# Joint European Research Infrastructure network for Coastal Observatories


## Report on recommendations for future research and developments for filling gaps in the areas where observations are unattainable due to lack of best practice or technologies from all ROOSs D2.2

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# 1. Document description

**REFERENCES**

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# 2. Executive Summary

The main aim for this report is to provide an overview of the main challenges the existing observational systems are facing to provide an integrated status of the marine environment and to identify knowledge gaps, which are recommended to fill within the upcoming years.

An analysis has to be made with respect to developments in science and technology and future user needs at policy and operational (commercial) level in order to comment on the future research, gaps between present observational systems and user requirements

These recommendations are contributing to the roadmap for the improvement of an European Marine infrastructure based on components at National and International level and a shared vision on an sustainable Regional basin wide integrated network and a common strategy to reach this at European level in an accessible and inter-operable way..

The JERICO-consortium represents the institutes, which have national responsibilities for operating and maintaining existing in situ monitoring networks as well as development of efficient data gathering to fulfil future information needs.

Jerico-D2.2 will contribute to the Common vision of the JERICO-project on the following elements:

- Showing gaps in available and missing key marine and coastal environmental parameters and the oceanic Essential Climate Variables.
- To support the development and implementation of new tools and technologies
- To increase the governance of regional based systems and services (i.e. the Regional Alliances of the European Global Ocean observing system, ROOSs)

The analysis of existing infrastructure and the gap with data for the future needs has let to a set of recommendations, which will support an EU-monitoring strategy. It is composed out of three elements:

1. Developments in user requirements
2. Organisational structure
3. Governance on continuity, quality assurance, fit for purpose, financing,

The overview is provided detailing the specific needs of the observation systems provided for the Regional Alliances of the European Global Ocean observing system (EuroGOOS).

The regional systems covered are:

1. Arctic Regional Ocean Observing system (Arctic ROOS)
2. North West European Shelf Operational Oceanography system (NOOS)
3. Baltic Sea Operational Oceanography system (BOOS)
4. Ireland-Biscay-Iberia Regional Operational Oceanography System (IBIROOS)
5. Mediterranean Operational Network for the Global Ocean System (MONGOOS)
6. Black Sea Global Ocean Observing System (Black Sea GOOS)

There is a need to improve the in-situ observing system to achieve an appropriate and comprehensive understanding of the functioning of the marine environment and the monitoring of marine and maritime activities to ensure their sustainable development. Key priority in order to implement EU legislations such as the Marine Strategy Framework Directive (MSFD) offers the opportunities for operational observatories. New technology in platforms (gliders), multi sensor systems (ferrybox), communication and data management has offered new opportunities to bridge the gaps in research needs and user requirements.

To reach the objectives for an integrated network for in situ data the experience and best practices from leading projects and organizations should be combined with the organizational model as we know from meteorological information services. The science-policy interface and the financing mechanism through (Inter-) National mechanisms for implementation are key elements for success.

# 3. Introduction

The European waters are rich in natural resources and contain a large number of diverse marine habitats. The sectors of fisheries & aquaculture, tourism, maritime transport, renewable energy and oil and gas exploitation and increasing human activities (offshore and onshore) are utilizing these resources and climate change impacts form considerable pressures on the marine environment.

The different European regions are characterized by their own specific needs and therefore the monitoring systems aiming for a good overview of the status of the oceans are of very different form, i.e. in the use of measurement methodology in the divers regions of the European waters. However through mechanisms of harmonizing the information gathering, assessment and reporting in the framework of the Marine Conventions the International marine community has learned to cooperate and to reach co-production (i.e. Ospar-Jamp, Helcom- Combine).

OSPAR has developed eutrophication monitoring guidelines for nutrients, Chl -a, benthos, phytoplankton species composition and oxygen and developed manuals to monitor them (i.e. OSPAR, 2012). Monitoring data are used and reported with the Common Procedure (i.e. OSPAR, 2008) for the identification of the eutrophication status and for the calculation of the relevant to nutrients, Chl-a and phytoplankton Ecological Quality Objectives (EcoQO) (OSPAR, 2009).

Impact as well from climate change as human activities can have a variety of major implications for marine ecosystems and subsequently for individual marine species. Environmental, social and economic interests often form an area of conflict and sustainable management of marine resources is becoming increasingly important and has been implemented in EU policies and governance strategies such as the Marine Strategy Framework Directive or the Common Fisheries Policy support international activities such as the Global Ocean Observing System (GOOS) and the Global Earth Observation System of System (GEOSS).

However, sustainable management of the marine environment and its resources requires a deep understanding of the physical, biogeochemical, and biological processes, their interaction and synergies and impacts on the marine ecosystem. Only with this understanding it is possible to build predictive ecosystem based management models that are able to combine and integrate the major stressors and their environmental impacts.

The integrative approach to management of the marine ecosystem implies to develop challenging new tools (i.e. platforms with integrated sensor suites) and approaches (i.e. by developing cost-effective information services) that deal with the complexity of interactive processes to evaluate trade-offs by simulating scenarios of management plans.

The operational parts of this integrative approach are the observational systems implemented within the EuroGOOS regional alliances for the European waters. Over the last years several European wide projects have been conducted to integrate the in Situ observations towards a system that is aimed to serve all the needs from the different users (ref. to EU-ECOOP, EU-SEPRISE).

Based on the EuroGOOS ROOSes these different projects such as actually the MyOcean for mostly Real-time data and the SeaDataNet for historical data are complemented by programmes like EMODnet.

In general, the quality of the results obtained depends on how often it is measured – i.e. that the error decreases when the number of observations increases. It is however different requirements for preparation level, geographical coverage, number of stations and frequency depending on the different issues, measurement parameters and the area complexity. For example, one or a few times a year is enough to look at the changes in the deep ocean but there are however large claims to the accuracy of the observations. In comparison, the coastal areas needs to be measured substantially more often in order to capture the variability in coastal waters, but the required accuracy can often be less here. Where the frequencies of measurements are already high, increased efforts yield little profit but improved methodology can further reduce the uncertainty of the obtained data (Figure 1). Over time the measurement methodology also changed with more advanced instruments which must be taken into account when current monitoring will be evaluated. In addition, climate change involves new challenges, i.e. the warming effect is followed by larger ice-free waters opening new grazing areas to fish, northward movement of warmer plankton species, introduction of new species of plankton, etc. This type of change means that one must consider the monitoring, coverage areas, parameters and frequency in order to follow them up.

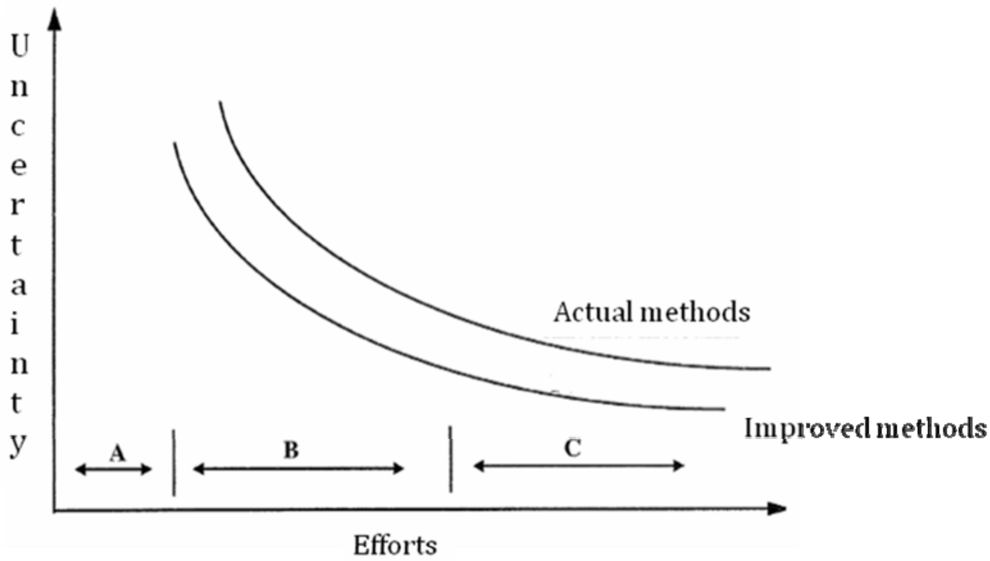


**Figure 1:** The relationship between uncertainty and bias errors and efforts (monitoring frequency, amount of samples). A: Area where the risks and stakes are too small to provide targets for precision or error, B: Area where precision is increasing rapidly (the error decreases) with increasing effort, C: Area where one must / should consider methods if greater precision to achieve. Adapted from Ottersen et al (1998).

