EMODnet

European Marine Observation and Data Network

EMODnet Stakeholder Conference and Sea-basin workshops

Stress-testing Marine Data – Towards a European Ocean Observing System

14-15 February 2017, Brussels

The EMODnet Stakeholder Conference and Sea-basin Workshops was organised by:

We would like to thank all the speakers, moderators and panelists for their input to the Conference. We wish to acknowledge the support of the European Commission, sponsors of the Conference, without whom this event would not have been possible. We also wish to thank Flanders Marine Institute (VLIZ) for their IT support to the event. Most importantly, we thank the numerous participants of the Conference for engaging in the proceedings and providing invaluable contributions to the discussions. We look forward to the next steps and hope to see many of you again at future EMODnet events.

Conference report edited by Oonagh McMeel, Belén Martín-Míguez and Jan-Bart Calewaert. Layout by Vikki Gunn

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EMODnet

European Marine Observation and Data Network

The European Marine Observation and Data Network

The European Marine Observation and Data Network (EMODnet) is a network of organisations working together to observe the sea, process the data according to international standards and make that information freely available as interoperable data layers and data products. The aim of EMODnet is to help scientists, engineers, policy advisors and all other stakeholders relying on marine data to increase their efficiency, promote innovation and reduce uncertainty about the behaviour of the sea. A fully operational EMODnet will lessen the risks associated with private and public investments in the blue economy, and facilitate more effective protection of the marine environment. EMODnet is an initiative of the European Commission in support of the EU's Integrated Maritime Policy.

The EMODnet vision

"A flagship project to prepare a seamless multi-resolution digital seabed map of European waters by 2020 ... of the highest resolution possible, covering topography, geology, habitats and ecosystems ... accompanied by access to timely observations and information on the present and past physical, chemical and biological state of the overlying water column, by associated data on human activities, by their impact on the sea and by oceanographic forecasts. All this should be easily accessible, interoperable and free of restrictions on use. It should be nourished by a sustainable process that progressively improves its fitness for purpose and helps Member States maximise the potential of their marine observation, sampling and surveying programmes."

European Commission's Green Paper Marine Knowledge 2020 – from seabed mapping to ocean forecasting. 2012. DOI 10.2771/4154

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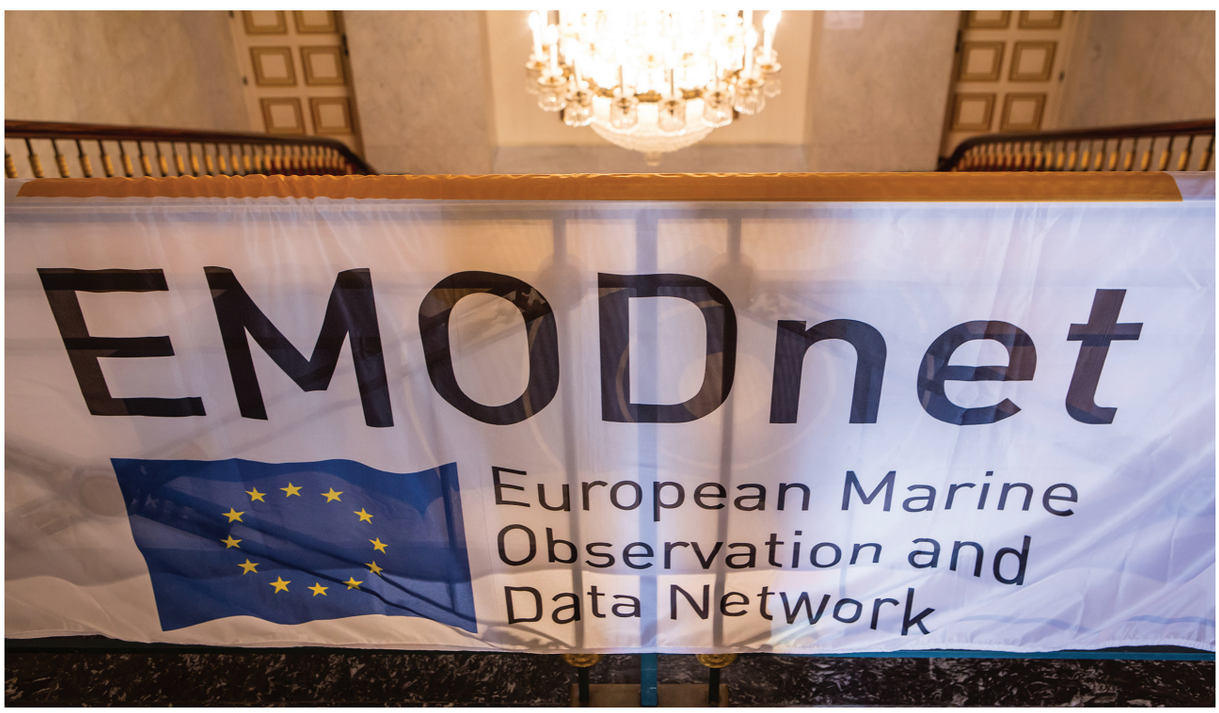
EMODnet Stakeholder Conference and Sea-basin Workshops



Introduction

On 14-15 February 2017, more than 150 marine data providers, users and enthusiasts gathered at the Royal Flemish Academy of Belgium for Science and Arts in Brussels for the first EMODnet Stakeholder Conference. Over the course of a day and a half, EMODnet experts and interested stakeholders discussed whether marine data collected via current observation and monitoring activities in Europe, satisfy the needs of those who rely upon it. Participants included marine data collectors, data-managers and users from both public and private sectors, as well as interested stakeholders from each of the regional sea basins: the Arctic, Atlantic, Baltic Sea, Black Sea, Mediterranean Sea, and North Sea.

The Conference centred on the innovative approaches taken by a series of EMODnet data stress tests, also known as Sea-basin Checkpoints[1], to evaluate whether the marine data currently available at the level of the sea basins is fit for purpose. The aim of the Checkpoints is to assess if the quality and availability of the data are sufficient. Over the course of the meeting, the Checkpoints showcased the results of their work to date, highlighting where they have identified major gaps or bottlenecks towards improving Europe's observation capacity. Stakeholders were actively engaged in the discussion of these results and contributed to a wide range of recommendations to improve European marine data collection and sharing efforts, and to making progress towards a coherent European Ocean Observing System. This report provides a high-level summary of the Conference and associated break-out workshops.

[1] *Further information on the Checkpoints and access to all the Checkpoint resources can be found at http://www.emodnet.eu/checkpoints*

The EMODnet Sea-basin Checkpoints Concept

The EMODnet Sea-basin Checkpoints assess the quality and availability of the current observation monitoring data at the level of the regional sea basins. By testing the data against specific end-user challenges, the Checkpoints will demonstrate how well the current monitoring system provides data to meet the needs of users. In doing so data gaps and duplications will be highlighted.

The concept of EMODnet Sea-basin Checkpoints was introduced within the Green Paper 'Marine Knowledge 2020: from seabed mapping to ocean forecasting' (COM-2012-437). In spite of EU initiatives such as EMODnet, Copernicus and Data Collection Framework (DCF) for Fisheries to deliver seamless layers of marine data across national boundaries, there are still shortcomings with the availability and accessibility of EU marine data. Data collections have been largely put in place for specific and/or national purposes. There is still an approximate overview on a sea-basin scale of gaps and duplications and there is no overall view of what the priorities are for further data collection or assembly. Thus the EMODnet Checkpoint initiative will begin to link all existing monitoring data at the level of the basins and assess them in order to provide advice for future improvements.

Six Sea-basin Checkpoints are in operation. The first two Checkpoints were initiated in the Mediterranean Sea and the North Sea in 2013. Checkpoints for the Arctic, Atlantic, Baltic and Black Sea being launched in 2015.

All Checkpoints are addressing some or all of the following challenges which are relevant to the protection and preservation of the marine environment and its resources, assessing the impacts of climate change and anthropogenic activities and to supporting the activities of maritime actors.

The EMODnet Checkpoints are focusing on finding data to address challenges at the level of the regional sea basins from all possible sources, including but not restricted to EMODnet.

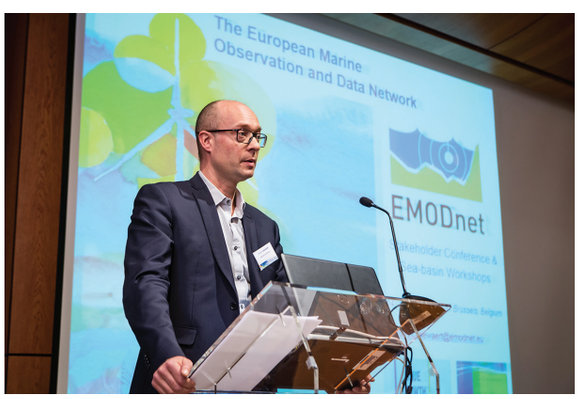
More information about the Checkpoint Concept and links to all relevant websites can be found at www.emodnet.eu/checkpoints

	Checkpoints					
Challenge	Arctic	Atlantic	Baltic Sea	Black Sea	Med Sea	North Sea
Windfarm siting	•	•	•	•	•	•
Marine protected areas	•	•	•	•	•	•
Oil platform leaks	•	•	•	•	•	•
Climate and coastal protection					•	•
Climate change	•	•	•	•		
Coasts	•	•	•	•		
Fisheries management	•	•	•	•	•	•
Marine environment management					•	•
Fisheries impact	•	•	•	•		
Eutrophication	•	•	•	•		
River inputs	•	•	•	•	•	•
Bathymetry	•	•	•	•		
Alien species	•	•	•	•		

14 February 2017 (Day 1): Plenary Opening
Stress-testing European marine data - the EMODnet Sea-basin Checkpoints

Welcoming the numerous participants, Chair of the EMODnet Steering Committee **Phil Weaver** opened the Conference by noting the growing interest in Europe in the challenges and opportunities associated with marine data acquisition, management and open access. Over recent years EMODnet has seen a big increase in the volume of data flowing through it, but also in the usefulness of this data, with a widening range of data products finding their way to a growing number of users. Of these products, the EMODnet Bathymetry's Digital Terrain Model (DTM) is currently the most visible and popular EMODnet product, with more than 40,000 downloads per year. The growing success of EMODnet follows the understanding that sustainable growth in the blue economy while simultaneously achieving good environmental status in our European seas and oceans requires easy access to adequate and accurate data. Access to more and better data are particularly important, he added, to improve the management of the growing pressures on our ocean from human activities and to assess the impacts of climate change. EMODnet has been built bottom-up, largely by the scientific community who also represents its main user group. However, EMODnet is now at a stage where the available datasets are comprehensive enough to involve users from industry, the public sector and civil society to promote wider re-use of the data resources and to ensure that services and products that are being developed are fit for purpose. Summing up, Phil Weaver invited all participants to contribute to what he hoped would be an open dialogue, to identify what is working well and how European marine data collection and sharing efforts can be improved in the future.

Jan-Bart Calewaert (Head of the EMODnet Secretariat) started by reflecting back on the outcomes of the EMODnet Open Conference which had focused on the progress of the EMODnet thematic data sharing activities. He explained that less than two years later, the first EMODnet Stakeholder Conference takes a different perspective by zooming in on European marine data collection, availability and adequacy from the perspective of users via the EMODnet Sea-basin Checkpoints. This Conference brings together all those involved in the EMODnet's regional data stress-tests, to provide a common forum for sharing experiences, whilst allowing for regional specificities to be discussed during dedicated breakout sessions. This is important, he continued, because EMODnet was borne from the recognition that the huge investments in Europe in observing our seas and oceans were not always carried out in a coordinated way and with limited integrated assessment of the needs, gaps and duplications of efforts. Similarly, the data collected via these activities were stored in a fragmented way in numerous and diverse repositories making them difficult to access. The Marine Knowledge 2020 strategy recognized the economic and societal value of these diverse data, but also that they could only be used by Europe's scientists, public authorities, maritime operators and innovators if they could be easily found, accessed and if they were fit for purpose. EMODnet has made great strides towards achieving this goal and continues to develop activities to promote open data sharing practices. Most recently, the launch of a Data Ingestion Portal (www.emodnet-ingestion.eu) was set up to facilitate the process for data owners to



contribute their data. In addition, new data layers would soon be available on marine litter, marine noise and vessel traffic density and the current third phase of development would focus on achieving more machine to machine communication, higher performance of portals and more coherence. Complementing the many other EMODnet activities, Jan-Bart Calewaert concluded that the Checkpoints provide a mechanism for assessing the adequacy and completeness of our current marine observation and data collection framework which is unique in the world.

