan-European and world-class RIs identified by the European Strategy Forum on Research Infrastructures (ESFRI) and the conceptual and technical design of new research infrastructures of a clear European dimension and interest. More 'traditional' RIs activities such as transnational access and service support to European researchers, networking and joint research activities amongst RIs (Integrating Activities), and e-infrastructures (e-I) will continue to be maintained.

New features of the programme are activities in support of the RIs innovation potential, the development of human resources and European RIs policy and international cooperation. The attention to the human capital and to new professions and skills is significant in as much as it addresses a very specific RIs/e-I need for adequate skills, expertise and professionals for which no formal education and training, curricula development and recognitions exist today. The activity will support the training of staff managing and operating RIs, the exchange of personnel and best practices between facilities, the adequate supply of human resources in key disciplines, and the engagement with universities to prepare curricula and courses specifically for pan-European RIs to address their intercultural and interdisciplinary nature.

Under the heading International Cooperation for RIs and within strategic cooperation activities with key third countries, support is also envisaged for multilateral cooperation in predefined areas, among which Arctic research, marine science and biodiversity.

After the approval of Work programmes and the release of the first calls for proposals, the beginning of capacity building activities under Horizon2020 is foreseen in the second half of 2014.

With a view to HCB needs and requirements, the potentiality and feasibility of setting up one or more partnerships and submitting proposals in the framework of the above mentioned, more structuring actions could be explored well in advance, and, in case, be accurately prepared. This would allow readiness to respond to the first calls of Horizon2020 and enable exploitation of these and other opportunities therein during the lifetime of the programme.

### 4.1.4 COMPARISON AMONG HCB ACTIONS IN THE FRAMEWORK OF INTERNATIONAL MARINE PROJECTS/INITIATIVES

In order to build on previous findings and actions, three different tables are presented, accounting for how the scenario of European projects and networks is dealing with the HCB issue: (i) EU FP7 ERA-NETs Projects; (ii) EU RI Projects; (iii) International Organizations/Network of Excellence/Consortia.

**Table 1 – HCB IN EUROPEAN FP7 ERA-NET PROJECTS (on-going)**

| Acronym | Name | HCB action | Notes |
|---|---|---|---|
| COFASP (http://www.cofasp.eu/) | Cooperation on Fisheries, Aquaculture and Seafood Processing | Dedicated Tasks to Mobility for HCB and Training for HCB | Explicit mention of HCB mobility action in the text of the 1st joint call |
| MARINE BIOTECH (http://www.marinebiotech.eu/) | ERA-NET in Marine Biotechnology | WP foreseen on knowledge building: education/training (e.g. summer schools) + interactions with PLATFORM / ERA-LEARN, ELSA | |
| SEAS-ERA (www.seas-era.eu/) | Towards Integrated Marine Research Strategy and Programmes | Dedicated WP on HCB. Main products:<br>▪ inventory of HCB initiatives + analysis on needs and gaps<br>▪ proposals for HCB calls within Common Programs and Joint Calls<br>▪ a training and mobility strategy for human resources in marine science | First time the HCB issue was included in an ERA-Net project |

**Table 2 – HCB IN EUROPEAN FP7 INFRASTRUCTURES PROJECTS (on-going)**

| Acronym | Name | Typology | HCB action |
|---|---|---|---|
| AQUAEXCEL (http://www.aquaexcel.eu) | Aquaculture infrastructures for excellence in European fish research | CP-CSA Project | WP dedicated to design and deliver new pioneering training courses + 4 Training Courses organized (putting emerging aquaculture infrastructure centres of excellence at the forefront) |

| | | | |
|---|---|---|---|
| ASSEMBLE (http://www.assemblemarine.org/) | Association of European Marine Biological Laboratories | CP-CSA Project | Organization of service and technique based workshops |
| ECORD (http://www.ecord.org/) | European Consortium for Ocean Research Drilling | EU-Canada Consortium for participating to the International Ocean Discovery Program (IODP) | Workshops/Summer schools |
| EMBRC (http://www.embrc.eu/) | European Marine Biological Resource Centre | ESFRI Project | Interdisciplinary training in marine biological sciences and genomics |
| EMSO (http://www.emso-eu.org) | European Multidisciplinary Seafloor&Water column Observatory | ESFRI Project | Ocean Observatories Challenges and Progress – Conference Statement: 'Emphasising the need for young – mid career scientist support and training [...]' |
| EUROARGO (http://www.euro-argo.eu/) | European contribution to Argo Program | ESFRI Project | Capacity building of users during the preparatory phase +<br>Training day for new EC and non-EC countries +<br>Mention of training of personnel for operations at sea |
| EUROFLEETS (www.eurofleets.eu/) | Towards an alliance of European Research Fleets | CP-CSA Project | WP on Advanced Training and Education:<br>▪ organization of on-board education activities and ship-based training courses;<br>▪ investigation of opportunities for trans-national cross-training and exchange of technical personnel for the development of a shared management of human resources;<br>▪ training technicians and finding ways to associate them in a stable manner to the equipment;<br>▪ Foster the development of transnational deployment teams for |

| | | | |
|---|---|---|---|
| | | | co-invested equipment. |
| HYDRALAB IV (www.hydralab.eu/) | More than water; dealing with the complex interaction of water with environmental elements, sediment, structures and ice | CP-CSA Project | Young researchers' workshop |
| FIX-O3 (http://www.fixo3.eu/) | Fixed point Open Ocean Observatory | CP-CSA Project | WP dedicated to deliver a series of training opportunities for users (not only professionals) |
| JERICO (http://www.jerico-fp7.eu/) | Towards a joint European research infrastructure network for coastal observatories | CP-CSA Project | Summer schools |
| MARINET (http://www.fp7-marinet.eu/) | Marine Renewables Infrastructure Network | CP-CSA Project | Industry networking & training in the form of user workshops, staff exchange and free-of-charge training courses in order to provide opportunities for collaboration, joint ventures and expertise development |
| SEADATANET (http://www.seadatanet.org/) | Pan-European infrastructure for ocean and marine data management | CP-CSA Project | Training courses |

| Table 3 – HCB IN INTERNATIONAL ORGANIZATIONS/ NETWORKS OF EXCELLENCE/CONSORTIA/INITIATIVES | | | |
|---|---|---|---|
| **Acronym** | **Name** | **Typology** | **HCB action** |
| AQUA-TNET (http://www.aquatnet.com/) | European Thematic Network in the field of aquaculture, fisheries and aquatic resources management | EC Lifelong Learning Programme | Education Gate: Master courses database, PhD portal, Mobility platform |
| BONUS EEIG (http://www.bonusportal.org/) | The joint Baltic Sea research and development programme | Art.185 | Young Scientists Club + PhD/training courses and schools (focus on early career scientists)<br><br>Integration between natural and socio-economical sciences; linking between physical and biological science |
| EuroMarine+ (www.euromarineconsortium.eu/) | Integration of European Marine Research Networks of Excellence | Network of Excellence | Mobility Fellowships Programme: interdisciplinary, competency training and capacity building |
| IOC (ioc-unesco.org/) | Intergovernmental Oceanic Commission | UNESCO Commission | HCB as part of the thematic programs:<br>long term perspective; empowering network of directors with leadership skills; supporting network of scientists with proposal-writing skills; building scientific teams to collaborate on funded projects; training in decision support systems |
| ICES (http://www.ices.dk/Pages/default.aspx) | International Council for the Exploration of the Sea | Consortium | Training courses promoting new careers/curricula |
| EurOcean (http://www.EurOcean.org/) | The European Centre for Information on Marine Science and Technology | Foundation | InfoBase/job opportunities |

The three tables presented above aim at exploring how EU projects/initiatives on Sea Science address the HCB issue, with particular regard for identification and tackling of specific needs. The landscape of EU Projects and other initiatives clearly show a strong interest in contributing to capacity building process, according to the objectives of the project/initiative, through for example:

- identification of needs & gaps, promotion of mobility/training schemes and new careers/curricula;
- making available information and database on HCB initiatives;
- organization of thematic training courses;
- Promotion of mobility/staff exchange programs.

This is confirmed by SEAS-ERA findings, with a perspective oriented also to the Regional dimension. Specifically:

- HCB is increasingly becoming part of marine research programs at national level[5];
- among EU funding schemes, FP7 RTD projects used to include different types of action for HCB: summer schools, PhD courses, recruitment of young researchers, training (also through open access to facilities)[5];
- At regional level HCB is part of neighbourhood cooperation and/or interregional cohesion. Many organizations (e.g. IOC, ICES, BONUS, EuroMarine) identified best practices and methodologies for enhancing HCB[5];
- results of the 'Questionnaire on HCB' analysis indicate high priority for building profiles of researchers, technologists and technicians in different disciplines; mainly through initiatives like school education and internships[5];
- HCB actions shall become part of thematic Joint calls and Common Programs[6];
- The exchange of practices and guidelines is a milestone towards the identification of a common HCB roadmap in Marine Science shared by the Marine Community[7].

A non-homogeneous approach has to be outlined among the infrastructure projects. Some of them include a strong capacity building component to be implemented through programmatic actions (e.g. trans-national cross-training and exchange of personnel). Others, and in particular ESFRI Projects, do not show any HCB plan as part of the development of the infrastructure but only spot initiatives. Moreover, HCB actions address from time to time different targets: partners of the project, (young) scientists, users, public at large.

### 4.1.5 NON-ACADEMIC TRAINING

A non-exhaustive review of training possibilities in a non-academic environment reveals that maritime organisations and societies (e.g. Lloyd's Register: http://www.lr.org/sectors/marine) or shipping companies (for instance Maersk Group: http://www.maersk.com/Career/entry-level-jobs/Pages/entry-level-jobs.aspx) offer specialist training, entry-jobs and educational courses

[5] Reference: *Capacity Building: Identifying needs, specificities, and imbalances*, SEAS-ERA Project, D5.2.1 - March 2012.