For the monitoring strategy of the marine environment one can define key overarching issues, which should be expressed in information needs on indicators by science–policy interactions. These indicators are relevant for the monitoring of the status of the marine environment today and topics that will be important in the years to come. Table 1 provides an overview of these overarching issues for the specific regions covered.

The main aim for this report is to provide an overview of the main challenges the existing observational systems are facing to provide an integrated status of the marine environment and to identify knowledge gaps, which are leading to recommendations to bridge these gaps within the coming years. The overview will be provided for the regional Alliances of EuroGOOS respectively systems that act as Alliances i.e. the Arctic ROOS, NOOS, BOOS, IBIROOS, MONGOOS and Black Sea GOOS.

# 4. User reguirements and developments

The various drivers for the development of coastal and marine observational networks are related to a number of challenges and opportunities:

- Implementing the ecosystem approach (Common Fisheries Policy and Marine Strategy Framework Directive)
- Sustainable exploitation of the natural coastal and marine resources (Fisheries, Oil and gas, sand extraction)
- Reducing Europe's carbon footprint (change to renewable energy sources, Off-shore wind parks)
- Responding to threads and emergencies (coastal flooding, harmful algae blooms)
- Socially inclusive growth (information society, coastal tourism, more jobs)

An overview of areas of benefit, product lines and the specific users is given in Table1. It is to be expected that the use of the coastal zone and adjacent seas and ocean will increase in the coming decades. The human pressure in coastal areas is already high, but it will increase. Nowadays, more than half of the world population lives close to the sea and most of the mega-cities are spread out along the coastline.

Human activity can be divided into coastal landscape interventions, extraction of matter (e.g. fish, sand, gravel) and energy (e.g. heating and cooling of houses) and input of matter (chemical compounds as nutrients and contaminants) and energy. Of importance is not only the protection against undesired impact of anthropogenic use on the coastal zone but also the protection of people, property and economical infrastructure along the coastline must be protected against the rising sea level coastal flooding and poor water quality.

Scientific knowledge of various aspects of the coastal zone ecosystem is necessary to make optimal sustainable use of the ecosystem services and to protect safeguard coastal and marine ecosystems form further decay. In addition, it is necessary to monitor the impact of measures to improve the ecosystem quality. A way to collect scientific knowledge and information on developments of coastal ecosystems is by observatories and integrated basin-wide monitoring networks...

The various user groups will have different user requirements. The users of data from observational networks can be split roughly be split at three levels:

- **Policy level**: Local, National authorities responsible for early warning and emergency response (storm surge, toxic algae bloom) and periodic reporting on state of the environment (OSPAR, MSFD, Compliance checking and new indictors).

- **Operational level**: Information services for a broad part of the society from general public (being informed about their coastal waters or leisure's opportunities), Companies as service providers, which are active in producing information services based on NRT-data and commercial users in their operations at sea, depending on reliable information about MetOcean conditions.

- **Knowledge level**: Scientific users are developing knowledge on the coastal and marine processes and are building models for analysis of the behaviour of the system and forecast of environmental changes and predict impact of measures. Marine R&D Institutes having responsibilities under contract from local governments to operate services or advice on future policies, related to i.e. climate change or anthropogenic impacts.

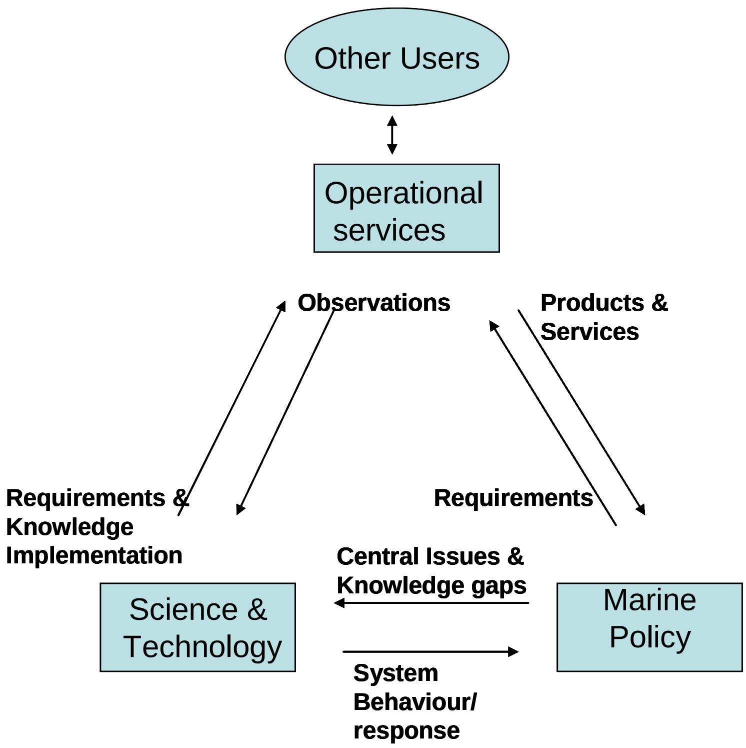


**Figure 2:** Overview of relevant relations between various levels of users of observational data.

*Table 1 A generic summary of areas of benefit, product lines, intermediate and final users*

| Area of benefit | Products | To intermediate users[a] | Final user |
|---|---|---|---|
| Climate research | Comprehensive and inferred observational data sets reanalysed in state of the art models | Climate research centres | Ocean and climate research; validation of scenarios. Policy-making on climate change |
| Marine Environmental Protection | State and impact data and associated indicators | EEA, OSPAR, HELCOM, Barcelona, National environmental agencies | DG ENV, Policy makers, general public |
| Seasonal forecasting and extended weather forecasts | Initial ocean conditions; reanalysis | ECMWF, National Meteorological Services (NMS) | Agriculture, insurance, energy, transport; public safety preparedness; research |
| Marine safety | High resolution ice/sea state and ocean current forecasts | NMSs, National Oceanographic Agencies, National Marine safety agencies, maritime transport industry | Search and rescue, drifting object management; extreme wave forecast preparation; marine transportation |
| Fisheries, ecosystems | Physical conditions; re-analysis of past conditions | National marine and fisheries institutes | ICES, DG FISH, National fisheries; research |
| Shipping and offshore industries | High resolution ice/sea-state and current forecasts for operations: reanalyses for design | Value adding service companies | Operation support, ship routing, structure design criteria, risk assessment; EMSA |
| Oil Spill management | Temperature, wind, wave and current data | Responsible National marine agencies and European Marine Safety Agency (EMSA) | Affected coastal public authorities and businesses |
| Civil Security | Temperature, wind, wave and current data | Customs and Excise, Coast Guards | DG TREN, Immigration and drug control agencies, police forces |
| Marine Environment, Ecosystems | Boundary and initial conditions, data products | National Coastal monitoring and forecasting system | National environmental or marine agencies; National WFD reporting; Coastal management. |

## 4.1. Monitoring network design (Developments)

Operational oceanography is defined as ‘systematic and long term routine measurements of the seas and oceans and atmosphere, and the rapid interpretation and dissemination of information’. Observations as element of the information chain do imply requirements with respect to data analysis and data-assimilation, data-management and dissemination in services, products and reporting.