The keynote presentation by **Valerie Cummins** (Irish Maritime and Energy Resource Cluster) focussed on the importance of data and information for users of ocean and coastal space and the role of industry as users and providers of marine data. She noted the tremendous efforts involved in developing and sustaining EMODnet and the huge benefits it could deliver to the diverse stakeholders and users of our ocean space. Open data and open innovation, she said, will provide opportunities for all stakeholders. However, these stakeholders all have specific data and information requirements for the planning, management and implementation of their activities and this presents a tremendous challenge. She pointed out that the term 'industry' represents a very diverse group of entities, encompassing users as well as producers of marine data – and often companies are both at the same time. An easy way to improve access to industry data would be to implement better regulations to make data collected in the context of Environmental Impact Assessments more available.

With today's unprecedented pressures on our natural resources, the burden on our coastal areas is particularly heavy as they currently accommodate 50% of the world's population in a narrow band between land and sea while providing 48% of global economic wealth. Integrated Coastal Zone Management and effective Maritime Spatial Planning are crucial to deal with these pressures. Looking ahead towards 2030, Valerie Cummins saw many opportunities for Blue Growth, but also a critical need for stability for the private sector to invest. An enhanced European marine monitoring and observation system must meet the requirements of science, policy, civil society and industry and the opportunity for Europe is to build capacity towards both physical infrastructure and institutional innovation. Ocean observing is a global priority and Europe can demonstrate leadership in this area. Valerie Cummins concluded that, in order to unleash the full potential of open marine data and innovation, interoperability is the key: interoperability of technologies, interoperability of data and interoperability of people.

Iain Shepherd (Directorate-General for Maritime Affairs and Fisheries – DG MARE) introduced the concept and challenges of the EMODnet Sea-basin Checkpoints. The rational for these data stress-tests, he said, was finding a way to assess the priorities in terms of planning marine observations and data collection as well ensuring openness and re-usability for those who rely on marine data. The Checkpoints provide a mechanism to assess available data against simulated user challenges and, in doing so, to identify gaps in the current observation and monitoring framework and opportunities for future observation needs. An example of a challenge that had been set for each of the Checkpoints was to select an appropriate site for an offshore windfarm. To solve this challenge, the Checkpoints had to consider what datasets were needed (e.g. wind profiles, sediments, protected habitats and shipping lanes), where they could be found and if they were fit for use. Other challenges included establishing the coherence of a network of marine

protected areas in a sea basin, forecasting the impacts following an oil spill within 24 hours, providing information on coastal change, eutrophication or riverine input, the impact of fisheries activity, invasive species and climate change. Attempts to solve these questions provide valuable information about whether the data are available and appropriate, and if the right data are being collected.

Results of the EMODnet Sea-basin Checkpoints to date

In advance of the meeting the results of the stress-tests to date were summarised according to the seven EMODnet themes: Bathymetry, Biology, Chemistry, Geology, Human Activities, Physics and Seabed Habitats to identify common and contrasting issues. A compilation of 'key findings' per thematic area was distributed to attendees of the conference and can be found in Annex 2 of this report. The main findings per thematic area were presented as outlined below.

- Bathymetry, **Eline Van Olsen** (Arctic Checkpoint)
- Biology, **Jun She** (Baltic Sea Checkpoint)
- Chemistry, **Atanas Palazov** (Black Sea Checkpoint)
- Geology, **Nadia Pinardi** (Med Sea Checkpoint)
- Human Activities, **Quillon Harpham** (North Sea Checkpoint)
- Physics, **Mikaël Vasquez** (Atlantic Checkpoint)
- Seabed Habitats, **Jan-Bart Calewaert** (Head of the EMODnet Secretariat)

Panel Discussion

In opening the floor to questions, **Iain Shepherd** (DG MARE) stressed that the presentations had focused on 'headline findings.' It was important to note that these were drawn from detailed Data Adequacy Reports (DARs) prepared by each Checkpoint and presented to experts for feedback. Therefore 'headline findings' were underpinned by comprehensive assessments and should be considered in the context of the full background provided by the reports. The intermediate results for each region have been published on the Maritime Forum website and all the Data Adequacy Reports and detailed literature reviews for the Atlantic, Artic, Baltic Sea, Black Sea, Mediterranean Sea and the North Sea, can be accessed via the EMODnet central portal here http://www.emodnet.eu/checkpoints/reports.

Common Challenges

- All Checkpoints experienced considerable difficulties in obtaining fisheries data which is mainly a policy issue. Regulations exist to ensure these data are being collected under the Data Collection Framework (DCF) for fisheries. However, the quality and the consistency of the data submissions by some Member States are sometimes an issue. Some Member States are not willing to provide this data to users or will do so only by passing on to users the cost required to process the data.

- While raw data is of more interest to some of the more experienced EMODnet users, others are mainly interested in data products such as maps. However, providing access to underlying raw data to the wider community was considered important to allow others to test, validate or improve existing products and to stimulate the creation of entirely new innovative products and services.

Checkpoint Methodology and Future Plans

- The EMODnet Checkpoints were free to develop their own approach to meet the requirements of the challenges. As a result, the North Sea and the Mediterranean Sea Checkpoints established in 2013 each developed their own slightly different approach. In 2015, Checkpoints for the Arctic, Atlantic, Baltic Sea and Black Sea were added: the Black Sea and the Atlantic followed the approach taken by the Mediterranean Sea Checkpoint. The Arctic and Baltic Checkpoints developed their own approach, although they incorporated some of the elements and terminology developed by the Mediterranean checkpoint. Despite taking different approaches, the Checkpoints generally reach similar conclusions where feasible, given the regional specificities. However, both audience and panellists agreed that should these stress tests be repeated again in the future, it would be useful to streamline the approaches with an agreed common methodology building on the experience of current efforts.
- Even with the same methodology, directly comparing results would always be challenging due to regional specificities.

• DG MARE noted that the findings and recommendations from the Checkpoints Data Adequacy Reports are extremely valuable not only to improve EMODnet, but also for other initiatives and authorities responsible for data collection and the implementation of monitoring programmes. Some results have already been taken forward in the requirements for the third development phase of EMODnet (2017-2020).

• Participants would welcome options to make correlations between the various results. For example, how would fisheries impact data compare to seabed habitats data? Would it be possible to see cause and effect? Whilst this is beyond the scope of work of the Checkpoints themselves, the facility to overlay data products and possibly to make calculations is part of the roadmap for the development of data services to be made available via the EMODnet Central Portal.

Research data

- A significant proportion of the data used in the Checkpoints' analyses originated from research projects. However, some of the research data of interest was not available or accessible because the project had ended and/or the data was not open-access. It was recommended that it should be mandatory for Horizon 2020 projects collecting marine data to make this data available via an appropriate data repository which is feeding into EMODnet.

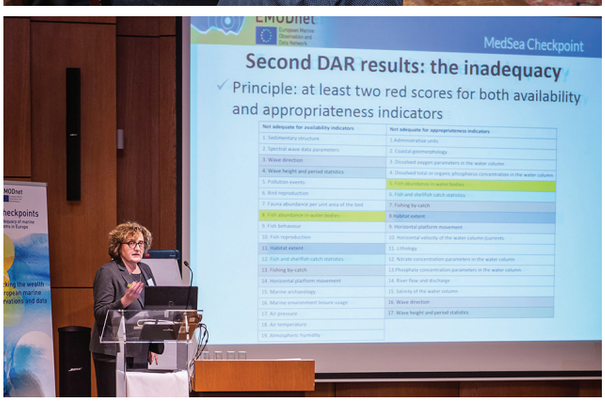
- Many academic laboratories are not ISO (International Organization for Standardization) accredited which may limit the use of resulting data, for example when marine chemical data is required for MSFD (Marine Strategy Framework Directive) reporting. However, this data may have many other potential applications without such strict requirements so it is crucial to ensure that these data are not lost. Nevertheless, the importance of providing appropriate information about the provenance, quality and precision of the data cannot be underestimated.



Breakout session: Regional Sea-basin Stakeholder Workshops

During this session, each of the Checkpoints hosted a regional Sea-basin Stakeholder Workshop. Participants had been invited to register in advance for the workshop of most relevance to them. Due to the similar approaches taken between the Mediterranean Sea and the Black Sea, these workshops were merged.

Checkpoint coordinators presented the main findings from their Data Adequacy Reports and invited feedback from the stakeholders to reach a set of joint recommendations. An overview of the outputs from these workshops are available in Annex 1.


MedSea Checkpoint
Second DAR results: the inadequacy
Principle: at least two red scores for both availability and appropriateness indicators


Second DAR results: the inadequacy
Principle: at least two red scores for both availability and appropriateness indicators


Recap from first panel meeting;
Summary of challenges;
Summary of data gaps;
- Panel discussion
Summary of general conclusions and recommendations;
- Panel discussion
Preparation of panel meeting presentation

15 February 2017 (Day 2): Plenary Closing
Improving Europe's Marine Observation Capacity

During the closing session, Checkpoint coordinators presented the key outcomes from the previous afternoon's breakout session (Annex 2) as a starting point for an open floor discussion with the panel. The main comments and issues arising from this session were the following:

Data Gaps: absence of data versus restrictions on access

- When reporting data gaps, Checkpoints should clearly indicate whether the 'gap' reflects an absence of data (and thus a requirement for new/additional monitoring), or that the data exists but is currently unavailable. Often an absence of data reflects a lack of access to data, often due to policy constraints, as opposed to the data not having been collected. However sometimes it is not possible to distinguish these.
- The lack of information on sediment mass balance and the lack of access to important data on fishing activities (existing but difficult to obtain) are major problems and should be addressed as a matter of urgency.
- There is a need for expanding the coverage of the High Frequency (HF) radar network to obtain more data in Europe. In the US 70% of the coast is covered by HF radars.
- Many data sets are unfit for use, of very poor quality and poorly described by their metadata. Significant time and effort goes into screening large quantities of data to find that only a handful of datasets are useful and usable. This effort could be greatly reduced with good metadata. There is a particular need to develop better metadata standards for chemical contaminants.
- Data access constraints sometimes reflect commercial sensitivities: data may be of strategic interest to a company, or sharing it may raise liability issues. In some cases, specialized SMEs collect data for other companies and as such do not own it. There is a need to inform the private sector about the benefits of sharing data and provide incentives for them to contribute to open data repositories. EMODnet could facilitate safe keeping of data by offering to aggregate and anonymize the data. There are also opportunities to improve data acquisition working with industry to obtain access to cabled platforms etc.

- The conclusions of the stress tests and identified gaps are determined largely by the specific phrasing of a challenge. Therefore results must be considered in relation to the questions asked. Conclusions should only be drawn in the context of the details provided in full Data Adequacy Reports.

The Checkpoint Challenges: current and future

- Marine Spatial Planning (MSP) will represent a significant challenge in the future, requiring a huge variety of data, including transboundary data and the need to combine monitoring efforts with modelling.

• There was general agreement that the Checkpoints process should be repeated with more sea-basin relevant challenges representing real user needs as the current challenges are not all of equal relevance to all of the sea basins. For example, windfarm siting may be more relevant to the North sea than to the Arctic.

• Sector specific user challenges could be considered in the context of Blue Growth. Additionally, EMODnet should consider organizing workshops to bring together stakeholders of specific sectors, for example focusing on data needs for aquaculture.

• In some of the challenges the lack of long time series data inhibited the ability to produce the relevant data products, for example for climate change. This raised the question for the Checkpoints as to whether they should provide low-quality products and flag these as such, or not produce the products at all because the data was of low quality.

EMODnet

- A lack of information on vessel traffic will be addressed during the next phase of EMODnet, where Vessel Monitoring System (VMS) and/or Automatic Identification System (AIS) data will be obtained by EMODnet Human Activities portal to develop vessel traffic density maps.
- EMODnet should develop showcases providing examples of data or products being used demonstrating clear positive impacts, as these would demonstrate the relevance of EMODnet efforts.
- The results of the Checkpoints and the available data resources provided by EMODnet should be communicated more widely as they are still not very visible to some target user communities.

- By focusing on data gaps new monitoring needs can be identified. However, it is necessary to evaluate whether this monitoring is critical or not in relation to other efforts. These needs will vary on a sea-basin by sea-basin level.
- The Checkpoints identified many new data sets, some of which are relevant to the EMODnet thematic portals but not yet available by them. The new EMODnet Data Ingestion Project (DIP) and associated portal could facilitate the entry of these data sets into the system. The Checkpoint coordinators were invited to work closely with the DIP to ensure the success of this ingestion process.