[6] Reference: *Proposal for Human Capacity Building calls within Common Programs and Joint calls*, SEAS-ERA Project, D5.3.1 - December 2012.

[7] Reference: *A pan-European training and mobility strategy for human resources in marine science*, SEAS-ERA Project, D5.3.2 – March 2013.

combining structured educational programmes with on-the-job experience both for graduates and A-levels (or country's equivalent school leavers' certificate).

A large number of enterprises and organisations advertising jobs, providing recruitment services and other opportunities in the marine and maritime sectors also offer specialised training and professional development courses[8].

Multiple and diversified educational paths and employment opportunities are actually available. Capacity Building efforts in marine sciences need to be based on highly interdisciplinary approaches.

## 4.2 HUMAN CAPACITY BUILDING AND SEA JOBS: A CASE STUDY

The role of education and training is fundamental for creating and supporting jobs of the sea which are well prepared to address the challenges of the third millennium. CSA Oceans aims at reviewing and analysing the needs and gaps of the European non-high education system supporting the maritime economy and the role of the research and technology, firstly limited to the transportation sector, in order to suggest JPI Oceans to act accordingly. So, concerned institutions (i.e. technological districts) were asked to provide their contribution in the consultation on HCB "Support of non-high education to marine and maritime economy" (see Annex 1) as mainly "strategic thoughts" about this issue based on their knowledge and experience. Answers have been initially collected from five Italian regional organisations (see Annex 2) and integrated into the international network and EC funding mechanisms. Possible extension of the consultation in order to map other sectors and countries can be discussed within the framework of the CSA itself or the JPI (e.g. through a pilot action).

Collected information is analysed here along with some recommendations.
Answers from participant organisations are elaborated in this section, in order to show a unified view of the realm of the Italian experience in the HCB. However, the locations of the different organisations span a large portion of Italian territory thus giving a wide overview of; the HCB realm in the relevant sector, the nature of organisations, their attitude towards the issue and their networks of relationships make this landscape significantly diversified, even in the description of the sector. So, it is worth pointing out, especially under some specific labels, who certain answers/comments are coming from.

### 4.2.1 OVERVIEW OF HCB FOR JOBS OF THE SEA: STRUCTURE

The five organisations participating in the initiative come from four Italian regions (Liguria, Friuli Venezia Giulia, Toscana, Sicilia), which are all characterised by a strong maritime vocation. Liguria is the Italian region with the highest incidence of the "Blue Economy" on the production system [1]. Sicily holds the second position in Italy (after Lazio) for employees in the "Blue Economy" activities [2]. Friuli Venezia Giulia shares the lead with Liguria in the added value multiplier of the "Blue Economy" activities [2]. Tuscany host the leading district for super yacht industry in Italy.

#### DISTRIBUTION ON THE TERRITORY OF SUPPLY AND DEMAND

[8] see for example: http://www.vikingrecruitment.com/jobsatsea/; http://www.nuwavepersonnel.com/; http://www.careersatsea.org/index.php; http://www.job2sea.com; http://maritime-connector.com/; http://www.vcrew.com/.

Despite the significant common features of the economic landscape in territories where participant organisations operate (and then a quite similar distribution of HCB demand), a rather inhomogeneous pattern of HCB suppliers and relevant initiatives is revealed by the enquiry.
The overview from Sicily (NAVTEC, DTAMar) shows a principal role for universities and research establishments; particularly their conventional products(high-education paths) and with no significant involvement in non-high education.
A different situation is depicted in the scenarios proposed by Liguria (DLTM) and Friuli Venezia Giulia (ProgettoMare). In these cases, although with some differences, the education system seems to reflect the map of requests for a rich and articulated set of educational and training opportunities coming from the industrial sector.

#### JOB OPPORTUNITIES AND BUSINESS SATISFACTION

Contributions of a different nature are given to this topic. Basically, they can be summarised in two points of view: one is to give a picture of the scenario, more (ProgettoMare) or less (NAVTEC) detailed, by listing the most required professional roles and skills (see Annex 3); the other (DLTM, NAVIGO) is to stress the dynamics of the evolving policy, on the side of job offer, which is strongly affected by the global crisis and its fallout on this particular sector.

### 4.2.2 OVERVIEW OF HCB FOR JOBS OF THE SEA: EXPERIENCES

The overall expected outcome of this section concerns the perspectives of the HCB scenario in terms of adequacy: 1) mapping the employment associated with the sea; 2) circulation of professional expertise through different districts; 3) evolving technologies and relevant innovation contents.

#### ADEQUACY OF TRAINING TO THE MAP OF THE JOBS OF THE SEA

Consistent with the pattern of answers to point 2.1.2, some (ProgettoMare, NAVTEC) have given a detailed description of education and training paths and their matching the demand. On this side, the picture of the action plan highlights (ProgettoMare[9]): 1) the proposal of courses for unemployed; 2) development of learning path to update expertise of enterprise's current and new staff; 3) strengthening the typology of work experience, to foster the achievement of expertise on the job.

From a different point of view (mainly DLTM, partly DT-AMar) emphasis on the policy of continuously updating the offer according to the evolving landscape of the industry needs. In this respect, it is pointed out (DLTM) that "The promotion and organisation on the territory of actions aiming at increasing the Human Capacity can have long term valid effects only looking to the real changes of the requirements expressed by industry and work world with a medium-long term attention to the directions which can be detected at a higher national and international level...". So, well identified actions are envisaged as, "Definition of the education and professional requirements in the "blue economy" sector developing a dynamic map of the related job and expertise, of the specific and potential new skills as well as of the training paths useful to develop them...", as well as "Structured

[9] http://www.progettomare.fvg.it/eng/content/the-training-path.aspx

processes of demand forecast and sharing of integrated training programmes setting up synergies among training and education institutions and the industrial sector...". Also (DT-AMar): "... an innovative and multi-disciplinary approach towards the jobs of the sea should be put into place...", and "It should be strongly science-oriented..."

#### UNIFICATION AND INTEGRATION IN THE COMPARISON OF NATIONAL STANDARD AND REGIONAL POLICIES FOR JOB TRAINING

Educational and vocational activities for high school and graduated students resulting from the full involvement of industry, high schools, university, Research Institutions, Training Centres exhibit high quality standards. Therefore (DLTM, NAVTEC), to make a further step towards the growth, it is necessary to set up a structured network among the different educational institutions to create effective and complete training paths, including also the contribution of research and industry. It would be necessary (ProgettoMare) "... to further develop successful experiences ... connecting to the ITS Foundations ITS to foster the construction of a coordinated offer of specialized courses at the local level between technical colleges, vocational schools, vocational education and training, based on the establishment of technical-professional of the sea".

#### THE ROLE OF THE RESEARCH SECTOR. PLEASE GIVE EXAMPLES OF ACTIVITIES THAT ALREADY USE, NECESSITATE OR WOULD NECESSITATE THE SUPPORT FROM THE RESEARCH COMMUNITY/EXPERTISE

All participant organisations promote and are actively involved in cooperation with universities and research establishments to develop and deliver education and training activities with a significant innovation content. These activities are addressed to students of different levels, ranging from first level secondary school to graduated (DLTM), they often involve industrial partners as hosting organisations for PhD and R&D programs which enables application of innovative technologies to products, production systems and management (NAVIGO, NAVTEC), while research institutions also provide opportunities for education in fields related to marine science (DT-AMar).

### 4.2.3 COMPARISON WITH HCB INITIATIVES FOR JOBS OF THE SEA AT EUROPEAN LEVEL

Contributions to this section come from two participating organisations, those having the strongest links with the industrial sector related to "Blue economy" in their own territory, along with long-lasting well-established relationship with European Union institutions and initiatives.

#### LEARNING PATHS: NEED FOR HOMOLOGATION AND OPPORTUNITIES FOR DIFFERENTIATION

It is necessary to involve all the concerned stakeholders and create synergies among them to work together and create effective paths that avoid inhomogeneous activities and fund dispersion. It is the only means to confer excellence and quality and then "homologate" the educational paths. It is necessary to map the existing careers and, analysing in detail the "blue economy" cluster, detect new professional profiles which would lead to added value and diversify the territory with respect to the past (DLTM).

It is crucial, downstream the education and training phase, to certify and recognize skills. The certification of technical and professional skills would allow the development of more refined education policies for the construction of specific career paths. Besides, it would help companies in their employment needs, increase the flexibility and employability of workers, and would allow a true labour mobility within and outside the national territory. The citizens would see the abilities they acquired during their periods of training formally recognized, in terms of an actual "value in use", and certified skills (ProgettoMare).

## STANDARDS: ORGANIZATIONAL PROFILES, ACCESS TO RESOURCES

The role of the "Blue Economy" in Italy's growth has been further stressed by the European Community, promoting an integrated maritime community policy aiming at the achievement of the Europe 2020 Strategy targets for a smart, sustainable and inclusive growth. The attention is focused not only on traditional activities, such as fishing and shipyards, but also on the most innovative ones; research and marine biotechnologies. In order to create an effective education programme leading to a real improvement and growth, it is now necessary to conform all the education actions to the EC standards and recommendations, promoting more and more quality, exchanges, comparison and sharing among the different EC countries. On the other hand the funding system should be simplified to shorten the path between the project's planning and completion. Indeed, a large part of ideas are not fulfilled due to the current situation, characterized by the long procedures of the funding bureaucracy (DLTM).

The organization of ProgettoMare has been a strong point for the success of the intervention. The investment (in terms of resources ESF) of the Friuli Venezia Giulia Region, the link with the District and the building of partnerships through the ATI made it possible to continuously monitor objectives, actions and results.