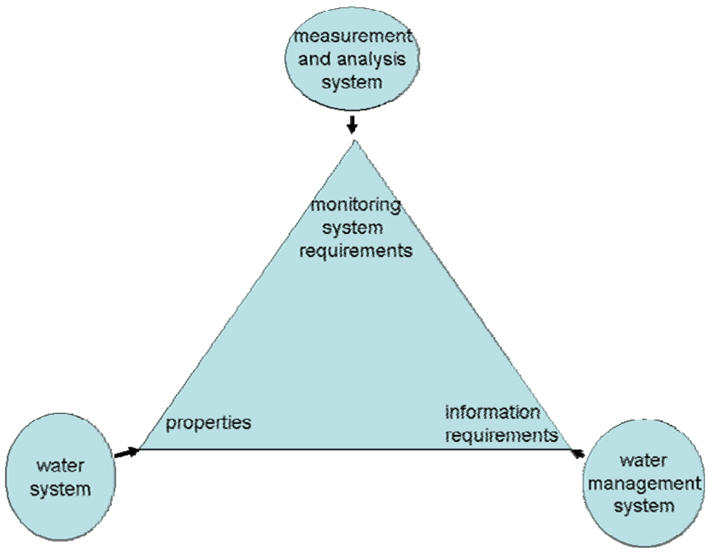


**Figure 3:** Overview of aspects of system knowledge, information and management of the coastal and marine system.

However, monitoring is not as static as it looks. The developments can be connected to aspects indicated in the scheme of Figure 3. For instance: an adaptation or a change in the routine procedure can be induced by:

- new policy or management approaches; for example the monitoring strategy for the Dutch coastal zone moved from national to international (e.g., WFD, MSFD),
- financial constrains,
- decreasing concentrations, targets are (nearly) reached,
- new statistical techniques to design monitoring network; (e.g., data model integration, data assimilation),
- new scientific and technological developments; for instance new system knowledge from the existing monitoring data, new sensors (e.g., Smart Moorings, Ferryboxes, Remote Sensing)

### 4.2. Requirements from International Conventions and EU-Directives/legislations

The Water Framework Directive (WFD) is particularly relevant as it provides the framework of the management of coastal waters (and even partly territorial waters in the EU)
MSFD and associated Regional Seas Conventions (i.e. OSPAR, HELCOM) have defined more specific objectives (see JRC-report:

a. undertake and publish at regular intervals joint assessments of the quality status of the marine environment and of its development, for the maritime area or for regions or sub-regions thereof;

b. include in such assessments both an evaluation of the effectiveness of the measures taken and planned for the protection of the marine environment and the identification of priorities for action.

The Directive includes a set of monitoring requirements that aim at ensuring that an ongoing assessment of these elements can take place. The monitoring programmes set up by the Member States, on the basis of the MSFD, will provide the data necessary for updating management measures to achieve GES by 2020.

**Assessment and monitoring** (ref MSFD-Article 11)

MSFD requires Member States to carry out an initial assessment of their marine waters in 2012 and again in 2018, following the principle of adaptive management. This initial assessment allows keeping track of the state of the marine environment, including all pressures and impacts. This requirement for Member States to make an assessment of their marine waters implements similar obligations at the international level. For instance, Agenda 21, Convention on Biological Diversity and Common Fisheries

The MSFD requires Member States to establish coordinated monitoring programmes, which aim to ensure the systematic observation of the state of the environment. These programmes should therefore cover all the different thematic and geographical marine areas defined under the scope of the MSFD. Article 11 specifies that Member States should monitor in particular the specific elements mentioned in Annex V. In addition to providing information on the different elements of the marine strategies (initial assessment, GES, environmental targets and associated indicators, etc.), monitoring programmes should provide information on, *inter alia*, chemical contaminants in species for human consumption from commercial fishing areas, on human activities to identify what corrective measures are needed to achieve or restore good environmental status and ensure that they do not have negative side effects or on major changes in the environmental conditions and new and emerging issues.

Ref.: EU-ENV-Study on the contribution of the Marine Strategy- Framework Directive to existing international obligations- April 2012

### 4.3. User requirements based on central issues

From the inventory along the regional alliances an overview of central issues has been gathered in Table 2. The central issues are crucial in understanding the system behaviour under climate change or response to human activities.

Table 2: Overview over central issues that are important to monitor for getting holistic information on the status of the marine environment.

| **Arctic ROOS** | **NOOS** | **BOOS** | **IBIROOS** | **MONGOOS** | **Black Sea GOOS** |
|---|---|---|---|---|---|
| Climate Change | Climate Change | Climate Change | Climate Change | Climate Change | Climate Change |
| Water masses distribution | | Water masses distribution | Water masses distribution | Water masses distribution | Water masses distribution |
| | Water transport | Water transport | | Water transport | Water transport |
| | Water exchange | Water exchange | | Water exchange | Water exchange |
| Mixed Layer | Mixed Layer | Mixed Layer | Mixed Layer | Mixed Layer | Mixed Layer |
| Acidification | Acidification | Acidification | Acidification | Acidification | Acidification |
| Model validation | Model validation | Model validation | Model validation | Model validation | Model validation |
| Production basis | Production basis | Production basis | Production basis | Production basis | Production basis |
| Biodiversity | Biodiversity | Biodiversity | Biodiversity | Biodiversity | Biodiversity |
| Climate effects | Climate effects | Climate effects | Climate effects | Climate effects | Climate effects |
| | Eutrophication | Eutrophication | | Eutrophication | Eutrophication |
| | Harmful algae | Harmful algae | Harmful algae | Harmful algae | |
| Alien species | Alien species | Alien species | Alien species | Alien species | Alien species |
| Management plan; MSFD | Management plan; MSFD | Management plan; MSFD | Management plan; MSFD | Management plan; MSFD | Management plan; MSFD |

# 5. Development of InSitu observing systems in the Arctic ROOS region

The Arctic ROOS region covers the high latitudinal Oceans north of 62 N. A group of 16 partner's institutes collaborate within the Arctic ROOS community providing operational services and scientific data from the observational system. Overall, the Arctic ROOS area is severely under sampled regarding In Situ observations. A major part of the observatory is conducted in annual or biannual cruises. In addition to servicing the moorings, the cruises are important for obtaining high resolution hydrography both in the horizontal and vertical. Water samples taken on the cruises are providing stable oxygen isotope ratios and nitrate to phosphate ratios are supplementing the permanently installed instrumentation. In addition, work on the sea ice (ice thicknesses, snow depth, radiative properties) supplements the observations made from the upward looking sonars on the moorings. A detailed overview of the Arctic In Situ observing system provided by the Arctic ROOS can be found in Deliverable D-2.1 Report on existing observation network from all ROOSs. For the monitoring of the marine environment one can define key overarching issues that are relevant for the monitoring of the status of the marine environment today and topics that will be important in the years to come. Table 1 provides an overview of these overarching issues for the specific regions covered.

The Arctic region is the region experiencing the most dramatic changes and transformations trough the influence of the climatic changes occurring recently an which are expected to impact the higher latitudes even more in the upcoming years.

The opening up of areas that until recently have been almost inaccessible for commercial activities is a major development following the retreat of the sea ice. These changes in ocean climate and ice regime are likely to be followed by changes in the Arctic Ocean ecosystem.

There is a need of quantitative knowledge regarding processes and energy flow at lower trophic levels (phytoplankton/micro zooplankton, zooplankton and zoobenthos) to higher trophic levels (e.g., fish, sea mammals).

Increased human activity including ship traffic in the now openly accessible areas of the Arctic entails a high risk for introducing alien species from remote areas, causing bio invasion hazards to the ecosystem. The increasing exploitation of petroleum resources in the Arctic is very likely to have a potential impact on the development in the Arctic marine environment. Moreover, the Arctic Ocean is also the most vulnerable to the effect of increased CO2-levels because of the high solubility of CO2 in cold waters.

These potential changes in the environment make it necessary to evolve the observational system accordingly. Dedicated baseline studies are recommended to get improved knowledge of potential impacts of the expected changes within the Arctic Region.

The changes within the Arctic region are expected to be dramatically.
Primary production will increase by up to 60 g C $m^2$ $year^{-1}$ in today seasonally ice-covered zones. Mesozoo plankton productivity is expected to increase over the entire Arctic Ocean, but boreal forms may not be able to penetrate into the Arctic Ocean and reproduce there.
Due to the thinning of the ice, the significance of ice algae for the total primary production of the Arctic Ocean may increase in the central Arctic Ocean, but decrease in the outer seasonal ice-covered zones. The blooms of ice and plankton algae will stretch over longer periods of time.

A shift in the community composition towards smaller phyto- and zooplankton forms is expected due to the freshening of the Arctic Ocean, nutrient limitation and a prolonged growing season.
A long-term monitoring program for the Arctic Ocean should be established in order to observe the changes in the physical and chemical environment and to assess the impact of these changes on the ecosystem.