Progress on Establishing a European Ocean Observing System (EOOS)

Glenn Nolan (EurGOOS) provided an overview of the progress made on establishing a European Ocean Observing System (EOOS), a process driven by EuroGOOS and the European Marine Board (EMB). These efforts go hand in hand with the growing recognition that Europe needs a comprehensive, end-to-end European Ocean Observing System to align and connect existing initiatives and to identify gaps in the current observing system. In 2015, EuroGOOS and the EMB launched a joint activity on EOOS, bringing together the marine scientific and operational oceanographic communities to develop a roadmap, time-line and governance structure for EOOS. A joint public stakeholder consultation on EOOS was held between December 2016 and January 2017. The consultation collected views from the European ocean observing community and wider stakeholders spanning policy, industry and national agencies, on what EOOS should look like and how it should be run. In total 115 responses were received, and the vast majority of the respondents endorsed the EOOS concept and the need for a coordinating framework for European Ocean Observing.

In the brief discussion that followed, participants stressed the need for a strong statement that the data management aspect of EOOS should be taken on board by EMODnet. It was also recommended that a cost benefit analyses would provide an important contribution to the justification of the need for an EOOS. In response, Glenn Nolan stressed again that EOOS would build on existing initiatives, such as EMODnet, and would not try to 'reinvent the wheel' but would rather focus on adding value where possible and appropriate.

An EMODnet Use Case Perspective

Clare O'Neill (UK Met Office) provided a keynote from the perspective of an EMODnet user. She presented the recent improvements in the UK Met Office storm surge forecasting through the use of EMODnet digital bathymetry. The new system, developed in collaboration with the National Oceanography Centre (NOC) in Southampton, uses NEMO as the underlying ocean model. In order to correctly forecast storm surges, it is vital that the model's tidal solution is accurate, which in turn requires an accurate bathymetry. As part of the setup a number of different bathymetry products were tested, and the results compared with observations from tide gauges around the UK. Using EMODnet bathymetry led to an overall improvement in the model tide solution compared with the previously used bathymetry data. Systematic biases in particular have been significantly reduced.

Day 2: Concluding Panel Discussion
Towards improved data collection and open access: synthesis of findings

In introducing the panel, **Bernhard Friess** (Directorate-General for Maritime Affairs and Fisheries – DG MARE) reflected that there was a clear consensus in the room on the importance and role of EMODnet. It represented a huge achievement and is considered to be unique globally in terms of providing access to transnational, multidisciplinary data. The Checkpoints represented an important evolution within EMODnet, in terms of considering data availability and usability from the perspective of the user. Earlier phases of EMODnet's development had focused on the data aggregation, in this new Phase, EMODnet is in a position to explore how the data could be used by stakeholders. Are the data sufficient and what cross-links need to be made? Perspectives looking forward include the business use of EMODnet and how it can be used towards achieving good environmental status and effective Maritime Spatial Planning. To strengthen stakeholder involvement, an end-user forum will shortly be established for EMODnet and a study will be carried out to assess the economic value of EMODnet.

Niall McDonough provided the perspective of the European Marine Board (EMB) as a pan-European network advancing marine science through science-policy advice to the EU institutions and national agencies. Referring to the long term interest of the European Marine Board in ocean observations, Niall McDonough referred back to an EMODnet vision document produced by EMB and EuroGOOS in 2008 and noted that significant progress has been made in the intervening period. He stressed that the vision for EOOS today is to develop a light and overarching framework, building on existing initiatives. In this context one of most important initiatives in the marine data and observation landscape is EMODnet and the Commission deserves great credit for bringing it to where it is now. The scientific community is the biggest user of EMODnet but it is also a major provider of marine data, often collected through short-term research projects. Much of this data is not being taken up by EMODnet or made available for other users. Data rescue is an important issue to ensure these data holdings are not lost and there is a need to incentivise researchers to make their data available on open access platforms. EMODnet is now mature enough to really communicate its role to all users. Referring to the global open data movement and increasing requirements by funding bodies for open data policy through initiatives such as the EU Open Science Cloud and now the Blue Cloud, he proposed that projects funded through the Horizon 2020 programme should be required – with appropriate opt-outs – to upload data collected as part of the funded project to relevant repositories feeding into EMODnet. However, rather than just making this a mandatory requirement for scientists, it would be important to encourage scientists to contribute research data by providing incentives such as opportunities for peer recognitions and career advancement.

Introducing **Simon Jennings** (ICES, International Council for the Exploration of the Sea), Bernhard Friess said that the EC was probably one of the main users of ICES, a network of 1600 active scientists contributing to 160 working groups providing advice on fisheries and sustainable use of marine ecosystem resources. Data is central to everything ICES does, and increases the impact and relevance of ICES core work, its science and scientific advice. As such ICES welcomes and commends EMODnet for providing wider access to data. Open data and open-source

code is central to scientific advancement. It is through full transparency and scrutiny that science advances and so too does science-based advice. The Checkpoints provide an excellent example of this, through acting as hyper stress tests of the available data. The more open the data, the greater the audience that can provide scrutiny. In relation to fisheries there have been some very clear messages from the Checkpoints that access and availability to VMS (Vessel Monitoring System) data is critically important. Access to these data is also crucial for ICES to carry out their rigorous analyses and for the advisory process. There is also a requirement to collect by-catch data, but the information coming from the Member States is not always complete which creates significant challenges for basin scale analyses.

Samantha Burgess (World Wildlife Fund - WWF) introduced WWF as a civil society organisation with a focus on nature conservation working to ensure that the planet and people thrive together. Access to high quality data and information is critical to the WWF work she said. They use environmental data to understand the physical structure of habitats, as well as data on species abundance and diversity. Impact data is also crucial to their work, to assess our societal footprint on European seas and oceans. WWF would agree with many of the gaps that have been identified by the Checkpoints. This raises the question as to whether management is effective: are we asking the right questions? Developing questions such as, 'what data do I need to deliver this?' must involve dialogue, to ensure that environmental managers, all relevant stakeholders and the data providers fully understand what is being asked and what is necessary to deliver the appropriate answers. What EMODnet has already achieved to date is incredibly beneficial to the transparency agenda, to enable civil society and the public to understand what we know as well as what we don't know, and what steps remain to be taken to reduce the uncertainty in our knowledge.

Valerie Cummins (UCC) made a number of high level observations from the perspective of a private sector stakeholder, as founder and leader of the Irish Maritime and Energy Resource Cluster, a maritime innovation hub bringing together the research community, naval actors and industry stakeholders. Firstly, she observed that many of the data gaps discussed during the Conference are particularly relevant to coastal zones. These would include High Frequency (HF) radar data, sediment budgets and habitat mapping. Another important issue is in relation to existing data that is not available, and a good example of this is vessel AIS (Automatic Indentification System) data. Thirdly, there is still a lot of data which is collected and stored somewhere, but not yet made available for re-use by others and this is where the EMODnet Data Ingestion Portal can have significant impact. EMODnet may also provide an opportunity for capacity building to support those who need to enhance their own data-sharing capability.

Finally, there is a huge amount of data which is available, but is not being used. The North Sea Checkpoint 'Data Advisor' concept which provides a way for users to evaluate datasets based on the principles of 'tripadvisor', could help other potential users to identify relevant datasets. For EMODnet, she said 'community' is the big take home message. The EMODnet community is already well established and the link to the EOOS initiative is very important; not only to ensure that information on data gaps are taken up and result in deployment of infrastructure, but also to address first the most important gaps in terms of value for money. EMODnet should also continue to develop links with industry, with the military, with civil society and policy. She concluded that EMODnet has made huge strides forward since it started in 2009 and is now mature enough to be widely promoted as a best practice.

Panel discussion key points

The Open Data Movement

- EMODnet has an important role to play in the open data movement. Increasingly national funding bodies are requiring researchers to deposit their results in open repositories and EMODnet could both support and benefit from this movement.
- The open data movement has many benefits. For one, the wider the community to which EMODnet data are made available, the greater the scrutiny of the data and services on offer and the greater the feedback driving progress; a positive self-perpetuating process.

Industry involvement in data-sharing and re-use

- Industry already contributes to marine monitoring and observation, for example for migratory species and higher level predators. These examples provide a basis to convince more businesses to collaborate and contribute relevant data.
- Nevertheless, more leverage and incentives are required for industry to contribute more marine data. One option could be for EMODnet to develop a 'blue-label' to recognize the data contributions from businesses. Another action could be for EMODnet to develop data policies in dialogue with the private sector to facilitate the development of public-private partnerships. There may also be opportunities to obtain historic data that is no longer commercially sensitive.
- It was recommended that EMODnet makes linkages with the World Ocean Council who could provide a forum to promote the dialogue between data acquisition and sharing initiatives and industry at a global level.

Next steps for EMODnet, the Sea-basin Checkpoints and European marine monitoring

- EMODnet should dedicate time to explore the needs of specific Blue Growth sectors such as aquaculture. This sector is important because the EU remains one of the largest importers of seafood globally. EMODnet could serve the aquaculture sector for example by providing information on licensing, to support decisions around location of installations.

- There is a need for more information on species movements and migration. VMS data could potentially be used to provide information on pelagic predatory fish. There is also insufficient information on the entire life cycle of fisheries activities: there is not enough data on where the fish are being extracted from and what abundance there is to begin with, but also there is insufficient evidence to understand where the spawning sites are, where juveniles aggregate and how this can be temporally or spatially managed to ensure stocks remain sustainable.
- There will always be long and detailed wish lists in terms of data collection, particularly in relation to biodiversity data. One option is to work 'smarter' and many commission funded projects have looked at ways to collect additional data using existing surveys. An excellent example is the Bio-Argo initiative which provides a means of collecting biological data on the back of physical oceanographic monitoring systems. In coastal zones we should see fisheries surveys as an existing available platform and we should work smarter to collect more information within the framework of such existing initiatives.

Bernhard Friess summed up the session emphasizing that EMODnet was at a pivotal point, making a step-change from being driven and used by scientists to being a more outward looking network, developing in dialogue with stakeholders from industry, policy and civil society. An important take-home message from the panel therefore is for EMODnet to look for pragmatic ways of strengthening the involvement of these stakeholders, building on the efforts of this Conference. Finally, he expressed his thanks to the panellists and also to Jan-Bart Calewaert and the EMODnet Secretariat for their organisation of this event.

Conclusions and key findings

Data stress test results show that EMODnet and Copernicus have made significant improvements in access and usability of EU's marine data but that much remains to be done. Many data are still hidden, unavailable or mutually incompatible. Data related to fisheries impact, river discharges and coastal erosion are particularly troublesome, but efforts are underway to tackle these parameters.

Although the presentations and discussion during the EMODnet Stakeholder Conference provided many new insights, the real benefit lies in the detailed reports produced by the stress test partnerships and their stakeholders. Those wishing to know the state of knowledge of invasive species in the Arctic, eutrophication in the Baltic or coastal erosion in the Mediterranean will find this and much more information in the Checkpoints reports available from the Maritime Forum and via the EMODnet central Portal .

The Conference has made one thing very clear: EMODnet stress tests provide a unique and timely evaluation of the state of Europe's marine data which allow us to take stock of how far we are from reaching the objectives set by the

European Commission's Marine Knowledge 2020 initiative and guide future actions. The Conference also revealed a number of general lessons about what has worked well in the past and what can be improved in the future.

Positive observations

- EMODnet and the Copernicus marine service have brought real benefits. They are now the first port of call when looking for many types of marine information. National hydrographic agencies, geological surveys and oceanographic data centres are committed to the initiative. The improvement in storm surge monitoring is a classic vindication of the "collect once, use many times" principle.
- The regional sea conventions and ICES share the EU's marine knowledge objectives and have contributed to meeting them. The renewed EMODnet partnerships will work even closer with them in order to improve efficiency.
- At a global level, EMODnet contributes significantly to GEBCO for bathymetry and OBIS for marine life.
- Particularly in the Mediterranean, EU research projects have compiled valuable datasets even though it is not always straightforward to obtain this data.

Remaining challenges and bottlenecks

- Many data still remain hidden, poorly organised and beyond the reach of users. Metadata such as ownership or measurement date are often missing. In the majority of cases the stress tests were unable to identify future priorities for monitoring, other than perhaps a benthic survey, because they were unable to determine whether data in a particular area existed but could not be found or whether it had not been collected.
- Access to fisheries data for purposes other than scientific advice to fisheries - for instance impact on species caught as bycatch or bottom habitats - is extremely limited and not enough for a sound analysis.
- Similarly, the lack of shipping traffic density maps hampers spatial planning or impact assessment on a sea-basin scale.
- Coastal data are a particular issue given that this is where people live and where the majority of offshore activity takes place. In not one sea basin was it possible to provide a complete picture of the flow of water, nutrients, sediments or migrating species from rivers or the rate of coastal erosion or sea-level rise.
- Spatial resolution of derived products for the seafloor such as topography, geological strata and habitats is often too coarse, despite, in some cases the existence of underlying survey data that is much finer. Reasons include concerns from national governments of penetration by enemy submarines and, in the case of geology, the difficulty in harmonising different national classifications.
- The price charged by national meteorological offices for wind data severely limits their use.
- In some cases, long-time-series, such as Russian observations in the Arctic, Greek fixed platforms or Italian tide

gauges have been discontinued because of budget cuts.