In terms of access to resources ProgettoMare could count on ESF while also monitoring opportunities for funding under the EU Seventh Framework Programme (FP7) (with particular reference to the following priorities and thematic areas) for various reasons related to Sea Economy and other fields related to:

- Cooperation Specific Programmes: Nanoscience, nanotechnologies, materials & new production technologies; Energy; Transport.
- Capacities Specific Programme: Research infrastructures; Research for the benefit of SMEs; Regions of knowledge.

The monitoring of funding opportunities by ProgettoMare will result in a short general report, devoted to the illustration of the general characteristics of the sources of funding and its calls available under the (FP7) in support of the Sea Economy.

### 4.2.4 PRELIMINARY FINDINGS

Some further comments are reported here in the form of recommendations from participant organisations, aimed at highlighting critical points of education and training framework and contributing to renew policies for the enhancement of HCB scenarios at national and European levels.

DLTM emphasizes the importance of some topics mentioned in the previous sections, in order to detail the trends to pursue in the short and medium term a smart and effective "blue economy" development and revamping:

- concentrate the support of the institutions and investments on a selection of priorities, challenges and development requirements, fundamental for the "knowledge-based society";
- support the technological innovation and trials, promoting also the investments in the private sector;
- guarantee the full participation of all the stakeholders involved in the education paths;
- Base ourselves on tangible experiences and provide for valid monitoring and assessment systems of the education actions.

DT-AMar points out that weaknesses in the South of Italy in addressing the needs of education and training of human resources, due to strong economical structural problems still existing. Although Italian researchers are generally appreciated worldwide, it seems to be lacking the capacity to properly activate synergies between the training system and the economic system.

Existing legislation and bureaucracy create difficulties, and hurdles are even higher in the current crisis period. Italy has never invested a lot in research, and competitive research has only been recently introduced into the system. Without an effective reform of the Italian research system, in terms of increase of national resources (hopefully much more than 1.26% of GNP) and proper research planning, the current gap with more dynamic European regions is unlikely to be filled: this reflects in the training system and in the HCB strategies that need a stronger matching with the national economic system.

**REFERENCES**


[1] CENSIS-Federazione del Mare, IV Rapporto sull'economia del mare. Cluster marittimo e sviluppo in Italia e nelle regioni, 2011.

[2] Unioncamere-CamCom, Secondo Rapporto sull'Economia del Mare, 2013.

## 4.3 PRELIMINARY ANALYSIS OF THE HCB MAPPING

The mapping of HCB targeted three different issues: EU schemes, EU projects, non-academic training. The table below presents a synthetic view of the findings and a brief highlight on relevant aspects.

| Mapping object | Findings | To be noticed |
|---|---|---|
| **EU schemes/instruments supporting education, training and mobility** | ▪ General Programmes (e.g. ERASMUS/MCAs) foster excellent and innovative training<br>▪ Activities in support of the RIs innovation potential, the development of human resources and European RIs policy and international cooperation foreseen in Horizon2020 | EU schemes don't address any particular sector (e.g. marine / maritime science) but can help implementing HCB initiatives in the framework of Joint Calls or Programmes |
| **EU projects (ERANET & RI) and other international initiatives addressing HCB component** | HCB issues are tackled through different actions, from training courses to solid capacity building strategy related to the specific objectives of the project/initiative | Lack of: (i) coherent approach to develop human capacities; (ii) fluid HCB strategy in Marine Science shared and recognized at EU level |
| **Focus on non-academic training through a case study** | ▪ Private sector offers training course<br>▪ Non-high education can support marine and maritime economy = jobs of the Sea<br>▪ Research and technology play an important role in promoting training activities | Lack of: (i) international coordinated programs; (ii) synergies between the training system and the economic system |

# 5 ANNEXES

## ANNEX 1: HUMAN CAPACITY BUILDING CASE STUDY - STRUCTURE OF CONSULTATION

We report here the contents of the inquiry that was circulated to collect the information analyzed in a preliminary way in this document, and that we have outlined in the introduction.

**Consultation on Human Capacity Building**

**Support of non-high education to marine and maritime economy**

**STEP 1.**

**Which organization are you filling the questionnaire for?**

1.1. Name

1.2. Legal status

1.3. Contacts

**STEP 2.**

**Overview of Human Capacity Building (HCB) for jobs of the Sea: structure**

2.1. Distribution on the territory of supply and demand

2.2. Job opportunities and business satisfaction

**STEP 3.**

**Overview of HCB for jobs of the Sea: experiences**

3.1. Adequacy of training to the map of the jobs of the sea

3.2. Unification and integration in the comparison of national standard and regional policies for job training

3.3. The role of the research sector. Please give examples of activities that already use, necessitate or would necessitate the support from the research community/expertise

**STEP 4.**

**Comparison with HCB initiatives for jobs of the Sea at European level**

4.1. Learning paths: need for homologation and opportunities for differentiation

4.2. Standards: organizational profiles, access to resources

Free text for comments/useful links/suggested documents

| ID Data | Contact Info |
|---|---|
| **Name:** Distretto Ligure delle Tecnologie Marine (DLTM)<br>**Legal Status:** Technology Cluster – Consortium | **Address:** Via delle Pianazze 74,<br>19136 La Spezia, Italy<br>**Tel.:** +39 01871868356<br>**Web:** www.dltm.it<br>**E-mail:** direzione@dltm.it |
| **Name:** Polo Formativo per lo sviluppo dell'Economia del Mare (ProgettoMare)<br>**Legal Status:** Temporary Joint Venture (Lead partner: ENAIP Friuli Venezia Giulia) | **Address:** Via dell'Istria 57,<br>34137 Trieste, Italy<br>**Tel.:** +39 0432693611<br>**Web:** www.enaip.fvg.it<br>**Web:** www.progettomare.fvg.it<br>**E-mail:** direzione@enaip.fvg.it |
| **Name:** NAVIGO scarl<br>**Legal Status:** Limited Liability Consortium | **Address:** Via Coppino 116,<br>55049 Viareggio (Lu), Italy<br>**Tel.:** +39 058438973<br>**Web:** www.navigotoscana.it<br>**E-mail:** info@navigotoscana.it |
| **Name:** Distretto Tecnologico Sicilia Trasporti Navali (Sicilia NAVTEC)<br>**Legal Status:** Technology Cluster – Consortium | **Address:** c/o Centro Prove CNR-ITAE,<br>Via Comunale Santa Lucia 40,<br>98125 Messina, Italy<br>**Tel.:** +39 090624406<br>**Web:** www.navtecsicilia.it<br>**E-mail:** navtecsicilia@cnr.itae.it |
| **Name:** Distretto Tecnologico dell'Ambiente Marino della Sicilia (DT AMar Sicilia)<br>**Legal Status:** Technology Cluster – Consortium | **Address:** c/o CNR-IAMC,<br>Via del Mare 3, 91021 Torretta Granitola,<br>Campobello di Mazara (TP), Italy<br>**Tel.:** +39 090624406<br>**Web:** dtamar.eu<br>**E-mail:** salvatore.mazzola@cnr.it<br>**E-mail:** antonino.adamo@iamc.cnr.it |

## ANNEX 3: HUMAN CAPACITY BUILDING CASE STUDY - DIFFICULT-TO-FIND PROFESSIONAL ROLES AND SKILLS

A. Professionals figures more difficult to find:
   - shipwright;
   - English language (technical and tourism);
   - designers skilled in Solidworks;
   - designers of electric and electronic systems;
   - master Roper student;
   - skipper; infuser;
   - painter;
   - technician with manual skills in mechanics and medium-high culture in electrical and electronic engineering system;
   - technician skilled in plant electronics/navigation systems and onboard systems;
   - CAD-CAM Programmer;
   - specialized assemblers;
   - welders with expertise in electronics and electrical engineering and mechanical automation;
   - carpenters;
   - competent workers;
   - workshop managers/resource management;
   - skilled craftsmen;
   - boats assemblers;
   - upholsterers artisans/seamstresses;
   - machine tools attendant;
   - project manager boating;
   - sales managers/marketing officer.

B. Professional skills more difficult to find:
   - ability to work away for long periods;
   - practical and manuals skills critical for the successful design;
   - CAD-CAM operation;
   - practical experience and extensive technical knowledge with availability to move;
   - experience mechanical/engine sector and machine tools; technical and administrative management of a contract;
   - construction of parts of carpentry from design to delivery; MIS-MAG-TIS welding;
   - professionalism and flexibility, overview, interdisciplinary;
   - business skills and marketing;
   - ability to work in "High-flying" on the shafts of sailboats.

## MEETING WITH STAKEHOLDERS MARINE RESEARCH INFRASTRUCTURES

5-6 June 2013, JPI Oceans secretariat, Rue du Trône 130, 3rd Floor, 1050 Brussels, Belgium

### LIST OF PARTICIPANTS

**Stakeholders:** Jacques Binot (EUROFLEET 2), Adelino Canario (EMBRC), Donatella Castelli (I-Marine), Patrick Farcy (JERICO), Paolo Favali (EMSO), Helen Glaves (ODIP), Herman Hummel (EuroMarine), Olivier Lefort (OFEG), Wouter Los (Lifewatch), Kostas Nittis (EuroGOOS), Marieke Reuver, Marc Vandeputte (AQUAEXCEL), Simone Van Schijndel, Peter Wellens (HYDRALAB IV), Henning Wehde (NOOS), European Commission.

**CSA / JPI Oceans:** Kathrine Angell-Hansen (Chair), Wendy Bonne, Aurelien Carbonniere, Florence Coroner, Willem De Moor, Fidel Echevarria, Jan-Stefan Fritz, Rudy Herman (Co-Chair), Berit Johne, Jean-Francois Masset, Angel Muniz Piniella, Pankaj Pant, Tom Redd, Erik Sandquist, Stefania Sparnocchia, Szymon Sroda, Kristin Thorud, Jacky Wood.