This program will have to reflect the seasonal fluctuation of sea ice in the area, since access will partly be limited to the summer/autumn period when sea ice coverage is at its minimum.

In order to get an improved knowledge the sampling frequency of the regional surveys should be increased aiming for an at least seasonal coverage.

Focal point of the future monitoring should include:

- Seasonal Oceanography and habitat mapping
- Sympagic community mapping during the regional surveys
- Pelagic community mapping
- Demersal community mapping

The uncertainties in the impact of the expected changes in the marine environment should be decreased by research efforts that are focusing on the following main topics:

- To estimate vital rates and parameters that are important for the functioning of the present Arctic Ocean ecosystem

- To evaluate the impact of changes in productivity and whether any such changes might result in restructuring of the Arctic marine ecosystem.

- To investigate the interplay between the Arctic Ocean and the shallow shelves.

- Evaluate environmental risks of human activities.

# 6. Development of In situ observing systems in the NOOS region

The NOOS region covers the extended North Sea region and European North west Shelf. NOOS is operated by the 9 bordering countries and 24 partner institutes cooperate for the provision of operational Oceanography services within the region.
The observational system consists of multiplatform real time observing system that is composed mainly by Drifters, Tide gauges/Moorings and Argo observations.
Ships of Opportunity and some Research vessel activity as well as HF radar systems complementing the real time data delivery system. Hereby especially the coverage of the In Situ observation system in terms of directs current measurements is subject for improvement.

A detailed overview of the NOOS In Situ observing system provided by the NOOS can be found in Deliverable D-2.1 Report on existing observation network from all ROOSs. For the monitoring of the marine environment one can define key overarching issues that are relevant for the monitoring of the status of the marine environment today and topics that will be important in the years to come.

Sustainability of the existing observational system is one of the key challenges for the NOOS region.
For the NOOS area the key overarching issues that are and will be important for obtaining knowledge about actual state of the environment are displayed in Table 1.
Depending on the extent to which one wishes to prioritize the specific issues the future monitoring program will be affected. The marine environment changes throughout the years as a result of both local and external influences, and phytoplankton and zooplankton undergo a succession governed by the chemical and physical conditions.
Table 3 is providing an overview of the important periods for the specific issues that should be covered by a monitoring program. Inclusion of many issues or parameters will be followed be a need for a greater focus on the frequency and timing of the monitoring coverage. There will be periods within the year for the various monitoring elements which are more important than data collection in other periods.

Already in place are all physical parameters (i.e. storm surge, flood-related, coastal protection, transport and drift, support of off shore oil and gas industry)

**Table 3:** Overview over important periods for central issues. Crosses reflect periods where monitoring is recommended. Crosses in parenthesis reflects periods of minor importance for the specific parameter

| | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Nutrients** | | | | | | | | | | | | |
| Production basis (abiotic) | x | x | x | x | x | | | x | x | | | |
| Eutrophication | x | x | | | x | x | x | x | | | | |
| Longtransport vs. local impact | | | (x) | x | x | x | x | | | | | |
| Oxygen(bottom water) | x | x | | | | | x | x | x | x | | |
| Management plan | x | x | | x | x | x | x | x | | | | |
| Nutrient dynamic | x | x | x | x | x | x | | x | x | x | | |
| Acidification (DIC) | x | | | x | | | | x | | x | | |
| | | | | | | | | | | | | |
| **Physical oceanography** | J | F | M | A | M | J | J | A | S | O | N | D |
| Transport | | x | x | x | x | x | x | x | x | x | (x) | |
| Ventilation | | x | x | x | (x) | | | x | x | x | (x) | |
| Mixed layer/ stability | | (x) | x | x | x | (x) | (x) | (x) | x | x | x | |
| Climate effects | | x | x | x | x | x | x | x | x | x | x | |
| Model validation | x | x | x | x | x | x | x | x | x | x | x | X |
| **Phytoplankton** | J | F | M | A | M | J | J | A | S | O | N | D |
| Production basis/ Primary Production | | X | x | x | x | x | x | x | x | x | | |
| Biodiversity | | (x) | x | x | x | x | x | x | x | (x) | | |
| Climate effects | | | (x) | x | x | x | x | x | x | x | x | |
| Eutrophication/environmental status | | X | x | x | x | x | x | x | x | x | | |
| Harmful algae/ blooms | | | x | x | x | x | x | x | x | (x) | | |
| Alien Species | | | x | x | x | x | x | x | x | x | x | |
| Management plan | | X | x | x | x | x | | x | x | x | | |
| | | | | | | | | | | | | |
| **Zooplankton** | J | F | M | A | M | J | J | A | S | O | N | D |
| Production basis/Primary production | x | | x | x | x | x | x | x | x | (x) | | |
| Biodiversity | | | x | x | x | x | x | x | x | | | |
| Climate effects | | | x | x | x | x | x | x | x | | | |

Furthermore NOOS has a strong need for observational data for forecasting models concerning freshwater input from rivers that is still an issue to be improved for the more reliable prediction of the coastal ocean at high resolution in order to serve the public and users with detailed information where the demand is highest. In addition, numerical prediction of ocean bio-geochemistry is a growing activity.

There is the following issue to be addressed:

Improvement of the accessing possibilities and making use of freshwater flux and nutrient/contaminant concentration observations

# 7. Development of In situ observing systems in the BOOS region

The BOOS region covers the entire Baltic Sea region. 20 partner institutes cooperate for the provision of operational Oceanography services within the region. The observational system consists mainly of tide gauges and moored buoys/fixed platforms providing real time observations.
Ships of Opportunity and some Research vessel activity complementing the real time data delivery system. It is obvious that the BOOS real time observational system is mainly based on Tide gauges and moored systems/buoys, a consequence of the deep financial crisis in the Baltic within the 1990´s which was followed by a large reduction of Vessel based observational efforts. . An detailed overview of the Baltic In Situ observing system provided by the BOOS can be found in Deliverable D-2.1 Report on existing observation network from all ROOSs. For the monitoring of the marine environment one can define key overarching issues that are relevant for the monitoring of the status of the marine environment today and topics that will be important in the years to come. Table 1 provides an overview of these overarching issues for the specific regions covered.

The existing observational system serves the main needs of the actual Marine Forecasting system. However the observational system should be improved in order to reduce the uncertainty of the knowledge obtained. Hereby the BOOS community identifies the following main issues that are subject for improvement of the observational system for the BOOS area within the actual environmental status:

- Ferrybox network – The existing Ferrybox network should be expanded
- Establishment of additionally at least one fixed platform in every basin of the Baltic with near real time measurements in the water column for temperature, salinity, waves, currents, oxygen, nutrients, fluorescence and meteorological parameters
- Near real time current measurements in the Belts and the Sound
- Extension of the Water level measurement network especially in the Southern Baltic and Gotland (Visby) region
- Development of a reliable Real time data transmission system from research vessels

There is a need to improve the in-situ observing system to achieve an appropriate and comprehensive understanding of the functioning of the marine environment and the monitoring of marine and maritime activities to ensure their sustainable development. Key priority in order to implement EU legislations such as the Marine Strategy Framework Directive, the Common Fisheries Policy, as well to improve the ability to monitor the effect of climatic variability the BOOS community has identified the major issues to improve the observational system for the Baltic Sea:

- Stable long-time series multiparameter bottom network for the monitoring of climate variability. For this purpose the long term stability for the variables temperature, salinity and possibly oxygen should be improved
- Improvement of the monitoring system that covers the variability in the biogeochemical variables in order to improve the ability to serve the Baltic Sea Regional Strategy
- Establishment of monitoring capacity to investigate the adaptation of the ecosystem to changed climatic conditions is necessary to fulfil the needs of the marine spatial planning activities ongoing within the BOOS region. That makes it necessary to obtain more detailed basic information for decision making at local as well as at regional scales.

# 8. Development of In situ observing systems in the IBIROOS region

The IBIROOS region extends along the Atlantic front of Europe, covering from the Irish Sea to the most southern Iberian region. 17 partners cooperate for the provision of Operational Oceanography services within the region. The observational system consists of a multiplatform real time observing system currently composed basically of Drifter, Tidal gauge/Mooring, vessel and Argo floats observations. Observations provided by Ferryboxes, Gliders and Fishing vessels as well as HF radar systems are complementing the observational program.

