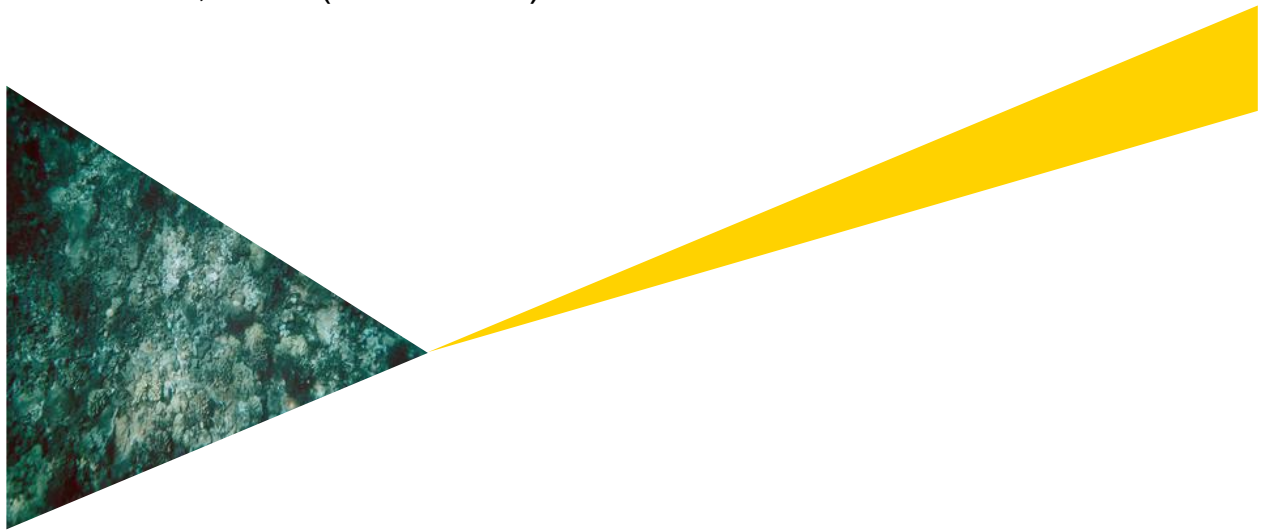


DG MARE

Assistance in elaboration and prospective evaluation of the Atlantic Action Plan

Thematic report "Coastal and deep sea natural resources"

19 October, 2012 (Version 3.0)



A project undertaken by the Consortium comprising:

- COWI
- Ernst and Young
- BIOIS

This report has been drafted by the Consortium, on behalf of DG MARE.

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1. Foreword

The EU Directorate General for Maritime Affairs and Fisheries (DG MARE) and the Atlantic Forum has initiated a stakeholder process for the development of an action plan for the Atlantic Ocean Area.

As part of the development of the action plan, five workshops will be held. For each workshop, a thematic report will be prepared to inform discussions.

The purpose of the thematic report is to inform each workshop by providing background information on the workshop's discussion topics. The thematic report poses questions and provides potential recommendations for the Atlantic Action Plan that can be used as a starting point for discussions. After the workshops, conclusions and comments have been incorporated into the thematic reports.

On completion of all workshops, DG MARE will compile recommendations for priority research, investment and policy actions in an Atlantic Action Plan. The Atlantic Action Plan will implement the five themes of the Atlantic Strategy (COM (2011) 782):

1. Implementing the ecosystem approach
2. Reducing Europe's carbon footprint
3. Sustainable exploitation of the Atlantic seafloor's natural resources
4. Responding to threats and emergencies
5. Socially inclusive growth.

DG MARE has commissioned COWI and E&Y to assist with the development of the Atlantic Action Plan. The work has been launched under the framework contract for impact assessments and evaluations, referenced MARE/2011/01 Lot 1 Maritime Policy.

The objectives of this assignment are to:

- ▶ Support the development of the Atlantic Action Plan
- ▶ Prepare its performance monitoring and evaluation modalities (performance framework and indicators)
- ▶ Undertake its ex-ante evaluation.

Any suggestions for the thematic reports are most welcome. Please do not hesitate to contact COWI (Christina van Breugel, cvbr@cowi.dk) if you have ideas or comments that may encourage and support the further development of the thematic report.