- Data reported to authorities in impact assessments, such as for the German wind farms, are often unavailable for re-use despite their having no commercial value.
- The southern shore of the Mediterranean is still very poorly served. EMODnet partners indicated that the many interactions they have had with institutes and agencies in northern Africa, to obtain relevant data hosted at these organisations, had resulted in little success so far.
- Budget limitations mean that EMODnet has so far only been able to provide distribution maps of a limited number of species of marine life.

Reasons to be optimistic

- The new EMODnet partnership will gather, harmonise and disseminate data on marine litter and underwater noise. Records of water and nutrient outlet flow from rivers will also be included.
- The base resolution of the seabed map layers will shift from 7½ arc seconds to 3. And, where underlying data permit, higher resolution data will be disseminated.
- The new Data Ingestion facility (www.emodnet-ingestion.eu) greatly facilitates the transfer of data from completed research projects, impact assessments and industrial monitoring programmes to national or regional repositories for subsequent dissemination through EMODnet.
- The new partnership for EMODnet Human Activities will begin work on construction of ship density maps. A process to obtain the data from ships' Automatic Identification Systems on which these maps will be constructed has begun.
- A new Horizon2020 project to start in April 2017 aims to galvanise a more collaborative approach from institutes and authorities in north African countries.
- A new expert group representing users of marine data will provide additional guidance for the further development of EMODnet data portals, products and services to ensure these are fit for purpose.
- The next phase of EMODnet will aim to develop common standards with international efforts over and above those with GEBCO and OBIS.

Towards the future

In the course of their work, the EMODnet Sea-basin Checkpoint partnerships have developed a number of tools to advise on the whereabouts and suitability of data to solve particular problems. These could be used more widely. Some work is needed to refine and streamline the tools, applied methods and indicators to a more coherent and common approach, building on the lessons learned and the best elements from each of the stress test exercised. Steps will be undertaken towards the end of 2017 to reach this goal.

Although some of the individual challenges could be rethought, it is difficult to think of a better way of highlighting gaps and identifying priorities.

Annex 1: Summaries of the Checkpoint Stakeholder workshops

As part of the First EMODnet Stakeholder Conference, a break-out session was organised for stakeholders to meet and discuss the findings of the individual Sea-basin Checkpoints. Checkpoint Challenges are the core of the Checkpoint stress-tests as they are used to assess the fitness for purpose of the data. The aim is to assess if the quality, resolution, availability and consistency of the data are sufficient. The specific challenges have been selected by the European Commission and are very diverse as described on the EMODnet Central Portal at www.emodnet.eu/checkpoints. A literature survey to search and describe all potentially relevant datasets is produced as a report. The identified datasets are subsequently analysed for usability in addressing the different challenges. The assessment results in a Data Adequacy Report (DAR) which is reviewed by an external panel where experts comment on the work in order to give recommendations to the Member States and to the EC on future improvements.

This annex provides summaries of each of the breakout workshops.

Arctic Sea-basin Checkpoint

During this interactive session members of the Arctic Checkpoint team presented the approach and main findings of the project to date. The Arctic Checkpoint covers a vast area connected to Europe, Canada, North America and Russia. All outputs (reports, findings, presentations, etc.) of the Arctic Checkpoint are available on a dedicated website www.emodnet-arctic.eu, accessible also via the EMODnet central portal http://www.emodnet.eu/checkpoints.

Discussions centred around following themes/challenges:

For Marine Protected Areas, the objective is to analyse the existing network of MPAs in the Arctic, categorise them, determine whether the network constitutes a coherent one and assess the impact of climate change. 492 MPAs were identified so far.

Lessons learnt:

- The world database on MPAs contained 90% of the MPAs but it is not complete.
- GIS maps need to be projected to a polar projection.
- Datasets are often available in national languages (e.g Russian), which may cause interpretation problems.
- Data on species distribution has not yet been received from IUCN.
- At the current point in the work, no major knowledge gaps for MPAs have been observed.

For Offshore wind farm siting the objective is to determine the suitability of sites for the development of an offshore wind farm. Suitable sites are interpreted as economically viable for offshore wind energy with little impact on both ecosystem and human activities. In Norway there are around 200 blocks with potential to develop offshore wind farms. A short discussion ensued on the available resolution to adequately answer the questions in this challenge.

Lessons learnt:

- An adequate assessment can be done.
- There is a need to check the impact of the icing factor on turbines.
- The datasets used are available on the internet but the search tools could be improved.
- More detailed datasets can be found when the search area is more focused.

- Open challenge: impacts of floating turbines on seabed still needs to be investigated.
- For Fisheries Management & Impact, the data availability is much less in the Arctic than for other areas. FAO data (FAO area 18) is available but it only contains data on catches (catch + discards) and no landing data. Discards and bycatch (incidental catches of mammals, reptiles and seabirds) are mandatory to report in some countries but not in all.

Lessons learnt:

- There is still a big knowledge gap in terms of fisheries in the Arctic region.
- It's not always clear whether data relates to catch or landings.
- Catch data in the Arctic basin are too low to be credible (FAO area 18).
- Russian data is often not available and this poses a problem to address this challenge. There are Russian fishing quota available in Norway on government sites.
- There is overlap between the Arctic study area and the ICES areas. The full ICES areas were used for this challenge, not parts of them.
- AIS (commercial) data would be useful in this challenge but it is not always available.
- NGOs such as Greenpeace might be able to add data or information.

For Bathymetry, Depth profiles from multibeam data for habitat mapping can be useful. Norway has an enormous amount of bathymetry data, but it's not always available (eg. Due to military restriction). It is however expected that 0-30m data will soon become available.

For Alien Species, information on the introduction and distribution of alien species in the Arctic Ocean, and on the impact on the ecosystem and economy was collected. Collected information includes taxonomy, geography, introduced range and year of introduction, vector or reason for introduction and impacts. Maps are constructed showing the area in the Arctic where the species is introduced. It was found that biodiversity research in the Arctic is quite patchy and limited monitoring of invasive species in the Arctic results in data and knowledge gaps.

The Climate change challenge is a broad challenge with nine different sub-challenges. For some topics, such as sea-ice extent for example, a lot of data from different sources is available. For other topics, such as phytoplankton, it can be quite difficult to gather useful data for the entire area. For many parameters, data can be found on a very small spatial and temporal scale, making it difficult to present an overview of the entire Sea Basin. For certain parameters, this is not a useful exercise as different parts of the sea basin can have completely different circumstances. This is the case not only for phytoplankton, but also for animal behaviour for example.

The River input challenge has to date focused on water volume and temperature, sediment and total nitrogen and phosphates. This challenge will look at salmon and eel in the coming phase of the project. So far the data availability was very different for the requested parameters. Most data were found for the volume of water discharge. The data availability for the other parameters was considerably less. Water quality monitoring is expensive, especially at remote sites. Measurements are erratic, time series are short and measurement protocols differ between sites.

Conclusions regarding possible follow-ups to this contract:

- The current checkpoint projects can be considered as pilots, it shows what works and what doesn't. Possible follow-ups should focus on what works.

- The network built during this project is key for any future developments. It takes time for people to find and work with new developments such as EMODnet, it would be a waste to lose this experience and network after the end of the project.
- The websites built in the checkpoint projects will provide links to data sources and datasets, as the websites do not hold the data themselves but link to the sources, if the sources are kept up-to-date the upkeep of our websites will be minimal.
- Having local contacts at a global level can be very useful (e.g. Russia).
- Any future challenge questions should be more focused on what is important and why this is important. For example, looking at possible windfarm sites is only useful if there is a need for wind energy in the area. Another example is instead of looking at platforms for the oil spill challenge, to look at oil spills from ships and how to deal with oil and sea ice.

In conclusion, the Arctic Checkpoint workshop covered various useful topics of discussion. Valuable contacts and beneficial suggestions were made. As part of the larger EMODnet Conference, the meeting contributed to share and gain knowledge and building a useful (Arctic) network of data experts and stakeholders.

Atlantic Sea-basin Checkpoint

In a short opening presentation, the Chair defined the objective of the workshop, namely to provide concrete solution-oriented proposals to some data adequacy issues so far identified by the Atlantic Checkpoint. The Project had produced a list of issues to be discussed, grouped by theme (physics, human activities, biology, bathymetry, habitat, chemistry, geology), as previously agreed with the Secretariat. The participants considered these issues and attempted to provide a recommendation for each of them.

Main outcomes of the discussions

All the recommendations developed in the course of the workshop are available in full in the break out session report. The following are a short selection considered by the group as the top recommendations.

- HF radar presence should be increased. Compared to the USA, where 75% of coasts are covered by HF radar, the presence of HF radars in Europe is poor. HF Radars provide real-time information on sea-surface currents, which is key for many applications: marine safety (search and rescue, oil spill), marine resource (renewable marine energy), environment (water quality monitoring, pollution control), weather forecast and ocean 3D modelling.
- A GPS vertical correction should be implemented for all existing operational tide gauge platforms in Europe in order to enable the integration of land vertical motion in the computation of absolute sea level.
- A free AIS (Automatic Identification System) service should be developed to make available AIS vessel tracking data. Such a service would foster the use of AIS data by applications such as “Oil leak” (impact of spill on traffic), “Windfarm siting”, “MPAs” (competition for space, traffic statistics), “Fisheries impact” and “Invasive species” (ballast water as a vector of species transport). It would also be in support of surface current computation (which itself is in support of many applications) because current speed and direction can be derived from boat drift.
- In some fields there is a need for standardization prior to integration in data platforms
    - Alien species

- Species mobility/behaviour
- Human activities layers (e.g. aquaculture)

We encourage initiatives (e.g. working groups) for such standardization.

- More efforts are needed to demand promote free availability of existing data whose acquisition was funded by public money. This is obvious for survey data on bathymetry.

Baltic Sea-basin Checkpoint

Stakeholders present agreed that the current practices in the Baltic Sea-basin Checkpoint (BSCP) were extremely useful and that continuous Checkpoint efforts are needed in the future.

User-oriented products and presentation: users demonstrated significant interest in the Baltic Sea-basin Checkpoint Portal and products (http://www.emodnet-baltic.eu/) and expressed a desire to further develop the current demonstration products into a dedicated web service. A series of user needs were identified:

- More information on metadata is needed in the portal, e.g. on methodology.
- New functions are suggested, e.g. dynamic feedback, authorship of the data, possibility for easy updates and uploading data by users, dedicated sectorial page with centralized access to all sector-related data and products, analysis function for users to relate different parameters, a layer of EEZ information etc.
- The data portal can be a useful tool to facilitating marine knowledge generation, i.e. from open data to open science.

More gaps and optimization identified: in dynamic shallow water zone for bathymetry, sediment, currents etc. Adaptive, autonomous high resolution monitoring tools are effective and supplementary to improve current monitoring system. Optimal strategy could be reached by combining monitoring and modelling with OSSEs/OSEs and statistical optimal design methods.

New challenge areas for future checkpoint assessment are recommended: adequacy of air pollution deposition data, Marine Spatial Planning, ocean acidification, hypoxia, operational forecasting, marine pollutants, underwater noise, atmospheric deposition etc. More in-depth definition of some of the existing challenges, e.g. fishery, will reveal more data needs.

Data policy and future European Ocean Observing System: data policy should be an integral part of Checkpoint assessment for data related to research, military and commercial interests (e.g. bathymetry, fishery and private data). Checkpoints can provide much needed information for optimizing future European ocean observing systems and data management, rather than just data adequacy. This includes identifying key issues and potential solutions for building up a sustained European marine data infrastructure through more efficient

- public-public partnership to maximize collection and integrated use of data, one example is to integrate operational in-situ data with environmental monitoring data (HELCOM), via speeding up environment data delivery and extensive use of modelling and assimilation. The benefit will be huge, both for operational oceanography and environment assessment in national, regional and EU levels.
- public-research partnership to maximize the data delivery from research projects, one example is to make BONUS (meta) data available to EMODnet. Further related is EMODnet-H2020 partnership.

- public-private partnership to engage private partners in EMODnet and maximize their data sharing with EMODnet, flexible business models should be developed to engage existing commercial data practices and policies. One example is to gather more sediment data from companies. Normally many of these data can be shared after 5 years.