### 1. INTRODUCTION AND PRESENTATION OF JPI OCEANS AND CSA OCEANS

Kathrine Angell-Hansen and Rudy Herman welcomed participants and presented the objective of this workshop which aims to discuss with stakeholders potential needs and priorities that could be addressed by JPI Oceans to achieve its goals and objectives (cf. "Vision document"). The Chair mentioned previous work in the area of marine research infrastructures (MRI) including the report of the Expert Group "Towards European Integrated Ocean observation" (European Commission publication) and SEASERA deliverables. JPI Oceans will build on outcomes of these projects and initiatives among others. Then the Chair insisted on the importance of building a comprehensive plan that would not look at infrastructures as an isolated component of the landscape. It is important to look at infrastructures in relation to short and long term needs, science and technologies needs, data and monitoring needs, capacities. With this regards, the example of 'ocean acidification' as a societal challenge was mentioned. The introduction to the workshop was followed by a presentation of JPI Oceans and CSA Oceans as well as a tour de table of participants.

### 2. SESSION I-III: INPUT AND DISCUSSION WITH STAKEHOLDERS

In session I, stakeholders provided input related to the main goals of JPI Oceans (Q1) and other issues addressed in the preparatory questionnaire. In session II, a structured discussion addressing specific questions with particular attention on technologies, competitiveness, innovation barriers and growth potential in the maritime sector was conducted (Q4, Q5 Q6). Session II also focused on science to policy (Q7, Q8), the potential role of JPI Oceans, and additional questions by CSA WP leaders. In relation to goal 1 "*Enable the advent of a maritime economy, maximising its value in a sustainable way*", availability and interoperability of marine data was identified as a key component. This issue includes, the integration of data services, awareness of other initiatives and coordination of services in the long-term. In relation to goal 2 "*Ensure GES of the seas and optimise planning of activities in the marine space*", stakeholders highlighted the lack of coordination for the definition of GES descriptors to be developed in the framework of MSFD. There is a need to identify and tackle common gaps and overlaps and to link existing networks together. In relation to goal 3 "*Optimise the response to climate change and mitigate human impacts on the marine environment*", stakeholders discussed the concept of EOOS (European Ocean Observatory System) which needs to be developed further.

In session III, a categorisation of infrastructures based on the output of the SEASERA meeting hold in Toulon was proposed to stakeholders in order to structure a discussion on the identification of key marine research infrastructures to reach JPI Oceans' goals. The following 6 categories were presented by Jean-François Masset (WP6, Ifremer) and discussed: Research vessels and their underwater vehicles (for sea access and deep sea exploration/sampling), in situ data acquisition systems (for seawater and seabed observation and monitoring), satellites (remote sensing for sea-surface monitoring), marine data centres (for data validation, storage and dissemination through web portals, incl. access to high computing facilities & generic modelling), marine land-based facilities and in situ testing sites for ocean engineering (deep wave basins, water circulation canals, hyperbaric tanks, material behaviour in sea water testing laboratories, marine sensors calibration laboratories, in situ test sites for marine renewable devices) and experimental facilities for marine biology, biodiversity and ecosystem studies (marine genomics, aquaculture, Mesocosms, biodiversity observatories). The coverage of marine stations among these 6 categories was debated and the categories need to be further elaborated according to some participants.

Then stakeholders discussed the need to define a process towards the identification of key marine research infrastructures to be sustained at EU level. The possibility to mix a bottom-up and top-down approach was mentioned.

## 1. Meeting follow up and presentation of the extended questionnaire

The workshop was one of the nine consultation workshops with different stakeholder groups. The input from the stakeholders around the table is very important as raw material for the development of JPI Oceans' Strategic Research and Innovation Agenda (SRIA). Participants were informed that they would receive some highlights from the discussions where there seemed to be consensus, but no comprehensive meeting report.

As a next step, the stakeholders will receive an extensive electronic questionnaire and everyone was urged to put an effort into responding to it, building on the momentum between them and consider consolidating messages further through cooperating in areas where they foresee synergies.

The participants stated appreciation for this kind of meeting, and that we cooperate with structures that exist in the follow up of JPI Oceans. Be ambitious was the message, expressing a strong support to the initiative and high expectorations to the potential of JPI Oceans long-term and strategic role.

## 4. SOME HIGHLIGHTS

This part of the meeting report aims at gathering few highlights from stakeholders focusing on where JPI Oceans can add value, based on needs and gaps discussed in the previous sessions.

- Streamline national roadmaps / capacities

Stakeholders agreed on the need to work upon the sustainability of the whole chain of ocean observation from in situ observation, modelling, products and services, to the users and community as well as the need to have a more coherent and coordinated framework. The chain needs to be considered as a whole system which is entirely required to reach the 3 JPI Oceans goals. For example, e-infrastructures help making the data more useful to the economy and creating a market so they should not be isolated from observation infrastructures. Stakeholders agreed on the need to upgrade and adapt capacities to the new societal needs (and not only sustain), especially to respond to MSFD and to demands of economy. It implies to differentiate short-term and longer-term actions. Stakeholders see a potential role for JPI Oceans to streamline and harmonise national infrastructures roadmaps in this area, . This needs to be explored further in the next steps of the CSA Oceans Consultation process.

- Need to align descriptors in relation to MSFD indicators

A major gap identified by stakeholders in session I and II is the lack of harmonisation of descriptors in the framework of the Marine Strategy Framework Directive (MSFD). JPI Oceans is seen as a good instrument to launch concrete action in this area. One action could be to focus on 2/3 descriptors and act as a facilitator to gather the existing network together, share best practises and have a common approach.

- Build a comprehensive Monitoring strategy

Stakeholders agreed on the need for an overarching organisation to build a coherent long-term monitoring programme at European level. This European monitoring programme would integrate regional programme (EuroGOOS) in order to identify gaps, plan and promote future investments (i.e sensors). There are also some common responsibilities / spatial gaps to be addressed at EU level such as the Artic and the Black Sea, and the deep seas. Such a comprehensive monitoring strategy is necessary to avoid duplication and optimise the use of resources.

- Human Capacity Building

A number of possible JPI Oceans actions in the field of Human capacity building were mentioned by stakeholders, such as multidisciplinary PHD programme together with industry, also identifying new curricula in marine science and technology, developing training programmes related to marine infrastructures including for technical personnel, as well as exchange of scientists and technicians between the different infrastructures.

- Attracting investors / knowledge transfer

There is a need for technology and knowledge transfer platforms to allow fast and seamless dissemination and translation of scientific discovery into industrial applications and products. In general, the link between research and industry should be improved in order to attract investors. The tools mentioned to deal with this issues are strategic workshops, data bases.

## ANNEX 5: REFERENCE DOCUMENTS

- European Commission Expert group final report on MRI (January 2013): https://webgate.ec.europa.eu/maritimeforum/content/3158

- Marine Board position paper "Navigating to the future IV", and especially its chapter 11 dedicated to the EOOS issue (European Ocean Observing System) (June 2013): http://www.marineboard.eu/images/publications/Navigating%20the%20Future%20IV-168.pdf

- Seas-Era deliverables related to the MRI: http://www.seas-era.eu/np4/19.html
    - D4.1.1 "MRI updated overview, European integration and vision of the future" (October 2012)
    - D4.2.1 "MRI common management guidelines for joint research activities" (March 2013)
    - D4.3.1 "Access methodology to both private and public MRI" (October 2013)

- OceanObs'09 Plenary and Community papers: http://www.oceanobs09.net/

- 'A Framework for Ocean Observing' , report prepared by the post-Oceanobs'09 Task Team for an Integrated Framework for Sustained Ocean Observing (IFSOO – UNESCO 2012): http://unesdoc.unesco.org/images/0021/002112/211260e.pdf

- EuroGOOS Strategy for 2009-2013 http://www.eurogoos.org/documents/eurogoos/html_page/eg09_05eurogoos_strategy5.pdf

- EurOcean 2010 declaration: http://www.marineboard.eu/images/publications/EurOcean%202010%20and%20Ostend%20Declaration-76.pdf

- Consultation on "Marine Knowledge 2020: from seabed mapping to ocean forecasting" (15 dec. 2012): http://ec.europa.eu/dgs/maritimeaffairs_fisheries/consultations/marine-knowledge-2020/index_en.htm

- Marine Data Infrastructure: Outcome of Public Consultation. EC staff working document SEC(2010)73 final: https://webgate.ec.europa.eu/maritimeforum/system/files/COMM_PDF_SEC_2010_0073_F_EN_AUTRE_DOCUMENT_TRAVAIL_SERVICE.pdf

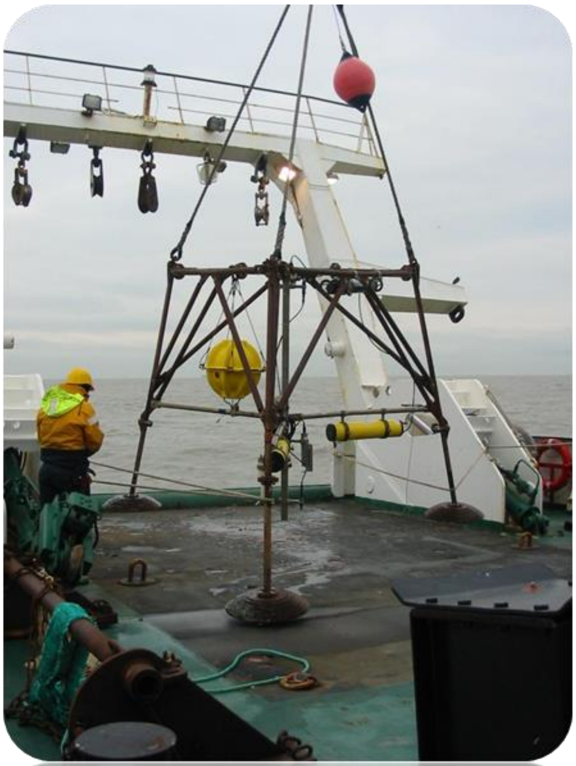
- The Rio Ocean declaration (16 June 2012): http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/pdf_Rio_Ocean_Declaration_2012.pdf