2. Introduction and context

The aim of this report was to inform the discussion at the workshop held on 20 and 21 September 2012 in the Azores. The workshop theme was "Coastal and deep sea natural resources" and included the following themes of discussion:

- ▶ Subtheme 1 - Coastal and Deep Sea Natural Resources knowledge
- ▶ Subtheme 2 - Mineral resources – Exploration and Exploitation
- ▶ Subtheme 3 - Bio Resources – Exploration and Exploitation
- ▶ Subtheme 4 - Research and Technology
- ▶ Subtheme 5 - Access and Preservation
- ▶ Subtheme 6 - Support to innovation and Entrepreneurship.

The workshop report and conclusions can be found in Annex A. To provide background information for the workshop, each of the subthemes above was introduced by a description of the context, the baseline scenario and an assessment of the situation. Further, potential recommendations were presented. These discussions and considerations can be found in Annexes B to G of this report

In sum, the thematic report synthesises baseline, trends and outlook into an analysis of gaps and possible recommendations for the Atlantic Action Plan. The focus has been on major trends as local interests are outside the scope of the Atlantic Action Plan, which aims to be a general and generic action plan for the whole European Atlantic region. However, inspiration has been found in local initiatives, which have the potential of being implemented on a larger scale.

The document will be used for the development of the Atlantic Action Plan.

3. Baseline situation - trends - outlook

This report concerns the exploration and exploitation of natural resources found in the coastal and deep-sea areas of the European Atlantic basin, specifically marine minerals and biological resources for biotechnology. Fishery and aquaculture resources are not considered here but in a dedicated report on ecosystem services.

Biotechnology

The biotechnology sector is characterised by few operators doing pioneer work. The companies have strong links to the research societies in the Member States with an Atlantic coastline and have mostly emerged from these.

Activities are partly financed by public research funds and partly by private funds in the sector and the necessary financing seems to be available for sector operations. The value added from these companies is still modest, but there is expectation that this will change in the near future.

The impact on the environment of sector operations is limited as the samples collected in the sea are analysed or further processed in laboratories, typically onshore.

The companies in the sector have strong links to the research communities in the five countries, most of them having emerged from these communities. The impact from the operations of this sector on the marine environment is considered minor, since the volumes of collected samples are very small. Typically, analyses are conducted in laboratories, and large-scale production processes take place in dedicated onshore facilities.

Minerals

The minerals exploration and exploitation sector is more developed than the biotech sector, however, concerning deep-sea exploration and exploitation, there is a way to go before operations can be commercialised on a large scale, if they prove profitable. Today, activities are on a small scale in the European part of the Atlantic Ocean and the technologies to exploit resources still need to be further developed to accommodate deep-sea operations and to become cost effective. In addition, the presence of minerals needs to be determined more accurately. Today, some locations rich in resources are known, e.g. in areas with volcanic activity. The impact on the sea floor from exploiting the minerals can be severe, but the impact on e.g. the ecosystem is still unknown. The impact will naturally depend on the scale of exploitation and methods used.

Presently, it is estimated that approximately 8.7% of the total number of marine species is known, this figure being a mere 0,0001% of all species inhabiting the deep sea¹. Current expectations are that deep-sea habitats contain a large number of species with greater genetic diversity and larger arrays of structurally and functionally unique molecules than marine species from shallower waters.

Exploration of marine natural resources takes place, but knowledge is scattered and limited. Presently, there are no large-scale exploitation activities in the Atlantic Ocean. However, it is foreseen that the biotechnology and natural resource sectors will emerge here in the coming years and have high growth rates in the future.² This is supported by a desire of the exploration and exploitation sectors to be first movers in the field; a wish that will nevertheless depend on their ability to combine the right skills and competencies with the ability to attract capital and ensure stakeholder involvement. Technological developments, e.g. in the offshore sector

¹ Presentation of Ricardo Serrao Santos at the workshop in the Azores 20 and 21 September 2012

² Seas-era, *A draft marine research plan for the European Atlantic sea basin*, 2011

of the North Sea, market prospects and growing knowledge, have demonstrated that the marine resource sector is still only in its very early stages but also that the sector has development potential in the short and longer term .