Mediterranean and Black Sea-basin Checkpoints

The coordinators and partners from the Mediterranean and Black Sea Checkpoints presented the main outcomes as follows:

- MedSea Checkpoint final gap analysis (N. Pinardi, INGV)
- BlackSea status of development (A. Palazov Institute of Oceanology, Bulgarian Academy of Sciences)
- The MedSeaTargeted Products (S. Simoncelli, INGV)
- BlackSea intermediate assessment results (A. Palazov)
- MedSea final DAR and recommendations (G. Manzella, INGV)

The final MedSea Checkpoint recommendations, extracted from the second Data Adequacy Report were presented and the audience asked to consider these in the context of the two key questions outlined below. The questions and the feedback obtained is outlined below:

1. What do you think of the CKP methodology?

- Interesting approach, more Challenges are probably needed such as:
  - atmospheric deposition data sets;
  - aquaculture;
  - contaminant accumulation in sediments and biota.
- An element that will assess the quality of the input data sets should be included in the future.
- There is a need to evaluate the Checkpoints products quality
- The complementarity of input data sets in a product must be assessed.

2. How would you continue the CKP effort? What would be the time scale?

- Need to maintain a good balance between private and public sector needs
- A 5-year framework for the planning of the continuation could be a reasonable timeframe

General discussion points

- Why is ocean acidification not included among the challenges? Hypoxia is also very important in the Black Sea.
- The assessment of adequacy of the atmospheric forcing data is partially biased. The partners of the "Oil platform leaks" Challenge, have access to the data as Monitoring and Forecasting Centres of CMEMS, otherwise the data would not be accessible. The lack of data availability emerges in the availability indicator but not in the appropriateness of the Targeted Products.
- Issues related to the recommendation of making a specific EMODnet portal for Fishery data. Currently data are not easily available, not in the proper form and coverage/resolution is very inadequate for Challenge products.
  - An EMODnet initiative for Fishery should also focus on capacity building for data collection best practices

and common tools of data analysis;
- For fishing vessel track data sets, data are collected at very different time resolution, new standards should be established that are common;
- New maritime traffic data sets should be made available to the Portals, possibly via connecting with new SAT-AIS ESA initiative and EMSA;
- It's important to consider that different bodies are looking at different kind of data. Taking into account the impact of trawling on the sea floor, there are two main reason for gaps in VMS data (the institutional fishing control tracking system of each MS): the first is related with the privacy and the second one is related to the need for capacity building in VMS data analysis. In general Member States do not know how to process the data and they cannot provide the raw data because they are sensitive data. There is a need also of standardization procedure for data analyses. There should be a larger involvement of scientists on the data analyses and management. The data should be processed using a more scientific approach, this would result in the release of higher quality derived products.

- Considered a critical recommendation was the need to address the lack of information on sediment mass balance, either through including this in existing EMODnet Portals, or developing a new thematic portal. Data are, at the moment, not available for the Challenge products (also in the North Sea). The following suggestions were made:

  - It was suggested to develop a new scheme for monitoring the sediment mass balance on the basis of satellite multi- or hyper- spectral sensors in a complementary way to in situ data sets and connect it to coastal morphodynamics modelling and predictions. (Land Copernicus service for water levels);
  - Estimate sediment mass balance and sediment transport in the coastal zone from algorithms that detect Total Suspended Matter (TSM) from satellite data, as has been carried out for the Belgian coastal area. The consortium supported the idea of putting in place a new integrated monitoring system, by combining in situ and remote sensing data for cal/val activity, focusing on both empirical and analytical algorithms that aim at retrieving both TSM concentration and sediment characteristics (i.e., grain size distribution). Models for sediment transport are extensively used for morphodynamic investigations in particular case studies (e.g., the Venice lagoon), however, there are very few observations and no operative products related to this challenge. Due to the diverse scales of the sediment mass balance processes there was a recommendation to consult the specific scientific community. EMODnet's Coastal Mapping Lot could be the community to address this issue (EMODnet should properly interface with the hydrological monitoring community, data collection practices not standard for the river stations, Interface with the Coastal Mapping Portal to initiate planning of new data collection might be a way).
  - The problem of beach erosion, for example, is very specific but at the same time both the EU landscape and the regional scale have to be considered in the near future. "Think globally and act locally" is the answer since the regional dimension is the right one to pursue. There is a need to monitor continuously the environment and make this activity operational.

- The complementarity of different type of data for inter-calibration could be an assessment criteria. This represents more of a scientific issue or a thematic portal issue. The introduction of a quality measure for upstream data sets that pass through a Quality Check process might be included. This has been one of the criteria applied by the partners during the upstream data selection among all the potential input data sets.

- The "River inputs" challenge might be extended to land input and atmospheric deposition. There is a need to

connect to the hydrology community. However, EMODnet physics will include river inputs soon. The location of monitoring stations at the river mouth is not a standard, they are currently inland or at sea, this represents an issue for the operational oceanographic community. An additional comment was related to tidal regimes that might be also important in the Med Sea for this purpose. A connection with Copernicus Land could be another way to address these points.

- In terms of a future Checkpoint effort:
  - A 5-year cycle was considered a reasonable time-frame, providing also an update on the monitoring landscape at the regional level
  - The audience suggested that a future partnership composition should have private and public institutions equally represented to guarantee a broader overview. The engineering community should be also represented.
  - A future challenge for aquaculture/fish farms as proposed. EMODnet Human Activities is already collecting information, however aquaculture requires very high resolution currents fields and biodiversity data. Closer to the coastal area requires the increase of spatial resolution; at present, the adequacy of data is not sufficient yet.
  - A future challenge for radioecology was proposed (this could be included in existing challenges about pollutants/ contaminants) or bioaccumulation of pollutants in the trophic chain, this would highlight the gaps in the bioaccumulation data.
- In relation to the critical recommendation to improve the habitat databases and the wave data set assembly and start new collection, the following points were made:
  - For habitat mapping new data collection is required. In the EMODnet portal the data are not downloadable and one is redirected to the data provider, limiting the responsiveness in case of stress tests. This is consistent with the DAR recommendation Improve the EMODnet Portal Data Policy visibility and the Data Policy for specific data sets that are not downloadable
  - For wave data sets the gap comes from in situ and modelling data. It is suggested that it would be interesting to have a wave data rescue initiative, wave data sets are probably not available for European waters before the 1980s, but still it is very important to have long time series. HF radar data can fill the resolution gaps

North Sea-basin Checkpoint

This summary is a record of the discussions and observations made at the second of two project panel meetings for the North Sea Checkpoint (NSCP) project, with the aim of allowing the Project Panel and other stakeholders to comment on the results and recommendations arising from the work.

Some high level results and highlights from the North Sea Checkpoint project were presented during the conference plenary opening alongside the Human Activities theme. The open panel meeting followed as a breakout session from the conference.

The main points raised by the panel discussion can be summarised in terms of the nature of the challenges themselves and the results obtained. These were also presented at the conference closing plenary:

- The framing of the results for the Challenges was fundamentally affected by the framing of the questions asked.

This is not necessarily seen as a weakness, especially since it produced a creative tension between the policy nature of the questions asked and the scientific nature of the responses.

- Notwithstanding the inevitable artificial element, overall, the Oil Spill Challenge was seen as an exercise in numerical modelling and substantial value lies in an assessment of how available data sources such as EMODnet can be used to drive such numerical models.
- When a data gap is reported, it is necessary to understand why it occurs. It may be that there is a genuine gap in the data available but it may equally be due to policy or management issues.
- Some stakeholders desire that EMODnet concentrates its provision on raw, low level data close to that which is obtained from sensors (or models). Other stakeholders prefer to receive higher level aggregated, derived products. Although raw data is an important base requirement, there is sometimes a case for creating higher level derived products.
- Poor quality metadata has led to a high level of inefficiency in evaluating whether candidate datasets were applicable for use. However, the North Sea Checkpoint project is not recommending the creation of a new metadata standard for marine data, rather, that existing standards be used with a mapping between them applied to aid the creation of a federated catalogue solution.
- Metadata records should be owned by the organisations supplying the data and point to the data files in their associated repositories. Users could then be offered a facility for evaluating the effectiveness of the data they have used, as prototyped on the project with the 'Data Advisor'.

This document forms a supplement to the North Sea Checkpoint (NSCP) Final Report issued to DG Mare and EMODnet in December 2016 (Reference: HR Wallingford Report DLS0342-RT016-R02-00).

Annex 2: Results of sea-basin stress tests to date – how good are European marine data?

Contents

This document is not a formal report or document, but was compiled by the EMODnet Checkpoint Coordinators only to provide summary information to Conference participants in support of the Workshops and plenary discussion. These key findings should only be interpreted in the context of the full data adequacy reports for each Checkpoint. These can all be accessed here: http://www.emodnet.eu/checkpoints/reports.

Parameter	Seabasin	Results
BATHYMETRY		
Water depth	Arctic	• The quality of the bathymetric data in the Barents Sea and Norwegian Sea is good enough to use the available data to determine where suitable water depths occur that are compatible with either a fixed or a floating offshore wind turbine. • Bathymetry data for the complete Arctic Ocean are available from EMODnet portals; SeaDataNet; Copernicus marine service; ACCESS; ICES; NOAA National Geophysical Data Center; Marine Cadastre; Geographic Information Network of Alaska; Bureau of Ocean Energy Management; USGS Alaska Geospatial Data Committee; US Coast Guard; National Weather Service but the datasets are extremely large. These datasets provide information on where water depth information exists for the study area, and where information is currently not yet available. While sufficient for general research and interest, the data is insufficiently granular to be used for navigation.
	Atlantic	• Bathymetry data product overall scored very high availability. However visibility of the data policy is not always optimal (see reasons under "legal framework"). • Some restrictions were found with the data policy of EMODnet bathymetry "background datasets". In the North Atlantic a high proportion of 88% of the 10,000 survey data occurrences were obtained by negotiation. Part of these restrictions are due to national or international legal constraints (defence, mining law, UNCLOS, ...). It should be noted that 'by negotiation' does not mean that the data are not available but it clearly slows down the data access process. • The literature survey indicates that higher DTM resolution than 250m is required for many applications (e.g. 50m to 100m for applications such as wind farms, sea level estimates or hydrodynamic modeling). • There is a need for better metadata completeness (e.g. soundings timestamp).
	Baltic	• Data are available from BSHC Baltic Sea Bathymetry Database (BSBD) and EMODnet, in 500m resolution; • Due to national regulations, data availability varies greatly with countries. In Lithuanian and Russian waters, BSBD uses data from GEBCO 30" bathymetry data. Sweden and Finland have restrictions on the resolution of released bathymetry, i.e., 500m, while other countries e.g., Denmark and Germany release data up to 4m resolution; • The existence of good quality bathymetric data sets is gradually improving but bathymetric surveys are expensive and time consuming operations. In a substantial area of the Baltic Sea the quality of available bathymetry is still low. This seems to be especially the case for shallower waters that are not of interest for commercial shipping.
	Black Sea	• The availability indicators for bathymetric data are mostly "partly adequate" and "not adequate" (see Annex 1). • There is no clear data policy or its visibility is low and pricing information is often missing. • The datasets do not provide a full EU Inspire catalogue service.
	Mediterranean	• The availability indicators for this theme are dominantly "fully adequate" (see Annex 1). Only 6 data sets were used for the evaluation. • The appropriateness indicators are "not adequate" (see Annex 1) for temporal coverage and temporal validity (last time the data set was updated).
	North Sea	• The wind farm siting challenge found that resolution of bathymetry varies with territorial waters, so comparison of boundary areas ended up with variable resolution. Less processing of data was required by using the SeaZone product (as against that from the bathymetry portal) which was preferred for this challenge.

Parameter	Seabasin	Results
GEOLOGY	Atlantic	• Only 7 metadata entries related to geology datasets were recorded, which hampers reliable statistics. Most of them concern the coastline. Two only are about seabed sediments,. The literature survey stressed insufficient scale of the seabed substrate due to lack of resolution in coastal zones and lack of knowledge in deep waters. • A wealth of sediment samples in analogue form are still unexploited. • There is a lack of information on vertical land motion (see point on GPS measurements in physics/sea level section)
	Black Sea	• General geological maps exist but the resolution should be improved. • There is a general lack of the sediment sea bed data.
	Mediterranean	• The characteristics categories in this theme are several: coastal geomorphology, concentration of suspended particulate material in the water column, depositional environment, lithology, sedimentary structure. • The availability indicators for this theme are dominantly "fully adequate" with the exception of sedimentary structure data sets where the score is "not adequate". • The appropriateness indicators are dominantly "not adequate" and "partly adequate". • A sediment mass balance cannot be developed for any part of the basin. Data are not available only in the literature. This is the single one product that cannot even be started to be developed. • Coastal geomorphology is the most unfit for use with all "partly adequate" and "not adequate" appropriateness indicators.
Seabed slope	Baltic	• Finer seabed slope products are needed, especially for Wind farm siting.
Sediments	Atlantic	• (…) models will need to use finer grid resolutions to account for local effects, such as coastal evolution and sediment transport.
	Baltic	• There is a lack of sediment concentration observations in river discharge; • Existing seabed sediment and substrate type data are useful in general wind farm siting assessment but not in refined wind farm siting design.
	North Sea	• The Climate and Coastal Protection challenge found that, on the scale of the North Sea basin, no sediment data was discovered that could enable calculation of annual sediment mass balance at the coast for each NUTS3 region. Indeed, any usable data for non-experts is rare, since those datasets that are available require expert processing. For example, geology data from EMODnet, OneGeology or the European Atlas of the Seas provided only a rough indication of sediments near the coast.