A detailed overview of the IBIROOS In Situ observing system provided by IBIROOS can be found in Deliverable D-2.1 “Report on existing observation network from all ROOSs”. For the monitoring of the marine environment one can define key overarching issues that are relevant for the monitoring of the status of the marine environment today and topics that will be important in the years to come. Table 1 provides a general overview of these overarching issues for the specific regions covered.

The IBIROOS region focuses an important European challenge consisting in developing a Maritime Strategy for the Atlantic Ocean Region (European Commission, Nov. 2011, Communication from the Commission to the European Parliament, the Council, the European economic and social Committee and the Committee of the regions). The challenges and opportunities facing the Atlantic Ocean area can be grouped within five themes. All will contribute to the overriding objective of creating sustainable jobs and growth:

- Implementing the ecosystem approach
- Reducing Europe's carbon footprint
- Sustainable exploitation of the Atlantic seafloor's natural resources
- Responding to threats and emergencies
- Socially inclusive growth

The **ecosystem approach** is the basis for marine management in both the Common Fisheries Policy and the Marine Strategy Framework Directive.

The Common Fisheries Policy proposes to manage the stocks so as to achieve maximum sustainable yield, whilst preserving goods and services from living aquatic resources for present and future generations. Single species management must make way for multi-species long-term plans that take into account the wider ecosystem.

The International Council for the Exploration of the Sea (ICES) Working Group on Operational Oceanographic products for Fisheries and Environment (WGOOFE) provides an interesting interface between the users of operational oceanographic data products and their providers. A potential mismatch between user requirements and the perception of requirements by the providers has been identified through a questionnaire (Berx et al. 2011). Temperature, Currents and Salinity were the first variables required, the latter unexpected. The ranking near the top of the list of biophysical products suggests that researchers also need integrated coupled analysis from chemical and biological oceanography. Moreover, researchers in fisheries and environmental science indicate that they need high-quality time series (historic data) that are regularly updated and flexible in terms of spatial and temporal limits and resolutions, more than they need real-time and short-term forecasts.

Another important driver is the Marine Strategy Framework Directive that aims to maintain or restore the correct functioning of marine ecosystems (preservation of biodiversity, correct interactions between species and their habitats, dynamic and productive oceans) whilst ensuring the sustainable use of the sea for future generations. The development of in situ observing systems should contribute, together with other technologies like remote sensing or numerical models, to monitor the achievement of the Good Environmental Status. Authors have mentioned the technological opportunities in marine observations arisen from marine environmental legislation (Borja, 2011). Currently a Working Group of IBIROOS is working on improving the design of new potential OO products for the MSFD accomplishment.

Finally, opportunities from new activities in coastal areas should need this ecosystem approach and thus, drive the development of networks. While continuing research, new technologies and innovative engineering will allow the industry of aquaculture to move further offshore, the sharing of space with other infrastructures, such as wind turbine platforms, is an opportunity. The strategy must therefore promote spatial planning as a tool for implementing the ecosystem approach in the Atlantic Ocean Region.

The second challenge deals with **reducing Europe's carbon footprint**. Wind turbines are included in EU's Strategic Energy Plan and already moving offshore in order to benefit from stronger winds and reduced landscape impact. The expansion of offshore wind farms in the Atlantic will offer key industrial opportunities for the ports that service them. By 2020, around 20% of the European offshore wind installed capacity could be located in the Atlantic basin.

These offshore wind farms will need coastal operational oceanography products to optimize the management of operations in a very competitive energy market. They will also need contingency plans that include drift forecasts based on a satisfactory surface current pattern characterization. This target skill will also contribute to optimize the routing of maritime transport, another element of the carbon footprint reduction strategy.

The EU needs to be prepared for **threats and emergencies** in the Atlantic, whether they are caused by accidents, natural disasters or criminal activity. The adoption of important legislative measures on maritime safety has reduced the risk of shipping accidents. However accidents can still happen and the Atlantic seaboard remains vulnerable to natural events such as the storms which struck the Vendée in 2010. The changing climate added to other human impacts on the sea, means that past behaviour may not be a guide for the future. The trends for extreme events should be considered in the roadmap of the Observing Systems.

The first hours in a crisis are vital. Early warnings require continuous monitoring of the sea and fast transmission of information. To improve the reliability of warning systems and behaviour monitoring and forecasting tools (like for surface transport) are strategic for efficiency of response actions.

The opportunities for growing and creating jobs in the Atlantic coastal area should be built looking for transfer of expertise between the traditional maritime sectors and careers, and the rising ones. Collaboration of maritime sectors in developing the observing system, communication and training on the use of the available data and products, are important to ensure the transfer between generation and sectors of activity, and to achieve a **socially inclusive growth**.

The evolution of each kind of observing platforms and the development of emerging networks should be driven by the earlier mentioned drivers.

The application of Argo buoy methodology is at a mature state and only the inclusion of biogeochemical parameters is recommended to be considered. The positive first experiences with the implementation of Oxygen sensors will encourage these evolutions.

Concerning the development of the Moored Buoys network, one main challenge identified for the IBIROOS area is also the provision of biogeochemical data, only marginally provided and lacking on most of the arrays. New technological solutions for reducing maintenance needs and clear advices on sensors selection are mandatory. The current coastal network is dense but still not homogeneous along the Atlantic coast. A better coordination at IBIROOS level for key identified platforms should be pushed.

Concerning the Tidal gauge network the IBIROOS area has mostly reached the final configuration. A few areas vulnerable to flooding have been identified to be equipped with Tide gauges in order to enable reduction on uncertainties for early warning system. An outstanding issue is the implementation of new transmission technology in parts of the Gauge network to minimize the delay in data transmission. Moreover, for climate purposes, geodynamics laboratories have been proposed to complete key tidal gauge stations as high precision level references.

The application of HF Radars is aimed to be intensified. Networking within the data providers' community should be pushed. A joint effort to homogenize the acquisition and exploitation procedures of the HF Radar data is needed. This development should contribute to a better characterization of the water surface dynamics and to increase the accuracy of forecasting tools.

The possibility of operating gliders on a routine mode in the IBI area will be studied. Past experiences from other regions will be transferred.

The application of Ferrybox methodology is still an opportunity for some partner institutes. Moreover in 2012 a large amount of fishing vessels have been equipped within the frame of the RECOPESCA activities. These ships of opportunity should contribute to improve the collaboration within some maritime sectors.

Effort will have still to be put on the Near-real time communication for Oceanographic Research Vessels as providers of key variables (i.e. from CTDs) for data assimilation.

Table 4 The main priorities have been crossed with the different drivers:

| DEFINING PRIORITIES | Implementing the ecosystem approach | Reducing Europe's carbon footprint | Responding to threats and emergencies | Socially inclusive growth |
|---|---|---|---|---|
| Geochemical sensors integration (Argo, Fixed platforms, gliders) | X | | X | |
| Coastal circulation pattern monitoring<br>HF Radars network & key moorings | X | X | X | |
| S&T NRT data from Ferrybox, Fishing vessels, Oceanographic vessels | X | | X | X |
| Tidal gauge network optimization | | | X | |

As for the other European water regions the sustainability of the existing observational system is one of the main challenges facing the partners within the IBIROOS region. Coastal observing system sustainability should be pushed through a better collaboration framework between actors of core and downstream services, aiming to reach a general coherent system in which the levels of founding (Regional, National and European) are clarified and complementary.

# 9. Development of In situ observing systems in the MONGOOS region

The MONGOOS region covers the whole Mediterranean Sea. 32 partners collaborate for the provision of operational Oceanography services. The observational system consists of multiplatform real time observing system that is composed by a Ship Of Opportunity Program (SOOP), moored buoys, so-called Mediterranean Multi- sensor Moored Array (M3A), ARGO buoys Gliders and an EMSO multiparametric deep seafloor observation node. These system is complemented by the near coastal national monitoring arrays that are mainly providing wave, surface meteorological parameters, sea level monitoring completed by coastal mooring providing meteorological measurements and physical-chemical-biological data in coastal areas and HF-radars. A detailed overview of the Mediterranean In Situ observing system provided by the MONGOOS can be found in Deliverable D-2.1 Report on existing observation network from all ROOSs. For the monitoring of the marine environment one can define key overarching issues that are relevant for the monitoring of the status of the marine environment today and topics that will be important in the years to come. Table 1 provides an overview of these overarching issues for the specific regions covered.