- EMSO OOCP conference (Ocean Observatories Challenges and Progress), Scientific ideas, early results and infrastructure development), Roma 13-14-15 nov. 2013. http://www.emso-

eu.org/management/index.php?option=com_k2&view=item&layout=item&id=43&Itemid=160

- EMODNET: The European Marine Observation and Data Network. Joint Vision Document by the Marine Board-EuroGOOS (2008) http://www.marineboard.eu/images/publications/EMODNET-7.pdf

# Proposal of Specifications for the Marine Research Infrastructures InfoBase: Structure and Functionalities



February 2013

EurOcean Office

# 1. Contents



# 2. Background

Since its beginning EurOcean devoted its efforts to provide information on topics related to marine science and technology in Europe with one of the priorities was given marine research infrastructures. In this scope EurOcean has developed and maintains several InfoBases on Marine Infrastructures in the past few years. Taking into consideration the expertize acquired by EurOcean, IFREMER, Member of EurOcean and responsible for the Infrastructures tasks in SEAS-ERA project and also within JPI Oceans requested EurOcean a proposal for an InfoBase that could integrate the information previously gathered for the SEAS-ERA Project and at the same time meet the needs of the work to be developed under the JPI Oceans. The purpose of this document is to comply with these requests.

## 3. Technical Specifications

### 3.1 Description of the components of the Marine Research Infrastructures InfoBase

The Marine Research Infrastructures database will be composed by several different components according with the flowchart below.

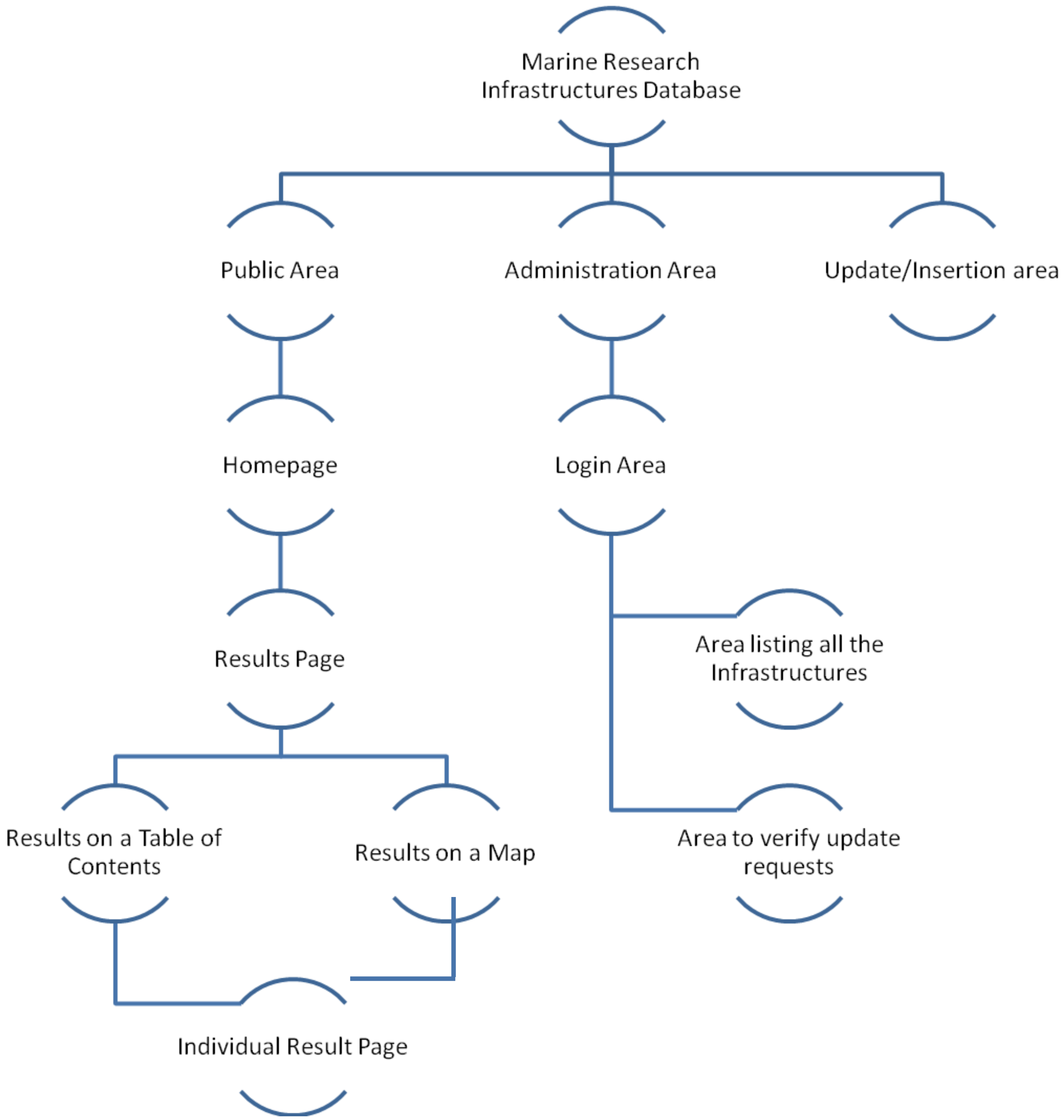



**Figure 1** – Structure of the Marine Research Infrastructures database

As it can be seen above the Database will be composed by three main components: the Public Area accessible to all the users, the Administration Area restricted and only available to the database managers and the Update/Insertion Area public and accessible to all the users who wish to contribute to the database.

The following sections will be focusing on the technical definition of each component and sub-components of the database.

## 3.2General Specifications

The interface for the new Marine Research Infrastructures InfoBase should be appealing, easy to navigate and clearly identify the scope/universe/content of the InfoBase. With this in mind it should comply with the following general specifications:

- Possibility of letter size increase and decrease;
- Display of all information fields active in the user's area;
- Display of all blank information fields as NA;
- Appropriate search fields drop down menu size as to not impair the readability of theinformation available;
- Not exact word match and case sensitive free text searches and;
- Possibility of search and display information with special characters.

## 3.3 Homepage

The Homepage will be the interface/entry point of the InfoBase and will have a more visual approach similar to the one developed for MarinERA and AQUAEXCEL.

The Homepage is foreseen to contain the following general features:

- InfoBase Logo (to be developed)
- InfoBase Acronym (to be provided later);
- InfoBase Name ( to be provided later);
- InfoBase Description (to be provided later);

On top of the description itself, an "About the InfoBase" section will propose information on the InfoBase aims, principles and first construction.

- Add or update InfoBase option "If you are aware of any Marine Research Infrastructure that is not yet in this InfoBase or any other updates please contact EurOcean (mailto:EurOcean@fct.mctes.pt) or insert (link to form) yourself a new record and updates.";
- Self-updatable Interactive Map;

• Search tips with definitions of the fields;

• Source of Information: logos of EurOcean, SEAS-ERA, JPI-Oceans, Bonus+;

• Fields for search.

The homepage will have two main SEARCH components

A. MAP SEARCH
B. FIELDS SEARCH

### *Map Search*

The functionality will imply two levels of information:

➢ At the **European Level** (by default)– when clicking in the icon of a specific country, the pop-up box will include:

| |
|---|
| – Name of the country<br><br>– Number of MRIs in that country<br><br>– "See all MRIs" option; which will zoom in to the National Level |

➢ At the **National Level** – all the RIs of a country will be located in the Map with the different type codes; when clicking in the icon of an specific RI, the pop-up box will include:

| |
|---|
| – Name of MRI<br><br>– Category of MRIs<br><br>– Sub-Category of MRIs<br><br>– URL of the MRI<br><br>– Location of the MRI: City, Town, Country (it can be the MRI location itself when relevant (e.g. sea-floor stations), or the MRI operator location, home port<br><br>– Link to MRI record in the InfoBase |

Regarding the category /sub-category, the starting list should be preferably the one adopted for the Seas-era MRI mapping:

**Research Vessels and their underwater vehicles**

Research vessels

Underwater vehicles

Other large exchangeable equipment

**In situ data acquisition systems**

Fixed point open ocean observatories

Mobile ocean observatories

Fixed coastal observatories

Infrastructure for deep ocean drilling research

Other facilities

**Satellites for seas and oceans observation**

Coast watch

Ocean watch

**Marine data providers**

**Land-based facilities and in-situ testing sites for ocean engineering and ocean observation support**

Wave basins, wave flumes

Current and wave-current flumes

Other land-based test facilities

In situ test sites

**Experimental facilities for biology and ecosystem studies**

Marine biology laboratories

Aquaculture research facilities

Mesocosms facilities

Ecosystem and Biodiversity Observatories (under construction)

Other facilities

### *Search Fields*

- Country (drop down box);
- Operator (free text search with auto-complete)
- Category of the MRI (drop down box);
- Sub-Category of the MRI (drop down box);
- Operating Areas;
- Main Specific Disciplines addressed;
- Year of Built (free text search)

Two options for displaying the information (2 different buttons):

➢ **Map display (in the Homepage):** it will locate in the Map the MRIs that fit the applied filters with zoom function.