Parameter	Seabasin	Results
PHYSICS	Atlantic	• Gridded models outputs provided by Copernicus typically have a resolution of around 7km. Some applications such as broad-scale habitat mapping or MPA connectivity require oceanographic data with ideally hectometric resolution. • Copernicus provides GIS layers on physical variables that are generally archived time series averaged over a predefined time period (e.g. temperature daily averaged), which may not meet the data user's need such as the same variable averaged over another time period or a percentile or a standard deviation rather than a mean value. With a view to broadscale habitat mapping over extensive areas (e.g. EU basins), Vasquez et al (2015) mention that there is a lack of high resolution modelling (e.g. 200–300m nearshore, 3–4 km offshore) of some key variables (e.g. wave or current energy, temperature, salinity) • There is a need for a spatial assessment of the confidence in the datasets provided by physical oceanography models: typically these models (e.g. currents, waves, light, temperature, etc.) provide little information on the reliability of the values they compute. Applications (e.g. habitat mapping, offshore energy) need an estimate of how confident they can be in the value provided by the model at any location.
	Mediterranean	• The characteristics categories in this theme are several: Horizontal velocity of the water column (currents), Light extinction and diffusion coefficients, River flow and discharge, Temperature of the water column, Salinity of the water column, Sea level, Spectral wave data parameters, Wave direction, Wave height and period statistics, Wind strength and direction. • The availability indicators for this theme are dominantly "fully adequate" with the exception of the INSPIRE Catalogue and the visibility indicators that are "not adequate" to "partly adequate" for most of the characteristic categories. Spectral wave input data sets score "not adequate" in the data delivery. • The appropriateness indicators are "partly adequate" for the majority of the input data sets and "not adequate" for vertical and temporal coverage, horizontal resolution, temporal validity (last time the data set was updated). • For most of the characteristic categories in Physics the major gap is the horizontal coverage and horizontal resolution. • Top of the list of unfit for use data is waves and all wave parameters both in terms of availability and appropriateness.
Ice	Arctic	• Starting from 2010 estimates of ice thickness are available from the European Space Agency's CryoSat-2 satellite. ESA Data are available from Centre for Polar Observation and Modelling at the University College London. However, there is no dataset available on change in average ice cover, and estimates must be made from available data on ice extent and ice thickness (assuming a constant density of sea ice). Obtaining good measures of average ice thickness over the last decade is challenging because of sparsity of data in space and time. For the past 50 and 100 years it was not possible. • Arctic data on ice cover in sea expressed in kg are not available. The choice was made to focus on sea ice extent and sea ice thickness instead of cover in kg. The data on this topic is widely spread and freely available.
	Baltic	• High-resolution (1-3km) weather and ocean-ice assimilation and reanalysis (>30years) should be developed; • The total mass of ice is difficult to measure and there is a lack of long-term time series;
Waves	Mediterranean	• The appropriateness indicators for waves and winds are "not adequate", meaning that the monitoring system is not capable to produce wave data at the needed horizontal and temporal resolution. Availability of both waves and winds is low because they are commercial also from Met Offices.

Parameter	Seabasin	Results
Wind speed	Arctic	• The quality of the wind speed and strength data in the Barents Sea and Norwegian Sea is good enough to use the available data to determine suitable areas for wind park farms on a less detailed level. However, we might lack information on vertical profiles for detailed assessment (to be assessed during the second phase of the project).
	Baltic	• High-resolution (1-3km) weather and ocean-ice assimilation and reanalysis (>30years) should be developed; • The total mass of ice is difficult to measure and there is a lack of long-term time series;
	North Sea	• The wind farm siting challenge found that datasets for key parameters e.g. wind and wave conditions, were available for the challenge. These were either charged for at a cost per point of data, making them expensive for a site selection study, or had a coarse resolution meaning that their usefulness for site selection was limited. For example, the UK Met Office charges £5000 per data point for its wind and wave 35 year re-analysis data time series in the North Sea. • The Oil Platform challenge identified that some wind data was difficult to locate from freely accessible sources at a sufficient spatial scale, particularly the hind and forecast information that would be needed for this type of assessment. The spatial resolution of some data sets, for wind and currents, near the coast was quite coarse leading to some interpolation of data. Also, oil spill trajectories sometimes did not reach the shore due to the coarseness of the MyOcean data around the coast.
Temperature and salinity	Arctic	• There are data available for both surface temperature and bottom temperature, but not very detailed; more data can be found on surface temperature; old data are more scarce than recent. Questions on spatial and temporal developments can only be partly answered.
	Baltic	• Spatiotemporal distribution of long time series for temperature and salinity (>50 years) are uneven, and are available only from a limited number of locations.
	North Sea	• The Climate and Coastal Protection challenge found that the only sources of data for mid-water and sea-bottom temperature are from global numerical models with reanalysis. Moreover, modelled data tends to be supplied in very large files, sometimes several gigabytes. Sometimes long downloads failed as a result, for example, downloads from the NOOS website either failed or appeared to be successful, but gave a corrupt zip file.
Current	Mediterranean	• Sea level does not have an INSPIRE catalogue service and from the point of view of appropriateness spatial and temporal resolution indicators the monitoring system is lacking resolution and coverage, both spatial and temporal. Temperature follows the same behaviour of the sea level.
	North Sea	• The oil spill challenge required water current data which was retrieved from the MyOcean.eu website. Some grid cells near the coastline do not give a value for the current. This complicated the oil spill modelling in an area of particular importance, that of predicting whether the oil would reach the coast. It is recommended to investigate the feasibility of providing water current data at grid cells close to the coast, or providing downscaled options. Also, MyOcean current forecasts are limiting the length of time that an oil spill simulation can be taken into the future.
Sea level	Arctic	• Sea levels are measured on 95 stations in the Arctic Ocean, and 52 have data over a time frame of more than 40 years. There are no long term data available in Greenland, Canada and the USA.

Parameter	Seabasin	Results
	Atlantic	• Sea level data scored about average for all criteria, meaning there is ground for improvement on all availability items. However, according to Slangen et al. (2016) sea-level change should be estimated on a national level, which is what coastal planners are interested in, but the spatial resolution of the current sea-level projections is still relatively coarse. • Sea level models will need to use finer grid resolutions to account for local effects, such as coastal evolution and sediment transport. • Likewise an increase in the number of GPS measurements at tide-gauge locations is needed (Church and White, 2011; Slangen et al. 2016) to provide information on vertical land motion. This applies in particular to the use of in situ data to monitor the accuracy of satellite altimeter measurement systems.
	Baltic	• By combining existing sea level data with models, it is possible to reconstruct high quality monthly sea level data in entire Baltic Sea in the past 100 years. • Most of the sea level data from Poland, Lithuania and Latvia are not included in EMODnet database. • Some historical data may be recorded in paper, therefore will need digitization.
River	Arctic	• The data availability is very different for the requested parameters. Most data is available for the volume of water discharge. For some large Russian rivers time series are quite long, more than 70 years, up to more than 100 years. But many time series are relatively short, a few decades in many cases, and often incomplete. It is worrying that stations have been closed and data are delayed.
	Baltic	• The river temperature dataset has few observations, discharge observations are available from different databases but with major data gaps. The BHDC is no longer updated. The E-HYPE model is used to fill in the gaps and has shown good results.
	Mediterranean	• River flow and discharge together with current velocities and wind strength and direction score RED for 3 out of 8 appropriateness indicators.
CHEMISTRY		
Nutrients	Arctic	• Nutrient data are rather scarce in the Arctic Rivers. Only nutrients and a couple of chemicals are described in the six largest rivers, and the data are recent. It is difficult to create time series from the available data.
	Atlantic	• Nitrate and Phosphate concentration in rivers: data is scattered, often available from local sources only, with the metadata sometimes incomplete (e.g. measuring date). • In the North Atlantic, in EMODnet Chemistry 44% of all raw datasets (i.e. 178 000 occurrences) are available by negotiation, which may lower data access. • Problems with robustness of EMODnet chemistry data access services were reported.

Parameter	Seabasin	Results
	Baltic	• River nutrient load is calculated using discharge and nutrient concentration. The observed concentration is often too sparse to calculate loads, while the E-HYPE model can be used to fill in the gaps with good results. • High data confidence for eutrophication is only found in less than half of all sub-sea ¬basins. • Both EMODnet and ICES have data that others do not have, but it is more time ¬consuming to download EMODnet data. • Generally, the sub-basins in transition waters and icing waters were lacking sufficient amount of data for the high confidence assessments. For DIN and DIP, more observations are needed in Danish Straits, Gulf of Finland, Åland Sea and The Quark; for Chlorophyll-a, more observations are needed in Great Belt, Åland Sea, Bothnian Sea, The Quark and Bothnian Bay; for secchi depth, more observations are needed in Danish Straits, Western Gotland Basin, Åland Sea, The Quark and Bothnian Bay.
	Black Sea	• There are significant amounts of data available, mainly for coastal waters. • The number of water column profiles in open sea was dramatically decreased during last decades.
	Mediterranean	• While data for "rivers" score "fully adequate" for availability, appropriateness is scarce especially for resolution and temporal coverage. • The characteristics categories in this theme are several: Dissolved oxygen parameters in the water column, Dissolved total and organic nitrogen concentrations in the water column, Dissolved total or organic phosphorus concentration in the water column, Nitrate concentration parameters in the water column, Nutrient fluxes between the bed and the water column, Phosphate concentration parameters in the water column, pollution events. • The availability indicators for this theme are dominantly "fully adequate" except for the Pollution events for which all the indicators are "not adequate". • The appropriateness indicators show a "not adequate" score for Horizontal resolution and coverage for all the characteristic categories and for almost all of them "not adequate" is the score for temporal coverage and validity.
	North Sea	• River inputs data is very patchy. For example, total nitrogen as reported to OSPAR, of rivers into the North Sea between 2002 and 2013, has no data for Belgium and only two years for Denmark, Germany and the Netherlands and only three years for France and the UK. • The Marine Environment challenge was not able to collect 'whole-basin' data for an assessment of Eutrophication. • There was a considerable amount of data on water chemistry available through EMODnet on nitrates, phosphates, silicates and ammonium. The primary issue with these data is the way in which dates are formatted. These are not in an immediately usable form and the link to the metadata online returns a blank page.
BIOLOGY	Black Sea	• Phytoplankton generic biomass and zooplankton wet weight biomass are not adequately covered by input data set. The data found was not up-to-date. • Chlorophyll pigment concentrations and Bird taxonomy are partly adequate

Parameter	Seabasin	Results
	Mediterranean	• The characteristics categories in this theme are two: bird counts and Chlorophyll pigment concentrations in water bodies. • The availability indicators for these two characteristic categories are: "fully adequate" for Chlorophyll and "not adequate" for the visibility of the Bird counts. • The majority of the appropriateness indicators for Chlorophyll have a "partly adequate" score and the "not adequate" score is associated with Bird counts for vertical and horizontal coverage.
Species	Arctic	• Most studies focus on primary production in the broader sense of the word, mostly focusing on chlorophyll concentrations and not on individual species. • There are gaps in both time and space of monitored areas when it comes to individual species of phytoplankton. The data found was not up-to-date. • The IUCN offers to deliver data on species distribution on their website. We have asked for 14 sets of distribution data, but multiple requests were not responded to.
	North Sea	• The Wind Farm challenge identified limitations of using biological and ecological data, particularly fisheries data and information on the migration routes for birds and marine mammals. For example, CEFAS spawning and nursery data proved to be the most accessible data on fisheries. It is, however, coarse and last updated in 2010. Beyond ICES, OSPAR and CEFAS, there is little data readily available online for planning purposes. Indeed, the main data gaps identified through the wind farm siting challenge were in spatial datasets for ecology and fishing activities. Aggregated, baseline data is found, but precise data was not practically available. It is therefore recommended that ecology and fishing data be made available in more structured and fine grain forms. Until then, interpreted AIS and VMS datasets (such as those published by the MMO in the UK) can be used, but need to be made more discoverable. • The Marine Protected Areas challenge identified that, generally, the data sets provided by the Biology Portal relate to data collected over short time periods or in relation to specific species in target locations, which was not useful for basin-wide analysis. No basin-wide studies were found which looked at the connectivity of species between MPAs. It is recommended that a list of 'priority' species be drawn up and associated methods then derived for analysis of MPA connectivity. • Also, there was a lack of spatial information with regards to certain and larval dispersal patterns within the MPAs. • The Oil Platform challenge identified gaps in the data supporting distribution of seabirds and marine mammals, also fisheries activity on a timescale shorter than a whole year. • Overall, data concerning fisheries and marine species (and bird) migration was a recurring inadequacy across the challenges. It is recommended that this be made a priority area for attention.
Migratioh from rivers	Arctic	• There is no ready-to-use information on fish migration from and to the Arctic rivers. Only combining results from monitoring programs in and outside rivers gives an impression of the fish migration
	Baltic	• Little observations of salmon in river runoff were found