One of the major challenges for the MONGOOS region is the sustainability of the established observation system. The ocean observatories established within MONGOOS are at locations that are expected to be the key ocean areas important for the variability in the Mediterranean Sea. Substantial funding has been provided by member states to support the operational costs. However, the long term existence is not assured by the present economical situation.

One first gap in the Mediterranean observing system is the lack of information along the African coasts, and MONGOOS recognizes it as one of the main priorities for the future years. The major technological gap regarding the in situ observational data provision in the MONGOOS, is the lack of biochemical data that is available in near real time for the assimilation into the ecosystem forecasting models and/or for the evaluation of the provided forecasts. This needs the evolvement of a biogeochemical observation program that provides near real time data for the whole Sea. The development of an observational approach combining the methodologies of the Ferryboxes with the Continuous Plankton recorder system is expected to be a first step to becoming the observational system improved.

Furthermore the application of Argo Buoys equipped with biogeochemical sensors would improve the situation. This is recommended to be complemented by establishment of Glider lines covered by Gliders that include the sensors for the ecosystem parameters.

Additionally there is a need to extend respectively upgrade the existing observational system in order to get an improved knowledge of the variability within the Mediterranean Sea. This extension includes:

- the complete evolution of the SOOP lines in VOS&SOOP in order to have meteorological information in all the basin;
- the provision of a minimum number of XBTs to assure the coverage of all Mediterranean sub/basins;
- the major integration of gliders observations in a coherent vision of Mediterranean observatories;
- the provision of the minimum number of ARGO to assure the minimum requirements of the MedARGO programme;
- The establishment and operation of other EMSO nodes in Mediterranean e.g., Marmara Sea, Hellenic Arc, Ligurian Sea and Gulf of Cadiz
- The harmonisation of the coastal observatories with the large scale observing systems

# 10. Development of In situ observing systems in the BLACK SEA GOOS region

Within the Black Sea region the main focus for monitoring the status of the marine environment is laid on collecting data from mainly coastal stations and through scientific cruises. Most of these data are included in databases and are available on the internet. Due to the financial breakdown the amount of observational data available for the Black Sea region decreased dramatically because of the largely reduced number of scientific vessels and cruises. A detailed overview of the Black Sea In Situ observing system provided by the Black Sea GOOS can be found in Deliverable D-2.1 Report on existing observation network from all ROOSs. For the monitoring of the marine environment one can define key overarching issues that are relevant for the monitoring of the status of the marine environment today and topics that will be important in the years to come. Table 1 provides an overview of these overarching issues for the specific regions covered.

At present, the Black Sea is the least monitored and scientifically studied system among the European Seas. Therefore monitoring and understanding its circulation and thermohaline structure and its control on transport and dispersion of biogeochemical properties are a strong priority.

The main challenge for the Black Sea region is the sustainability of the InSitu observation system. While coastal stations are supported by National Met Offices or Governmental Agencies on a routine basis, most of them do not provide real time data. Additionally some coastal stations are supported by Research institutes but are very vulnerable because of unsecured availability of national funding.

There is a severe lack of physical and biogeochemical observations in open sea to monitor changes of the basin stratification and seasonal variability of the upper layer. Observations of the ecosystem parameters are carried out regularly only in the coastal zone. Operational monitoring of the coastal zone is very restricted. Additionally the observational network for the measurement of Sea level is only marginal and not coordinated.

The main issue for improving the Black Sea observational system is to increase the number of available observations. According to Figure 1 will that increase be the most effective way to improve the reliability of the observational system. The Observation System Simulation experiments (OSSE) as they are conducted within Workpackage 9 could help identifying the most important positions to cover the main circulation patterns within the Black Sea region.

The general goal is to build and maintain Basin scale in-situ observing system, which will consist of coastal, shelf and deep sea components. These observing systems should consist of:

- Coastal observatories: meteorological stations, oceanographic stations, sea level stations; HF radar systems
- Shelf moored or fixed platforms and deep sea observatories;
- Vessels: Research vessels, small vessels, SOOP, VOS, FerryBox;
- Coordinated basin-scale multi-national surveys by research vessels.
- Autonomous instruments: Argo buoys, Drifters, Gliders

The installation of the same costal observatory which will consist of a Weather station, oceanographic station and sea level station in each Black Sea country is reasonable. The resulting network of six observatories will be equipped with the same instruments and connected to In-situ TAC to provide real time data.

Near future aim for the improvement of the observational system is to:

Install Ferrybox systems equipped with physical and biogeochemical sensors on at least two lines crossing the open Black Sea and establishing an XBT measurement program for these two lines

Deployment of annually 5 Argo Buoys to monitor the vertical structure of the Black Sea region. These Buoys should be equipped with biogeochemical sensors improving the very large scarcity of biogeochemical measurements and complementary 5 surface drifters should be launched every year to cover upper layer dynamics.

Evolvement of two Glider sections through the Black Sea is highly desirable.

Establishment of seasonal multidisciplinary basin-scale surveys covering the whole Black Sea region

Installation of HF radar systems to improve the knowledge of the circulation pattern is highly desirable

# 11. Risks and opportunities

**Risks**

With streams of new monitoring stations going live on or near Europe's shores in recent years, details of the evolution of physical and biological parameters are increasingly abundant. However, coastal monitoring initiatives are usually set up by countries or regions acting in isolation, often as part of projects for which the funding will eventually run out — and their monitoring targets, technical set-up, operational practices and dissemination strategies can differ significantly

Recommendations for future research and developments should be based on risk assessment of the existing monitoring networks on technological as well as organizational aspects. The rapid change in technologies for monitoring systems, integration with modeling and for distribution of information offers a number of opportunities, which have to be taken into account. On the other hand the implementation of new methods in an operational environment, where continuity in long time series are a quality issue, needs better exchange of expertise and lessons learned from successful development. Risk of loss of continuity in long time series due to changes in the governmental or technical system must be covered by initiatives at EU-level.

In a non-extensive list of risks and threads for the building an EU-observational infrastructure we mention:

- lack of access to high quality information
- lack of shared ownership
- lack of budget to support or continue services and maintenance of the system, developed in projects
- lack of governance with respect to institutional setting at national and international level, funding mechanisms and innovations
- lack of adequate science-policy interface
- lack of thrust and willingness to invest in a shared system

A number of these problems are mentioned and explained in the ROOSes development reports (part V to X). Others are explained here.

**Lack of Governance:**

The Oceanographic society is often judged as difficult to control or not easy to harmonize (by the EU-Flora). However the developments are not limited to the research community only but also involves the changes in the political climate. National budget cuts do change the priorities in environmental research and sustainable implementation. How do we involve all oceanographic institutes and commercial organizations to be part of the EU-monitoring network or service provision?

The ROOS-communities have shown to be a good practice, but needs structural support of all governmental partners and additional funding for development (less depending on FP-funding structures).

The quality of the products and services at the end of the line are depending on responsibilities at a large number of organizations, companies or stakeholders from designing and planning the monitoring up to the reporting of analyzed data and results of assessment. To guarantee the quality the chain needs an institutional setting with relevant expertise, procedures, funding, Guidance on Quality Assessment. (See the Black Sea development report Part 10)

**Science policy interface**

The science community helps us in better understanding the marine and coastal processes, which is also a vital source of information for many decision- and policy-making processes. With streams of new monitoring stations going live on or near Europe’s shores in recent years, details of the evolution of physical and biological parameters are increasingly abundant.

Successful implementing of recent knowledge and relevant observations and modelling capabilities in decision- and policy making processes are depending on a number of aspects related to the science-policy interface:

- Matching of policy needs and available science
- Communication and dissemination
- Scope / culture differences
- Responsibility and ownership
- Funding
- Timing
- Legislation
- Knowledge and trust

**Opportunities**

Without a monitoring strategy the additional costs for development of new systems to cope with changing information needs from National or EU-policies will be higher at national scales. By joining forces and integrating National systems we are able to be more flexible (by redundancy) and cost effective by sharing knowledge on implementation (lessons learned).