➢ **Search contents** (in the Table of Results): it will provide the records that fit the applied filters in the Table of Results page.

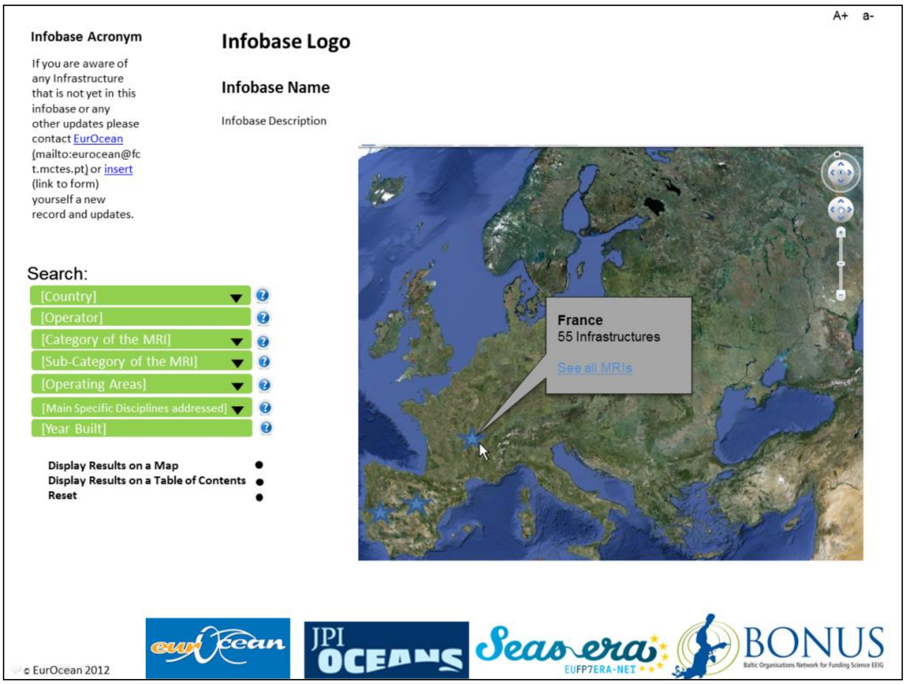



**Figure 2** – Example of a homepage

Lists for operating areas and scientific disciplines are proposed by CSA Oceans (Deliverable 6.1).

For both, more than one area could be ticked.

## 3.4 Results Page

As previous discussed the search results might be displayed in two ways (Figure 2 and Figure3), depending on the user needs, it will be possible to choose to display the results on the Interactive Map or in a Table of Results.

### *Display the Results on a Map*

The results will be displayed on the Homepage tacking into account the filters used.

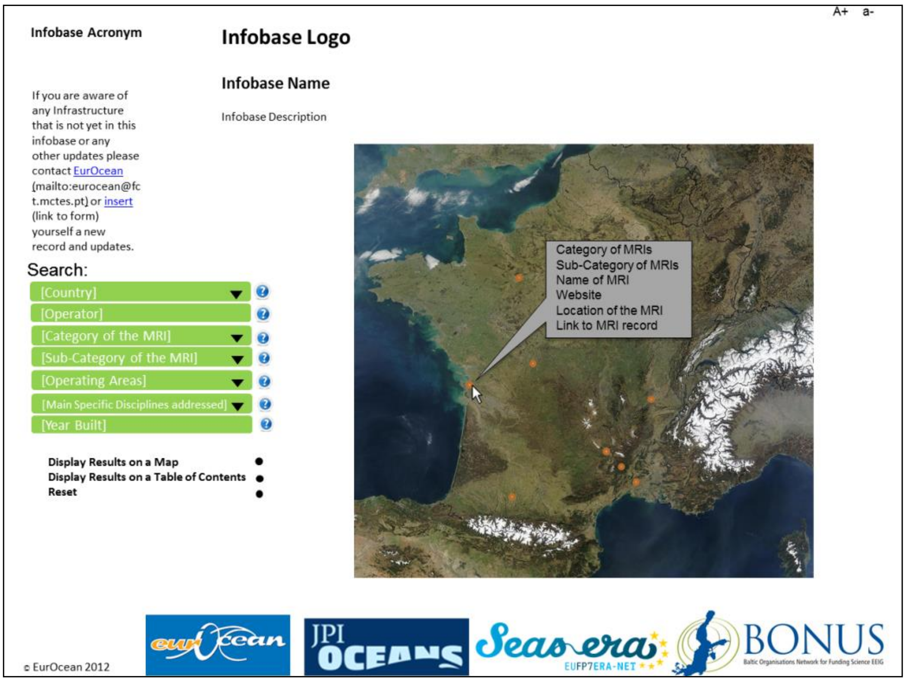



**Figure 3** – Example of a Results Page if *Display on a Map* is Chosen

## *Display the Results on a Table of Contents*

The table of results will have a list of all records of the InfoBase that are active for the user's search and will allow to be organized alphabetically by Name, Category, Sub-Category, Country and Operator. The page of results will have a two printing functionalities "Printable Detailed PDF" and Printable Tabular PDF, the detailed .pdf should have the logo of the InfoBase and the source: "Source: Acronym of InfoBase." and the date of generation.


**Figure 4**– Example of a Results Page if *Display on a Table of Contents* is Chosen

## 3.5 Individual Result Page

The individual Result Page will display the Acronym of the InfoBase, the Logo of the institution and the image of the instrument. Also it will be included a link to update that facility, a back to search link and an option to print a .pdf.

The information fields will be in accordance with the table 1. For the design please see Figure 4.

**Table1:** Information Fields

| **Facility Information and Contact** |
|---|
| Name |
| Owner |
| Operator |
| Status operator (public research, other public administration, private) |
| Category |
| Sub-Category |
| Type |
| Country |
| Main operating areas |
| Main scientific disciplines addressed |
| Contact person |
| Email |
| Phone |
| Address |
| URL Operator |
| URL Infrastructure |
| Year Built |
| Year of last refit |
| Last Update of the information: |
| **Additional information** |
| Length (RV) or max. waterdepth (underwater vehicles, stations) (m) |
| Location (home town or longitude / latitude) |
| Service currently offered by the infrastructure |
| Access conditions (none contractual information+ link to the contact person + (if any) link to open calls (national ones, trans national ones within I3 projects) |
| Examples of scientific data acquired (project acronym / URL of publications) |
| Gallery |
| Logo of operator |
| Technical Details File (Download file option that will only appear if exists) , or by default to give the operator site URL to ad hoc page. |

Length (for RV), maxi waterdepth (for Underwater vehicles, sea-floor stations, oceanic moorings, etc …) are important figures worth to be collected.

Locations are anyway necessary to build the map.

The Individual Page of results should have the possibility to *print a detailed* pdf. also a back to search button should be displayed.

The Individual Page of results should have a functionality to download a file with technical details.

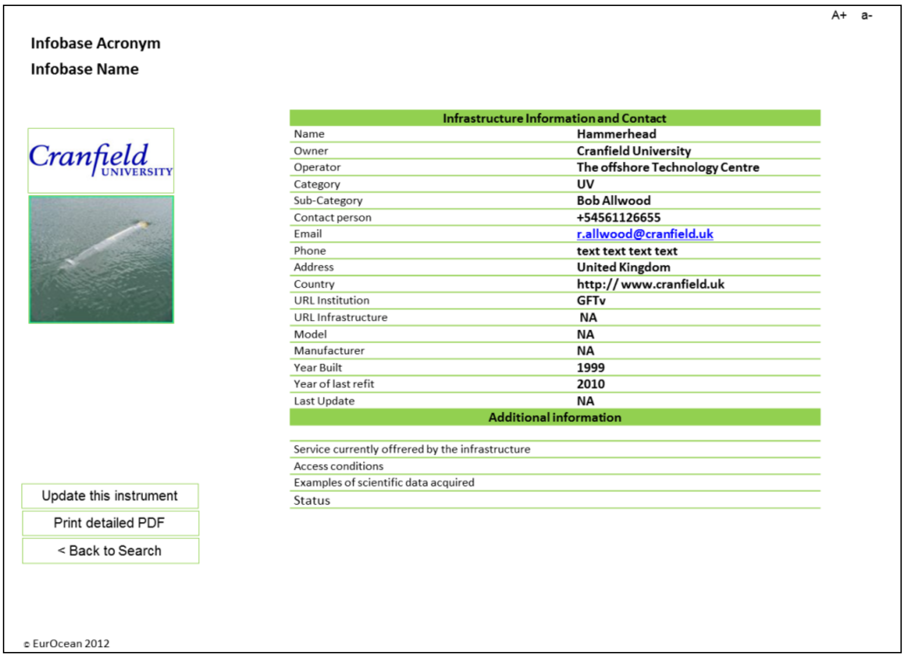



**Figure 5:** Example of an Individual Results page

## 3.6 Update/Insertion area

As the normal practice of EurOcean this area will be open to all people who wish to contribute, after a submission normally EurOcean office will validate it and in case of any doubts will try to identify the Operator in order to obtain further information.

### *Fields of Information*

The InfoBase update should consider the following fields of information (Table2):

**Table 2:** Information fields for *Update Area: idem fields as proposed in Table 1 (See my table 1 propositions)*

| **Instrument Information and Contact** |
|---|
| Name* |
| Owner |
| Operator* |
| Status operator (public research, other public administration, private) |
| Category (Drop down list)* |
| Sub-Category (Drop down list)* |
| Type |
| Country (operator) |
| Main operating areas ((Drop down list) |
| Main scientific disciplines addressed ((Drop down list) |
| Contact person* |
| Email* |
| Phone |
| Address |
| URL Operator* |
| URL Infrastructure |
| Year Built |
| Year of last refit |
| Last Update of the information: |

| Additional information |
|---|
| Length (RV) or max. waterdepth (underwater vehicles, stations) (m) |
| Location (home town or longitude / latitude) |
| Service currently offered by the infrastructure |
| Access conditions (none contractual information+ link to the contact person + (if any) link to open calls (national ones, trans national ones within I3 projects) |
| Examples of scientific data acquired (project acronym / URL of publications) |
| Gallery (Upload, with the possibility to delete) |
| Logo of operator (Upload, with the possibility to delete) |
| Technical Details File (Document Upload, with the possibility to delete) |

* Mandatory fields.