Parameter	Seabasin	Results
	North Sea	• The River Inputs challenge found that the data, for species of salmon and eel, only the UK (specifically England) held comprehensive datasets that included abundance of the fish. • Several datasets were not fully useable due to the lack of metadata detailing location or dates of collection. Where data was not geo-referenced it was difficult to determine if it was useful for the challenge.
Alien species	Arctic	• There are about 94 alien species which invaded the Arctic Ocean. • Some invasive species in the Arctic altered the habitat locally.
	Atlantic	• The European Union lacks a comprehensive framework to address the threats posed by the introduction and spread of non-indigenous species (NIS). Current efforts are fragmented and suffer substantial gaps in coverage. One of the problems facing the designers of roadmaps, programs and management measures of NIS is the lack of standardisation of terminology and metrics to describe the status of biological invasions, influenced, in turn, by quality, validity and potential bias of the underlying data. At present, data are rarely if ever gathered through standardized surveys specifically designed to detect NIS. Poorly studied NIS taxa, NIS in poorly-studied habitats and regions, small-bodied species and additional lacunae impede our understanding of NIS diversity. Existing data suffer from being referenced a lot in publications, so although data are easily found and get 75% of easy download, responsiveness and readiness are low. Data policy and its visibility are very low, probably due to the absence of these indicators in web sites dealing with this topic which are still in their early development.
	Baltic	• Alien species data are available from AquaNIS database, ICES and research communities; monitoring data is completed by the geo-referenced information from literature sources; it is recommended that point information should be completed by empirical modelling to show the areas where Non-Indigenous Species (NIS) are already present and may spread in the future.
	Black Sea	• There is no comprehensive data set for alien species in the Black Sea
Fish	Arctic	• Collected data on fisheries discards and/or bycatch is less readily available than landings or catch data. It was therefore not possible to generate overall comprehensive overview of discards and bycatch in the Arctic area; only fragmented data has been found. • For fisheries catch data used in the checkpoint assessment it is not always clear whether it relates to commercial fisheries catch or fisheries landings.
	Atlantic	• Fisheries data are not covered by the EMODnet "Human activities" lot but by the Data collection framework mechanism (DCF). Data on discards and incidental bycatch (e.g. marine predators) are not available for many countries in the Atlantic and only available on special data call from Member States. More specifically, data on PETS (Protected, endangered and threatened species) bycatch is scarce. • In general there are no programs collecting landings in terms of number of fish, thus this information is not available in the DCF database, an issue for the "fisheries management" challenge which has to report these figures.
	Baltic	• Fish landing data are adequate for stocks where relevant/available and used for stock assessment and subject to continuous improvements of sampling programs.

Parameter	Seabasin	Results
		• Fish discard data are acceptable for stocks where used in stock assessment and subject to uncertainty check. • No regular monitoring on the fish bycatch, the data generally adequate for the purpose when available and availability limited.
	Black Sea	• The Challenge 06-Fisheries and Challenge 07-Fishery impact have the best scores, probably due to the fact that source of data is well defined and available.
	Mediterranean	• Fishery data, such fish catch and by-catch, fish abundance in the water column are at the top of the list for their inadequate availability and appropriateness indicators. The key inadequate quality attributes for this monitoring are: visibility, EU INSPIRE catalogue, data policy visibility, readiness, data delivery and data policy, horizontal and temporal coverage, temporal validity.
HABITATS	Arctic	• There are also different European initiatives, e.g. EUNIS and MAREANO project, that provide some kind of habitat information for specific Arctic parts of the Northeast Atlantic.
	Atlamtic	• There's a need for better availability of habitat-related sample point data: the UK Marine recorder is a huge habitat-related database that has stored and made available for years all sample point data that were collected in the UK and Irish waters with a view to produce habitat maps. For each sample point the habitat type is characterised together with other descriptive attributes such as species, salinity or temperature regime, sediment type, etc. Unfortunately in Europe the Marine recorder is an exception. Elsewhere such data are held at best in national databases, and sometimes on personal computers, making access to this information difficult or impossible. • The literature survey reports a lack of habitat maps giving a full biological detail (maps from surveys), even in the coastal zone. Complete coverage is achieved by the EMODnet broadscale map, however with insufficient thematic resolution. • Many deep sea offshore habitats are under-studied and poorly inventoried. The most prominent data gaps involve the lack of consistent, region-wide surveys of biological data on marine species across taxa and trophic groups. This especially applies to the abyssal plain, which is under-represented, with available biological data being more restricted to surface or shallow water regions in and around coastal areas (Patricio et al, 2014)
	Black Sea	• The characteristics categories in this theme is habitat extent. • The availability indicators for this characteristic are dominantly "partly adequate" for data delivery mechanisms, easy found, INSPIRE services, pricing and "not adequate " for responsiveness.
	Mediterranean	• The characteristics categories in this theme are two: habitat characterization and habitat extent. • The availability indicators for these two characteristic categories are "not adequate" for pricing, data delivery mechanisms and responsiveness. • The appropriateness indicators are dominantly "partly adequate" TO "not adequate": temporal coverage scores "not adequate" as well as vertical coverage, horizontal and temporal validity (last time the data set was updated).

Parameter	Seabasin	Results
Fisheries impact	Arctic	• For fisheries impact on habitats, habitat information has been obtained from various sources. Different working groups within the Arctic Council provide some kind of information on important areas within the Arctic area. • Arctic: Information on fishing impact is scarce and mostly on low-spatial level resolution; it was not possible to generate an overall overview of fishing impact in the Arctic area.
	Mediterranean	• The VMS maps cover only EU MS fishing in the Mediterranean Sea. Moreover, the data were not available for all the countries (Italy, Croatia, and Spain did not provide them) while partially available for the other EU countries, and the time series does not cover the same period in the different countries. The greatest limitation of the characteristics and respective data sets is that they fail to meet the scope of the product due to the incomplete spatial and temporal coverage of the data sets. Hence, also the change of the level of disturbance of trawling on the seabed could be calculated on a shorter time period in respect to that required by the Tender. • The AIS data have a higher spatial coverage in respect to VMS data mainly because also non-EU vessels are equipped with this system. Therefore, although in the available time period there are no data for a part of the fishing fleets due to the fact that the obligation of adopting this system was gradually extended over the years, they allow to get a more spatial complete coverage of the overall Mediterranean basin in respect to VMS.
HUMAN ACTIVITIES	Atlantic	• Overall availability is quite good for Human activities data, with reservations in delivery mechanisms of which 40% are only moderate (simple online downloading) and also unclear data policy for 40% of them. • Most of the data products currently available on human maritime activities seem regionally clustered or are scarce. • For the assessment of impact of an oil spill on tourist beaches the dataset used as a proxy was the EMODnet dataset 'Quality of bathing water' which might not be comprehensive. • Aquaculture sites are often found as point locations rather than polygons boundaries. Data on shellfish aquaculture currently available on the EMODnet Human activity portal are clearly not satisfactory, as they are still mostly in point form from many sources. GIS compliant cadastre data were found for Ireland and France but are still missing elsewhere. More efforts are needed from the community to provide an effective representation of aquaculture activities suitable to address the challenges. • The Oil Platform challenge required fast data provision to support real-time operations for a variety of parameters. Among other issues, it was found that data concerning certain managed areas was difficult to obtain. • After 24 hours there was no data obtained on the locations of tourist beaches and shipping lanes and this limitation persisted through the challenge into 72 hours, particularly for the locations of tourist beaches in the Shetlands. • EMODnet human activity Lot should be extended to include more data necessary (e.g. cables and pipelines, navigation data) for the wind farm siting.
	North Sea	• The Oil Platform challenge required fast data provision to support real-time operations for a variety of parameters. Among other issues, it was found that data concerning certain managed areas was difficult to obtain.
Ship traffic	Atlantic	• Maritime traffic data (AIS vessel tracking), deemed useful for challenges such as "Oil leak" (impact of spill on traffic), "Windfarm siting" (competition for space) or "Invasive species" (ballast water as vector of species transport), are not available for download.

Parameter	Seabasin	Results
	Baltic	• AIS data are required for oil platform leak and wind farm siting, but is lacking in EMODnet. • Information required for identification of IUCN categories for approximately 15% of MPA's is not readily available, scattered among different sources and mostly in national languages. However, when access to the needed information is set, data are usually adequate for assigning IUCN categories.
	Black Sea	• Maritime traffic data provided by VTMS are very useful but should be made freely available for scientific use.
	Mediterranean	• Maritime traffic data are essential for the assigned task and input data sets are totally inadequate because of negative scores for visibility, INSPIRE Catalogue, responsiveness, horizontal and temporal coverage, temporal validity. In addition data should be made available to the research community following a protocol to be developed as soon as possible.
	North Sea	• After 24 hours there was no data obtained on the locations of tourist beaches and shipping lanes.
Tourist beaches	Arctic	• It appears there are not too many tourist beaches in the Arctic (yet).
	North Sea	• After 24 hours there was no data obtained on the locations of tourist beaches and shipping lanes.
Fishing	Arctic	• For assessing fishing impact, the coding of the presented unit of effort data is not always clear, making it not possible to use the data. • Due to privacy issues high-spatial resolution data on fishing impact is not readily available for general use. • Specific organisations that were addressed to identify accessible data did not reply. • Information on fishing impact is scarce and mostly on low-spatial level resolution; it was not possible to generate an overall overview of fishing impact in the Arctic area.
	Atlantic	• To date the most comprehensive and recent datasets available on bottom fishing effort and intensity are a series of maps generated in 2016 by the ICES Working Group on Spatial Fisheries Data (WGSFD) who assembled VMS data from vessels, coupled with log book data obtained via a data call to 21 countries of the NE Atlantic and Baltic Sea (four of them did not submit data and in another case data was worthless). These maps only cover the OSPAR area, their time coverage is from 2009 onwards and their resolution 0.05 degrees (~5 km). If the purpose is to assess fisheries impact on seabed habitats, this resolution is significantly lower than that of the broadscale habitat maps provided by the EMODnet Seabed Habitat lot (250m). Quality assurance is non-existent and this needs to be rectified.
	Baltic	• Fisheries data (VMS-data) are spatially and temporally restricted, they are only available at a scale of grid-cell size of approx. 10 km x 5km for the years 2009-2013 at a yearly scale. • For fishery impact assessment, species data are considered available and adequate, but variable in quality, e.g., variable prediction confidence in modelled data and substantial extrapolations due to lack of ecological data in some areas.

Parameter	Seabasin	Results
	North Sea	• Some fishing datasets have been aggregated to a level which hampers their use. For example, the ICES WGSFD dataset has aggregated fishing data across countries, leaving no possibility to assess which countries are connect with fisheries in a given area. • JRC and ICES datasets were free. National datasets, however, were potentially expensive. For example, when quotes were requested to provide several years of landings and effort data, Denmark quoted €20,000 - €30,000 and the Netherlands €15,000 - €20,000.
	Mediterranean	• Fishery data, such fish catch and by-catch, fish abundance in the water column are at the top of the list for their inadequate availability and appropriateness indicators. The key inadequate quality attributes for this monitoring are: visibility, EU INSPIRE catalogue, data policy visibility, readiness, data delivery and data policy, horizontal and temporal coverage, temporal validity
		Cross-cutting issues
LEGAL FRAMEWORKS Marine Directive	Atlantic	• Within the framework of the DEVOTES Project, Patricio et al. (2014) performed an analysis of the successes, failings and opportunities in the present monitoring systems, especially in relation to the biodiversity-related MSFD descriptors of good environmental status namely D1 (biological diversity), D2 (Non-indigenous species), D4 (Food-webs) and D6 (seafloor integrity). Below are the main weaknesses that the study identifies for the North Eastern Atlantic region. - The Macaronesian biogeographic region and the wider Atlantic (offshore areas) are poorly monitored; - Microbes, cephalopods and reptiles have limited coverage; - Monitoring of bathyal and abyssal habitats is not undertaken in many subregions (e.g. monitoring programmes in the Bay of Biscay and Iberian Coast subregion do not cover "upper bathyal rock and biogenic reef" or "upper bathyal sediment"); - Pressure "extraction of Maerl and Seaweed" is poorly covered; - In the Macaronesian subregion only 11 out of the 37 pressures considered in the analysis are addressed by the monitoring programmes; - The number of monitoring programmes that address D2 and D6 is limited compared to the number of programmes that address D1 and D4; - For a number of biodiversity components quality assurance is non-existent. This needs to be rectified.
	Black Sea	• EC directives are applicable for Bulgaria and Romania, but all Black sea countries are members of the Convention on the protection of the Black Sea against pollution.
	Mediterranean	• The fishery impact product was produced with upstream data sets that "fail the most" to meet the scope of the product due to the incomplete spatial and temporal coverage. • Another problem to compute fishery impact is that VMS data processing and production of anonymous maps requires technical capabilities not always developed in each country and, also in the case that the country has such competence, accessibility to the data set is still not easy as the competent authorities and/or the scientific bodies responsible for the data storage and processing do not often facilitate data access (e.g., Italy).