Inter dependency between member states in providing trans-boundary information based on EU-Framework Directives monitoring and information requirements will help to build the integrated system at regional scales (i.e. See 'ROOSes). The demand driven information needs at the level of commercial and general public users will reduce the fragmented patchwork of regional, national, public and private observational activities.

Integration of EU-policies on Fisheries, R&D and Environment as well as other regulations on shipping, off shore activities, marine spatial planning will bring together different organizations with monitoring responsibilities.

# 12. Results and Recommendations

Common elements of the analysis from the overview of the Regional alliances (ROOS) leads to central issues gathered under Nutrients, Physical oceanology, Phytoplankton and zooplankton. More regional specific:

- Attention to functioning of present Artic Ocean ecosystem and with respect to climate change and expected change in productivity, human activities (Artic region)
- Attention to fresh water inflow and validation of forecasting models; sustainability of existing observational system and development towards to eco-system approach and MSFD-indicator needs and assessments (North Sea Region).
- Attention for the monitoring the climate variability, improvement of LT stability for T&S and oxygen along the water column (Baltic Sea Region)
- Attention to growth, and impact from extraction use of natural marine resources (Atlantic front of Europe IBIROOS–region)
- Attention to lack of data from African Coast, NRT biochemical data and integration of gliders in the common vision of the Mediterranean observations (Mediterranean Sea-MONGOOS)
- Attention to the overall lack of observation continues monitoring programs and system behavior studies. Building and maintaining a Basin scale in situ observing system based on best practices in other Regions has key priority (Black Sea GOOS region).

As results the focus can be Integration: Coastal observational systems are designed at National level based on state of the art in technology and knowledge of the coastal and marine processes.

A mechanism for international 'agreements' how these coastal observatories can be accepted as a node in an integrated system or a chain of systems at basis scale (ROOS-level) will create homogeneity and ease access to basin wide information. Relevant aspects are: long term perspective as data source, inter-operability.

**Bridging Research gaps:** The science-policy interface can be strengthened by a shared view of the central issues covering the threads of anthropogenic impacts on the ecosystem, climate change impacts, extreme events and long term changes in eco-system. This has to result into focus within research programs and investments in research infrastructure.

**Lack of available technologies:** This demand driven approach must however benefit from project based innovations, best practices and from companies offering commercial services.

Embrace national funded programs with emerging technological developments (i.e. COSYNA)

Exchange of experience on QA, file/data exchange, interoperability as shown in EU-projects and initiatives (MyOcean, Emodnet,..) to all National organization with monitoring responsibilities.

Balance the user requirements from science needs (i.e. system behavior and model validation) and the operational and policy information needs by a common information strategy.

**More Governance**:

How should ROOS's, MyOcean, SeaDataNet develop, when they are depending on National contributions? The ECOMF could be a way forward for modeling and forecast services.

For monitoring information we are depending on a level of trust and willingness between partners in the ROOS's. Additional funding from EU-FP's has been an important basis for developments.

Reducing heterogeneity in monitoring methodologies and systems at basin scale can be obtained by optimization of monitoring programs in effort and budget planning by sharing experience, using innovations and cooperation at regional basin scale.

Build structure in International reporting systems with National contributions

Use MSFD-requirements (EU-policies, (inter-) national legislation) and the related Member States -obligations to demonstrate the opportunities (indicator driven use cases) in harmonization, transnational cooperation,

Funding mechanisms and top-down initiatives (risks based decision making on improvements/investments) must stimulate coordination and mutual dependencies and shared responsibilities among all organizations for coastal and marine monitoring at regional basin scale.

# Annex A: International projects, organisations and networks

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| Dutch Wadden Academia | Has the ambition that the trilateral Wadden Sea is in 2020 the best monitored and best understood coastal area in the world. To reach this goal, the project WALTER has been set up. |
| CFP | Common Fisheries Policy |
| ECOOP | The goal of ECOOP is to build up a sustainable pan-European capacity in providing timely, quality assured marine service (including data, information products, knowledge and scientific advices) in European coastal-shelf seas. Special interest in: ecosystem models, HAB warning systems, oil spills and maritime ship route applications. |
| EDIOS | European Directory of the Initial Ocean-observing System. The EDIOS directory provides a new internet-based tool for searching information on observing systems operating repeatedly, regularly and routinely in European waters. The EDIOS directory contains metadata on European observing systems such as platforms, repeated ship-borne measurements, buoys, remote imagery, etc. EDIOS is an initiative of the European Global Ocean Observing System (EuroGOOS). |
| EEA | European Environmental Agency, http://www.eea.europa.eu/ |
| EID | The objective of EID (Environmental Information Directive (Anonymous, 2003a) is to ensure that environmental in formations is actively and progressively made available and disseminated to the public in the widest possible sense. |
| EIONET | EIONET (European Environmental Information and Observation Network, Anonymous, 2003b) is a data network of the EEA that aims to provide timely and quality assured data for the purpose of assessing the state of the environment in Europe and the pressure acting upon it. |
| EMECO | The European Marine Ecosystem Observatory (EMECO) is a consortium of European Marine Institutes that aims to integrate marine environmental monitoring, ecosystem modeling and coastal and ocean research to provide a holistic approach to improve |

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| | understanding of the status and predict future changes in ecosystem structure and function. |
| EMODNET | EMODNET was announced in the Green Paper of DG-MARE in 2006. This paper stresses that the future EU maritime policy should be based on sound knowledge. EMODNET's purpose is to improve and streamline the access to high quality marine data as well as to improve the usefulness of marine observations and the resulting marine data collected and held by European public and private bodies to European users for scientific, regulatory and commercial purposes. It should ensure that data is compiled in a comprehensive and harmonized system and made accessible as a support for better governance expansion of value-added services and sustainable marine development. |
| EMSA | European Maritime Safety Agency, *www.emsa.europa.eu* |
| EUROcean | Established by Portugal and France in the year of the ocean (1990) to contribute to the development of Marine European Research by implementing an operational online system to identify sources of information and to facilitate access to their use |
| EuroGOOS | European Global Ocean observing system, http://www.eurogoos.org/ |
| EUROSITES | Integrated European network of deep-ocean observatories, measuring variables from the surface to the sea floor. Enhancement of the development of more sophisticated sensors to increase the knowledge and to improve advise to policy makers and managers. |
| FerryBox | The European FerryBox Project. The major scientific issues of the project were to investigate eutrophication processes, stability and transport of water masses, transport of sediments |
| GEOHAB | Marine Geological and Biological Habitat Mapping is an international forum and is designed to maintain awareness to technological developments and surveys standards, identify existing metadata sources relevant to marine habitat mapping and to develop new thematic maps and to apply and to evaluate habitat classifications. |
| GEOSS | Global Earth Observation System of Systems seeks to connect the producers of environmental data and decision support tools with the end users with the aim to crate benefits by developing and |

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| | integrating observation platforms, data and services. |
| GLOSS | Global Sea Level Observing System. Program started by the IOZ (International Oceanographic Commission of the UNESCO) to provide oversight and coordination over regional projects and networks. |
| GMES/COPERNICUS | GMES (Global Monitoring for Environment and Security) seeks to provide services in support of the EU environmental and security policy. The intention is to promote the widest possible use and sharing of earth observation information in support of the monitoring of the state of the environment and its short and long-term evaluation. The information services are derived from in situ and space observations. The objectives of GMES is consistent with the aims of EMODNET. In the Blue Book it is stated that EMODNET should inter alia build on GMES (Anonymous, 2008b). |
| GODAE | GODEA (Global Ocean Data Assimilation Experiment) aimed at a global system of observations, communications, modeling and assimilation, that will deliver regular, comprehensive information on the state of the oceans, in a way that will promote and engender wide utility and availability of this resource for maximum benefit to the community. Data management will be continued in JCOMM (Joint Commission for Oceanography and Marine Meteorology). Close collaboration with IODE (International Oceanographic Data and Information Exchange of the UNESCO) and E2EDM (End to End Data Management). |
| GODAR | Global Oceanographic Data Archaeology and Rescue. The goal of GODAR was to increase the volume of historical oceanographic data available to climate change and other researchers by locating ocean profile and plankton data sets not yet in digital form, digitizing these data, and ensuring their submission to national data centres and the World Data Centre System. In addition, data on electronic media that are at risk of loss due to media degradation are also candidates for rescue. |
| HELCOM | Helsinki Commision, Baltic Marine Environment Protection Commision is an intergovernmental organisation of the nine Baltic coastal countries and the EU, protecting the marine environment from all sources of pollution |
| ICES | International Council for the Exploration of the Sea (ICES) |