## *Inserting a new facility*

For the proposed design please see Figure 6.

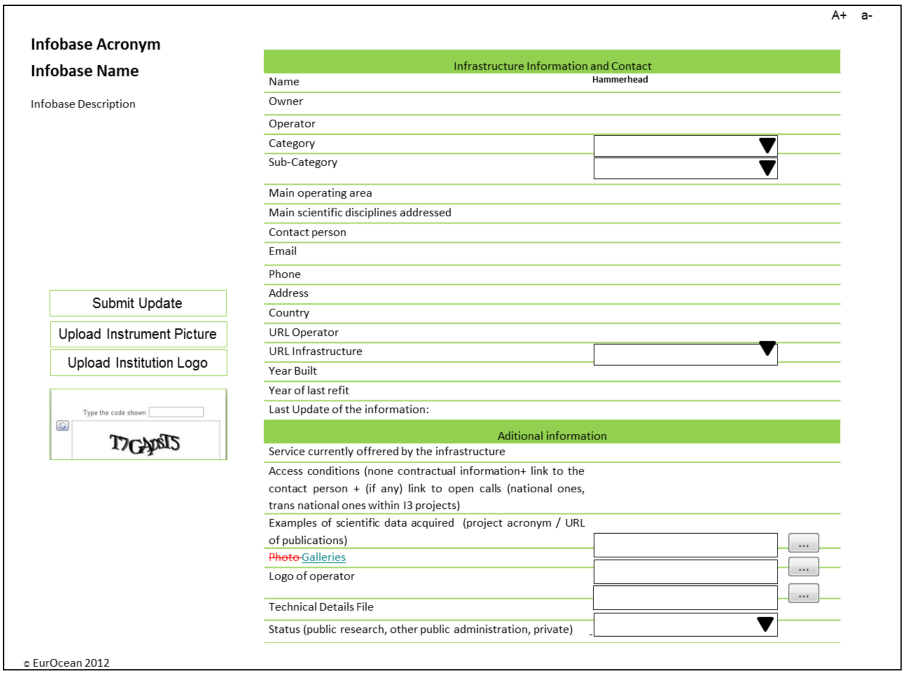



**Figure 6:** Example of the design of a form to insert a new Infrastructure

## *Updating of previous inserted instrument*

The form that will open should have the pre-filled information fields for design see Figure 7.

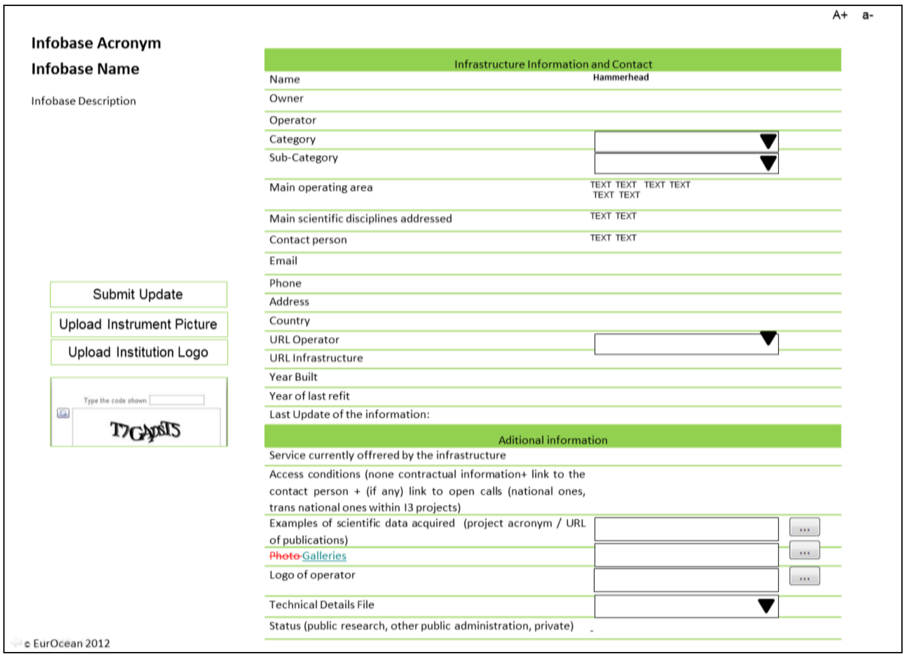



**Figure 7:** Example of the design of a form to update Infrastructures.

**a) Other Specifications**

As previous experiences have demonstrated spam update request have been normally received in all InfoBases. To deal with this problem a CAPTCHA[10] program should be implemented in each type of form.

After the submission of a new update an informing email will be send to EurOcean@fct.mctes.pt.

## 3.6 Administration Area

For the design specifications please see pictures 8 and 9.

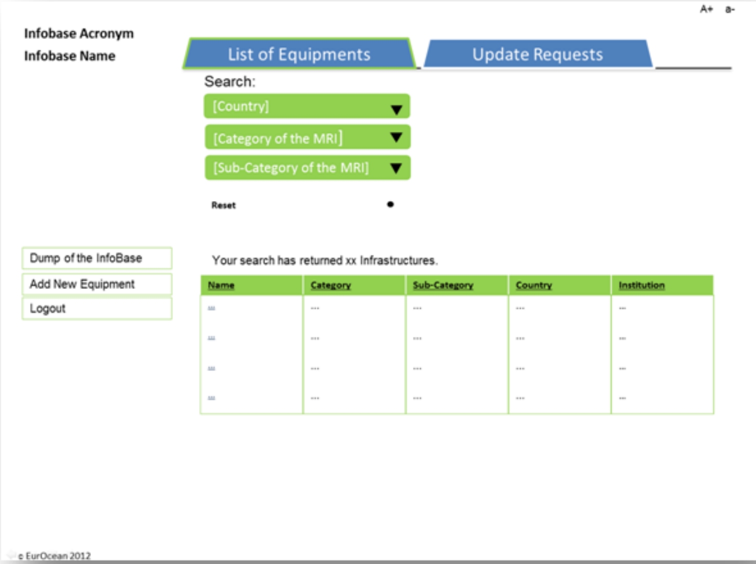
The Administration Area of the InfoBase will be protected from access by a login and password and will have two distinct areas:

1) An area listing all the Infrastructures, that allows the insertion of new Infrastructures and update of existing Infrastructures by the administration team and also a link to the functionality that will allow to generate an excel file with all the information available in the InfoBase.

2) An area to verify update requests, the updates can be accepted, rejected and deleted.

For administrators there shouldn't be any mandatory fields.

[10]A CAPTCHA (Completely Automated Public Turing Test To Tell Computers and Humans Apart) is a program that can generate and grade tests that humans can pass but current computer programs cannot. The process usually involves one computer (a server) asking a user to complete a simple test which the computer is able to generate and grade. Because other computers are supposedly unable to solve the CAPTCHA, any user entering a correct solution is presumed to be human.



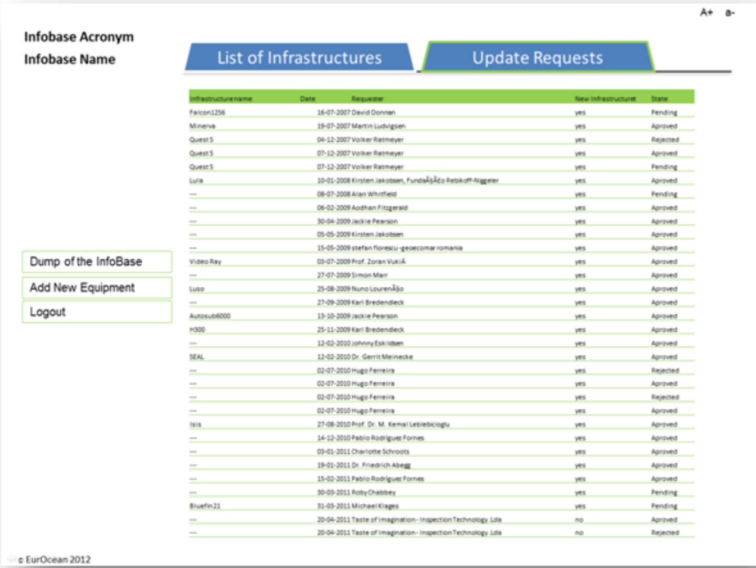




**Figure 8 and 9:** Example of the design for the administration area

## ANNEX 7: INFOBASE TERMS OF REFERENCE

***Text "About the database" for the MRI database home page:***

**About the database**

Objective: the database objective is to offer a comprehensive list of all existing facilities in Europe which are dedicated to marine sciences broad range of activities. It provides the first level of knowledge and characteristics for each facility, as well as the links and contact to access the further details provided by the operator. It was created with the support of FP7 "CSA Oceans", in order to foster all forms of open access and joint actions involving these research infrastructures in the framework of JPI Oceans.

For who: this database is intended for all stakeholders - scientists, engineers, policy makers, private companies, universities, ... - for their respective needs, either as user or as operator, or as designer, or as funder.

How to use it: search criteria + an iterative map allow any targeted search of information for every type of request. Criteria are such as: country, operator, category and sub-category, operating areas, main specific disciplines adressed, year built, … More on "Search tips".