Parameter	Seabasin	Results
	North Sea	• The INSPIRE themes which relate most strongly to the challenges are Hydrography, Oceanographic geographical features, Atmospheric conditions, Habitats and biotopes, and Species distribution.
		• The key issues affecting access to data include commercial sensitivity, intellectual property and cost. This means that it may be difficult to obtain relevant data, leading to the use of inferior or patchy data for projects where timescales do not allow for more complete information to be accessed. • EU data standards were helpful for basic information on designations of MPAs but countries implement MPA management plans at different paces and so availability of these data varies. Language was also a restriction when locating national information in some countries.
	Arctic	• The World Database on Protected Areas contained 90% of the MPAs, but is not complete.
THE CHALLENGES	Atlantic	• Eleven challenges were defined by DGMARE in their tender. We found in Atlantic that several topics were left out of this list. This is the case for "pollution of the water column" in general, but more specifically by contaminants, micro-plastics, acidification, sound etc. • Coastal surge (under the action of either storms or tsunamis) and related issues around coastal defence is also an important block of applications not dealt with by the checkpoints.
	Black Sea	• Starting with the Challenges, it is evident that the Challenge 06-Fisheries and Challenge 07-Fishery impact have the best scores - mostly "fully adequate". The worse cases are for Challenge 01-wind farm siting, Challenge04-Climate, Challenge10-Bathymetry and Challenge11-Alien Species where the "not adequate" and "fully adequate" values are in equal proportion or "not adequate"-yellow is dominant. • The Challenges refer to different data sets for the same characteristics. This highlights a gap in the sharing of information across disciplines in the marine community. While this could generate low quality products in one Challenge that uses multidisciplinary data sets, it might also be an indication of a duplication of efforts in the monitoring system. • The analysis clearly shows that most "red" and "yellow" scores are related to the Easily found, INSPIRE catalogue service and Visibility of Data policy indicators. This highlights the lack of an adequate data management infrastructure at the Black Sea basin scale level. • Whenever the characteristic category is monitored by "observations" instead of "model" outputs, the availability indicators for the data sets are less adequate, highlighting the lack of adequate availability of the observational data sets with respect to the model ones. • The input data sets regarding atmospheric characteristics are not adequate to meet the needs of the Challenges, which is probably due to the lack of an open data policy at the level of meteorological organizations.
	Mediterranean	• Challenge products quality (79 different Challenge products were generated) was assessed by means of appropriateness indicators and expert opinions. The results show that: (1) most of the products have consistent quality with respect to the Product requirements established before designing the product except for the sediment mass balance product that was not produced because of total absence of adequate data; and (2) the largest Challenge product errors are linked to inadequate horizontal coverage and resolution and to temporal validity of the resulting product.

Parameter	Seabasin	Results
	North Sea	• Overall, it was found across all the challenges that the metadata describing potential datasets wasn't sufficient to evaluate whether it could be used – the data had to be obtained and analysed before this could be ascertained. About 15% of datasets initially identified were used, whereas only 30% were rejected after a first evaluation. It is therefore recommended that initiatives be undertaken to introduce a simple, structured standard for marine metadata, focusing on clarity of parameters described, spatial and temporal coverage and resolution.
Data visibility	Atlantic	• To address poor data visibility, there is a need for: - data indexing: many datasets are indexed in thematic catalogues however finding these catalogues requires some expertise. Assembly data initiatives such as EMODnet attempt to fill this gap, however users are faced with a huge amount of data. A Master Directory to route end users towards the appropriate data sources is needed. NASA's Global Change Master Directory (http://gcmd.nasa.gov/) is an example which could be considered although it is limited to climate change. - better website indexing and design: Search engines are now the main tool to search and hopefully find data. However data portals and data providers' web sites suffer from several limitations entailing a waste of time and potential gaps due to sources of data being hard to locate. Most users do not go further than the first 2 pages of their search, which means data providers have to optimize their sites to be easily found among the top 40 results returned by a search. The Search Engine Optimization (SEO: https://en.wikipedia.org/wiki/Search_engine_optimization) is a series of techniques to meet users' needs which are probably overlooked by data providers, especially institutional and academic bodies. In addition the lack of standard and guidelines for harmonised web sites is a brake to the use of existing data. - further use of DOIs: DOIs provide persistent links to contents, helping users get to the authoritative, published version of the contents they are searching for, even when contents change location or ownership. Assigning DOIs to datasets and other research objects supports simple and effective methods of data citation, discovery and access. Citable data become legitimate contributions to scholarly communication. The use of data DOI should improve data search by providing links from scientific papers to datasets and their descriptions and will contribute to a better indexing of dataset by search engines in directories and catalogues thanks to the name provided for citation. - ommon vocabularies: one of the difficulties in finding data is the lack of a vocabulary common both to data providers and end users allowing discovery not only at catalogue but at portal level. To increase the relevance of a website to specific keywords, the use of the SeaDataNet common vocabulary lists (P03 and P02 in particular) by both providers and end users as tags and user words would make searches more efficient • Identifiers: common vocabulary and definitions have to be adopted by the different data providers.

Parameter	Seabasin	Results
		• Low visibility of data policy: data policy, when existing, is available either in a document related to the whole data collection, or within a web page, or attached to each dataset description in data catalogues, or in a README file for download with the data file (e.g. Scripps Global Topography). When the data policy is available on a web site, it is often difficult to find due to a lack of consistency in portal design. It can be found in menus such as: "Service commitment and licence " (Copernicus), "Acknowledgment" (Emodnet Chemistry), "Terms of use" (EMODnet Geology), "Disclaimer" (GEBCO) or sometimes "Data policy" etc. The lack of guidelines about the legal constraints make it difficult to know if data can be used and the lack of Service Level Agreement ensuring that users get the information in due time are potential sources of gaps. Guidelines for writing and displaying data policy in an understandable manner on data web sites would be useful and these conditions should be specified in EU calls for tenders. As a result this low visibility prompts end users to wrongly equate the presence of a downloading service with open data access.
	Atlantic	• Low data sharing: in the Atlantic more than 25% of the datasets required by the challenges suffer from restrictions or lack of information on the conditions of use. Restrictions concern mainly the Fisheries management, Bathymetry and Invasive Species challenges. It is noteworthy that most data available through publications fall in these categories. Data status is complex, depending on the kind of use: open to any kind of application, only to academic use, at a cost for commercial use or fully restricted. This variety of constraints is described using various wordings making it difficult to understand the policy and then to report it in a unique identifier
	Mediterranean	• Adequacy of availability indicators is low for 19 categories of monitoring data at the basin scale. Sub-diving them into "themes" they are: - for geology: sedimentary structure data is totally inadequate in terms of Data Policy, Pricing and Readiness and quite inadequate for INSPIRE Catalogue and responsiveness; - for physics: wave data (spectra, wave height and direction) is totally inadequate for the visibility, the EU Catalogue and the Data Policy visibility; - for chemistry: pollutants in the water column (oil) are totally inadequate for almost all the availability indicators (7 over 8); - for biology: sea birds and fish characteristics (abundance, reproduction, behaviour) are totally inadequate for visibility, INSPIRE Catalogue and Data Policy Visibility; - for habitat: habitat extent is totally inadequate for Data Policy, Data delivery and and responsiveness - for human activities: fish catch and by-catch, horizontal platform movement (maritime traffic), marine archaeology, marine environment leisure usage are totally inadequate for visibility, INSPIRE catalogue, and readiness. - for others: atmospheric conditions in general are totally and partly inadequate.

Annex A: Indicators for Mediterranean and Black Sea Checkpoints

		Indicator	Explanation
Availability	visibility	easily found	can the data sets or series of data sets be found easily?
		EU INSPIRE catalogue service	is the dataset referenced by a eu catalogue service or other bodies (private or public, national or international non eu services)
	accessibility	policy visibility	visibility on data policy adopted by data providers.
		delivery	data delivery mechanisms, i.e. the services available to the user to access data
		data policy	data policy
		pricing	cost basis / price policy
	performance	readiness	format for use
Appropriateness	completeness	horizontal spatial coverage	horizontal extent of product
		vertical spatial coverage	vertical extent of product
		temporal coverage	temporal extent of product
	consistency	number of characteristics	number of characteristics in product
	accuracy	horizontal resolution	horizontal mesh size or equivalent value for the given scale of product
		vertical resolution	average vertical sampling and description of specific vertical sampling schema
		temporal resolution	temporal sampling interval of product
		thematic accuracy	percentage error of the product and description of error concept for the product
	temporal quality	temporal validity	max elapsed time between last input data records update and product creation date

Please note the following score rules

"red" means "not adequate",
"yellow" means "partly adequate" and
"green" means "fully adequate"

EMODnet Stakeholder Conference & Sea-basin Workshops

Stress-testing European Marine Data – Towards a European Ocean Observing System

14 -15 February 2017

Royal Flemish Academy of Belgium for Science and the Arts

Brussels, Belgium

EMODnet

European Marine Observation and Data Network

Conference Chair: Phil Weaver (Chair of the EMODnet Steering Committee)

14 February 2017

09:00-12:30 Plenary Opening: Stress-Testing European Marine Data – the EMODnet Sea-basin Checkpoints

- **Welcome and setting the scene – 10'**
  Jan-Bart Calewaert (Head of the EMODnet Secretariat)
- **Importance of data & information for users of ocean and coastal space and the role of industry as users and providers of marine data – 30'**
  Keynote by Val Cummins (Irish Maritime and Energy Resource Cluster)
- **Concept and challenges of the EMODnet Sea-basin Checkpoints – 20'**
  Iain Shepherd (EC, Directorate-General Maritime Affairs and Fisheries)

/ Coffee break from 10:00 until 10:30 /

- **Results of the EMODnet Sea-basin Checkpoints to date – 90'**
  Jun She (Baltic), Nadia Pinardi (MedSea), Quillon Harpham (North Sea), Mikaël Vasquez (Atlantic), Atanas Palazov (Black Sea), Belinda Kater (Arctic)

/ Lunch from 12:00 until 13:30 /

13:30-17:00 Breakout session with six regional Sea-basin Stakeholder Workshops (in parallel)

Evening reception & networking dinner from 17:30 until 20:00

14 February

15 February 2017

09:00-12:30 Plenary Closing: Improving Europe's Marine Observation Capacity

- **Outputs and recommendations from the Sea-basin Stakeholder Workshops – 90'**
  Jun She (Baltic), Nadia Pinardi (MedSea), Quillon Harpham (North Sea), Mikaël Vasquez (Atlantic), Atanas Palazov (Black Sea), Belinda Kater (Arctic) - 60' updates + 30' discussion

/ Coffee break from 10:30 until 11:00 /

- **Outcome of the Consultation on establishing a European Ocean Observing System (EOOS) – 15'**
  Glenn Nolan (EuroGOOS)
- **Marine data & observations for storm surge forecasting and other Met Office ocean modelling - 30'**
  Keynote by Clare O'Neill (Ocean Modelling Scientist, UK Met Office)
- **Concluding panel discussion: Towards improved data collection and open access - Synthesis of findings from the Conference – 75'**
  Bernhard Friess (EC, Directorate-General Maritime Affairs and Fisheries),
  Niall McDonough (European Marine Board),
  Simon Jennings (ICES), Samantha Burgess (WWF),
  Val Cummins (Irish Maritime and Energy Resource Cluster)

/ Lunch from 13:00 until 14:00 /

14:00 -18:00 EMODnet Steering Committee Meeting **(closed meeting)**

15 Feb

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