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| | coordinates and promotes marine research on oceanography, the marine environment, the marine ecosystem, and on living marine resources in the North Atlantic. |
| IGBP | IGBP (International Geosphere-Biosphere Programme) research goals are to analyze the interactive physical, chemical and biological processes that define Earth System dynamics, the changes that are occurring in these dynamics and the role of human activities on these changes. |
| IMBER | IMBER project (Integrated Marine Biogeochemistry and Ecological Research) data management cookbook, important role of data manger and examples of how to handle information and data and standardized templates fro meta information. |
| INSPIRE | The INSPIRE (Infrastructure for Spatial Information in the European Community) directive came into force on 15 May 2007 and will be fully implemented by 2019.<br><br>The INSPIRE directive aims to create a European Union (EU) spatial data infrastructure. This will enable the sharing of environmental spatial information among public sector organizations and better facilitate public access to spatial information across Europe.<br><br>A European Spatial Data Infrastructure will assist in policy-making across boundaries. Therefore the spatial information considered under the directive is extensive and includes a great variety of topical and technical themes.<br><br>INSPIRE is based on a number of common principles:<br><br>• Data should be collected only once and kept where it can be maintained most effectively,<br><br>• It should be possible to combine seamless spatial information from different sources across Europe and share it with many users and applications,<br><br>• It should be possible for information collected at one level/scale to be shared with all levels/scales; detailed for thorough investigations, general for strategic purposes,<br><br>• Geographic information needed for good governance at all levels should be readily and transparently |

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| | available,<br>Easy to find what geographic information is available, how it can be used to meet a particular need, and under which conditions it can be acquired and used. |
| LOICZ | Land-Ocean Interactions in the Coastal Zone, |
| MARCOAST | MARCOAST (Marine Coast) is a GMES service network: covers two groups of services: monitoring and water quality assessment in coastal waters. Special attention to oil and algal blooms. |
| MCEIS | Marine and Coastal Environment Information Services. The Natural Environment Research Council (NERC) Earth Observation Data Acquisition and Analysis Service (NEODAAS) is funded by NERC to support UK research scientists with remote sensing data and information. |
| MERSEA | MERSEA (Marine Environment and security for the European Area) aims to develop by 2008 a European system for operational monitoring and forecasting on global and regional scales of the ocean physics, bio-geochemistry and ecosystems. This ocean monitoring system is envisioned as an operational network that systematically acquires data (earth observation from satellites, in situ from ocean observing networks, and surface forcing fields from numerical weather prediction agencies) and disseminates information to serve the various user needs. Precursor of MyOcean (see below) |
| MSFD | Marine Strategy Framework Directive |
| MUDAB | The Marine Environmental Data Base (MUDAB) is a joint project of the Federal Maritime and Hydrographic Agency (BSH) in Hamburg and of the Federal Environmental Agency (UBA) in Berlin. It is located at the German Oceanographic Data Centre in Hamburg and serves as the central German data base for marine data collected within the framework of international and national conventions for the protection of the North Sea and Baltic Sea. |
| MYOCEAN<br>MYOCEAN II | MYOCEAN aims at deploying the first concerted and integrated pan-European capacity for Ocean Monitoring and Forecasting. It is an implementation project of the GMES marine core service. MYOCEAN provides the best information available on the ocean and regional seas. Follow up on MERSEA. |

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| ODON | Optimal Design of Observational Networks. ODON will 1 ) investigate/develop techniques in optimal observing system design, 2) design ad hoc and rational sampling strategies for SST and temperature/salinity (T/S)profile monitoring in the Baltic & North Sea by using statistical analysis (including synergy among satellite, buoy, floating profiler, ferry and XBT sections), 3) demonstrate improvements in ocean now casts/forecasts due to improvements in the observing networks by using Observing System Simulation Experiment (OSSE), and 4) perform cost-benefit analysis of the designed observing networks. |
| OOI | The Ocean Observatories Initiative constructs a networked infrastructure of science-driven sensor systems to measure the physical, chemical, geological and biological variables in the ocean and seafloor. Greater knowledge of these variables is vital for improved detection and forecasting of environmental changes and their effects on biodiversity, coastal ecosystems and climate. |
| OSPAR | The OSPAR Convention is the current legal instrument guiding international cooperation on the protection of the marine environment of the North-East Atlantic. Work under the Convention is managed by the OSPAR Commission, made up of representatives of the Governments of 15 Contracting Parties and the European Commission, representing the European Union |
| RECOPESCA | Recopesca is a project of national scale, including overseas island and is a concrete achievement of participative approach:<br>scientists and fishermen team up to give to the voluntary fishermen a role of scientific observer. Recopesca provides an innovative<br>tool to collect data, especially through the integrated multidisciplinarity. The collected data can be used by both fisheries scientists<br>and physicists, who will have information for areas non- or little-accessible till now. |
| SEADATANET/SeaDataNET II | SEADATANET is a leading initiative in Europe, actively operating and further developing a Pan-European infrastructure for managing, indexing and providing access to ocean and marine data sets and data products, acquired via research cruises and other observational activities. SEADATANET is co-funded by the EU FP6 Research Infrastructures program (2006 - 2011). SEADATANET is interconnecting 40 data centers from 35 countries, bounding to |

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| | European seas, to provide integrated on-line access to the most comprehensive sets of multi- disciplinary in-situ and remote sensing marine data, meta-data and products. |
| SEIS | SEIS (Shared Environmental Information System) is a collaborative initiative of the Commission and the European Environmental Agency to establish an integrated and shared EU-wide environmental information system, modernising and simplifying the collection, exchange and use of data and information required for the design and implementation of environmental policy (Anonymous, 2008c). In this communication from the Commission a set of principles on the basis of which the collection, exchange and use of environmental data and information should be modernized and organized. A most important part of this process will take place through a legislative instrument, most likely a revision to the moment both GMES and EMODNET are seen as potential contributions to SEIS. |
| SEPRISE | SEPRISE (Sustained, Efficient Production of Required information Services) has been a Specific Support Action funded by the EC within the 6th Framework Program to further operational oceanographic services, in line with the priorities of the members of EuroGOOS. SEPRISE discerned and enabled methods of increasing, improving and coordinating production of European scale operational ocean products and services. |
| TMAP | To provide a scientific assessment of the status and development of the Wadden Sea and to assess the status of implementation of the trilateral targets of the Wadden Sea. |
| WALTER | Wadden Sea Long term Ecosystem Research concept under the wings of the Dutch Wadden Academia. Oriented on monitoring and use of new and innovative techniques to understand the functioning of the Wadden Ecosystem (incl. socio economical aspects) . First step is to construct a central open data base of all available data, second phase is focused on the scientific understanding. |
| WDC | World data Centrum. was created to archive and distribute data collected from the observational programs. |
| WFD | The WFD is a framework for EU water policy and is complemented by other legislation regulating specifi c aspects of water use:<br>• The Groundwater Directive (2006) |

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| | • The Environmental Quality Standards Directive (2008)<br>• Two Commission Decisions (2005 and 2008), on ecological status, established a register of almost 1 500 sites included in an intercalibration exercise to allow for comparison of diff erent countries' standards, and published the results. |
| WGOOFE | The Working Group on Operational Oceanographic Products for Fisheries and Environment (WGOOFE) provides an interface between the users of operational oceanographic data products and their providers.<br>The group runs a web based portal and is developing a number of new initiatives to improve the integration of operational oceanography in ICES Science and Advice |
| WISE | The Water Information System for Europe – or more commonly known as WISE – aims to be the gateway to information on European water issues.It compiles a number of data and information collected at EU level by various institutions and bodies<br>WISE is a partnership between the European Commission (DG environment, Joint Research Centre and EUROSTAT). |
| WOD | World Oceanographic Database is a project established by the World Data Center system (WDC) and the U.S. government's National Oceanographic Data Center (NODC) intended to centrally store oceanographic data. |

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