How to understand it: the landscape of marine research infrastructure is complex, a choice of descriptors was done to provide as much as possible a clear and consistent vision, to provide all relevant information for this "discovery" level of the facilities. All explanations necessary to understand each descriptor are given in the "Technical Notes"

How to update it: this database was initiated from the most recent overviews available, especially the one done in the context of the ERA-Net Seas-Era, as for October 2012: deliverables D4.1.1 and its annexes, available on http://www.seas-era.eu/np4/19.html. But the landscape is constantly evolving, new infrastructures appear, others have significant up-gradings, some disappear from the service, characteristics change. A continuously updated database is therefore a necessity and a procedure is proposed to allow all to contribute, see the functions "Insert" or "Contact EurOcean".

This paragraph is also the text of the **"Technical notes"** proposed on the web home page, i.e. explanations on every descriptors:

Technical note

- Definition and explanations proposed for each descriptor used in this database:
  - "Research infrastructures" and "Facilities"

"Research infrastructures" (RI) is the most common general wording to evoke the set of installations and services offered to researchers to carry out their scientific activities. But as long as we consider a list, it is the word “facility” which is the most often used, including by operators themselves on their websites. A “facility” is an installation or a service by itself, which offer a specific access to researchers, at national level at least, at transnational level when appropriate (e.g. in the framework of a European project I3 eg type), in all cases beyond the limits of the research institutes which host and operate them.

A research “facility” is more than an “equipment” or a “sensor”, which themselves can be part of the facility.

A research “facility” is not just a building with offices and usually equipped labs for home scientists, it should bring a specific support for a research activity.

The present database includes about 800 facilities.

**First section of information: “Facility information and contact”**

- **“Category”, “Sub-category” and “Type”**

In order to deal with the complexity of the lanscape and provide users with an understandable list if not perfect, we have retained the Seas-Era categorization proposed for their marine RI overview, and adding the notion of sub-categories and types whenever necessary to be descriptive at the best. Categories and sub-categories are part of the search criteria, they are representatives of the skills and jobs requested to design and operate every group of facilities so categorized by “horizontal" business lines. This approach could be compared with the scientific one, through projects usually “vertically” organized from experiments and data acquisition to scientific knowledge and dissemination, relying on different technical skills and related RI. It is also a choice guided by the existence of ESFRI and I3 projects and their perimeter, by the idea that operational coordination at European level with a central governance will develop more easily and naturally within these “horizontal” consortia.

For marine RI, we can distinguish 6 “Categories” and among them some “Sub-categories”: this latest sub-division being often representative of the perimeter of a Eu consortium (I3 or ESFRI or eq.) which could sustained operational and integrated activities. “Type” is more an additional mention of the facility main technical feature when relevant and useful. For example:

| Category | Sub-category | Type |
|---|---|---|
| **In situ data acquisition systems** | Fixed point open ocean observatories | Underwater observatory |
| **Research vessels and their underwater vehicles** | Underwater vehicles | ROV |
| **Land-based facilities and in situ testing sites for ocean** | Wave basins, wave flumes | basin 80 x 50 x 10 |

| | | |
|---|---|---|
| **engineering and ocean observation support** | | |

- **"Categories and Sub-categories":**

**Research Vessels and their underwater vehicles** (for sea access and deep sea exploration/sampling):

- Research vessels
- Underwater vehicles
- Other large exchangeable equipment

**In situ data acquisition systems** (for seawater/seabed monitoring and observation):

- Fixed point open ocean observatories (Nota: including moorings by > 1000m water depth)
- Mobile ocean observatories (Nota: including gliders and Ferrybox which can be used also in coastal waters)
- Coastal observatories (Nota: including moorings by < 1000m water depth)
- Infrastructure for deep ocean drilling research
- Other facilities

**Satellites for seas and oceans observation** (remote sensing for sea-surface monitoring):

- Coast watch (Satellites for land and coastal waters observation)
- Ocean watch (Satellites for ocean observation)

**Marine data providers** (for data validation, storage and dissemination through web portals, incl.access to high computing facilities & generic modeling)

- No Sub-category so far ....

**Land-based facilities and in-situ testing sites for ocean engineering and ocean observation support**:

- Wave basins, wave flumes
- Current and wave-current flumes
- Other land-based test facilities
- In situ test sites

**Experimental facilities for biology and ecosystem studies:**

- Marine biology stations (existence of genomics facility is mentioned in "type")
- Aquaculture research facilities
- Mesocosms facilities
- *Ecosystem and Biodiversity Observatories network (under construction)*
- Other facilities

- **"Name":**

The name of the facility, as it appears on the operators web site, is not always specified using an acronym or clear evident. Often, more than one word is necessary. Examples:

- "Ocean Surveyor" (*a Vessel*)

- “Iberian Margin” (*an underwater observatory*)
- “Pleiades-HR 1B » (*a satellite*)
- “MRI Data library” (*a marine data provider within MRI*)
- “Narec Large Scale Wave Flume” (*the wave Flume of Narec*)
- “Stirling Institute of Aquaculture” (*Aquaculture facilities of the Stirling University operated by its Institute of Aquaculture*)

We encourage the operator to clearly name their facilities, using an acronym or a very short expression.

- **“Owner”**

The owner could be either the head institution of the “Operator” (the most common case, e.g. “University” of which “Department xxx” operates the “Facility yyy”) or in some case a different institution.

- **“Operator” and “Status operator”**

As the database is “facility access oriented”, the mentioned operator is exactly the institution in charge of the service offered, of the access conditions and of the planning. Of course, most of such defined operators can be also in charge of long-term investment perspective, new design, updating, refit or replacement plan. A specific case: for the satellites, the “operator” so mentioned is the ground segment in charge of the data dissemination and of specific remote sensing orders for one area/one period when this ability exists.

“Status operator” could be “public research”, “other public administration” or “private”.

Nota: Private providers of vessels, facilities, equipment or services not commited on a regular basis with the public research community are not listed in this database. In particular, all the suppliers of the offshore oil & gas industry are not listed.

- **“Country”**

It is the operator country. At first, we consider all the EU countries with a coast line + the associated countries within the framework programme (FP7, H2020). In a second step of construction of the database, we will add also the facilities of countries which complete the perimeter of the Black Sea, the Mediterranean Sea and the Black Sea.

- **“Main operating areas”:**

  - All oceans
  - Atlantic ocean
  - Pacific ocean
  - Indian ocean
  - Artic ocean
  - Antarctic seas
  - Baltic Sea
  - North Sea
  - Celtic Seas
  - Bay of Biscay and Iberian coast
  - Mediterranean Sea

- Black Sea
- Red Sea *(due account to the Eilat station specific case)*

- **"Main scientific disciplines or issues":**

  - Multi-purpose
  - Physical oceanography
  - Bathymetry
  - Hydrography
  - Geology
  - Geo-hazards
  - Chemistry
  - Biogeochemistry
  - Biology
  - Marine genomics
  - Fisheries
  - Aquaculture
  - Marine environment
  - Ecosystems & Biodiversity
  - Sea/ice
  - Meteorology
  - Ocean engineering
  - Other

Even though this list has some overlap it is allows to cover properly all the scientific activities which could be performed with the use of a given facility. For the search process, more than one "operating area" can be ticked.

- **"Contact person", "Email", "Phone" and "Address":**

The "contact person" is as much as possible the one in charge (or at least to contact) for the facility access issue, and we mention its full coordinates to join him: "Email", "Phone" and "Address".

By default, the contact person is the entry point of the operator.

- **"URL Operator"**

The link to the Operator home page.

- **"URL Facility"**

The link to the facility page in the Operator web site. We encourage every Operator to create an home page for each of their facilities, in English, with exactly the same sections as the one proposed for this MRI database: see a proposed model in annex here after.

- **"Year built", "Year of last refit"**

It is an interesting data when available and/or relevant, as statistics could be derived on the age of a given population of facilities, and so to contribute to a needs and gaps analysis.

**For section 2: "Additional information":**

- **"Length (m") or "Max. operating depth" (m)":**

When relevant (e.g. length for vessels, max. operating depth for underwater vehicles or for in situ instrumentation), information from which we could derived useful statistics and also contribute to a needs and gaps analysis.

- **"Location , Latitude and Longitude":**

We consider several types of location depending of the facility sub-category:

  - For the general case, it is the operator location:  town or exactly town & address,
  - For the case of fixed in situ observatories or in situ test sites, it is the facility real location,
  - For the case of vessels, it is its usual home harbour, not its administrative one which could be different,
  - **"Services currently offered"**

Link to the operator dedicated web page, if any

  - **"Access conditions"**

Link to the operator dedicated web page

  - **"Examples of scientific projects and data acquired"**

Link to the operator dedicated web page

  - **"Photos gallery"**

Link to the operator dedicated web page

  - **"Logo of operator"**

Link to the operator logo

  - **Technical details file**

Link to the operator dedicated web page

  - **Annex:  Message to the operators**

Its is proposed to operators to adopt a common model / template for each facility entry page, within their web site, in English or with an English version, with description and links in correspondence with the similar sections in the database.

Proposition:  MRI database "URL facility" leads to this model entry page:

| | |
|---|---|
| **Name of the facility:**<br><br><br>**Operator:** | *Photo:* |

**Short description:**

**Services currently offered:**

*short description + link to more details (same link as in the database)*

**Access conditions:**

*short description + link to more details(same link as in the database)*

**Examples of scientific activities carried out with the facility:**

*Project(s) title(s) + link to more details (same link as in the database)*

**Photo gallery** *(same link as in the database)*

**Technical details** *(same link as in the database)*

**Contact us:**

Contact person:

Email:

Phone:

Address:

*Last update of information: xx-yy-zzzz*