The attractiveness of exploiting natural resources from the sea is directly correlated with the market price of the resources. In recent years, investments in the commodity markets have risen sharply. Through its communication “Tackling the challenges in commodity markets and on raw materials”³, the EU emphasises the importance of securing availability of resources. With the “Raw Materials Initiative”⁴, the Commission stresses the need to secure a sustainable supply of raw materials, the marine areas being one of such sources.

The overview below lists different types of deep-sea natural resources and their uses in different sectors.

Resources/sector		Mining	Energy	Food	Pharmaceutical cosmetics	Other biotechnology	Construction	Manufacturing
Energy resources	Oil and gas		+			+	+	
Mineral resources	Polymetallic sulphides	+					+	+
	Cobalt-rich ferromanganese	+					+	+
	Polymetallic nodules	+	(+)	(+)	(+)		+	+
	Superficial sediment types	+					+	+
	Sand and gravel	+					+	
Biological resources	Bacteria				+	+		
	Algae		+	+	+	+		
	Marine animals			+		+		

Resources and activities

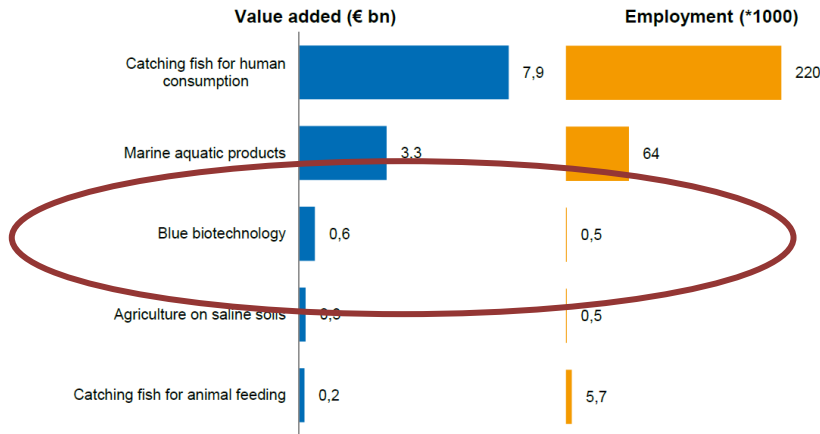
The resources in the Atlantic Ocean - in the deep sea as well as in the coastal areas - are only used to a limited extent. The total activity in the EU concerning utilisation of resources for biotechnology, aggregates and minerals is also minor when measured in value added and number of employees.

³ EU, COM(2011) 25 final, *Tackling the challenges in commodity markets and on raw materials*

⁴ EU, COM(2008) 699, *The raw materials initiative — meeting our critical needs for growth and jobs in Europe*

Figure 3-1 Value-added and employment level of specific marine food, health and ecosystem services sectors in the EU.

Food, nutrition, health and eco-system services

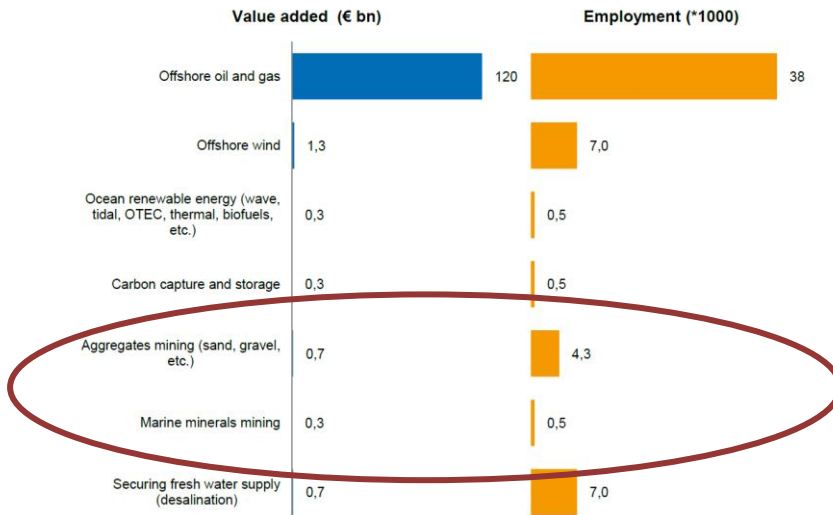


Note: Algae activities are a minor element in "Marine aquatic products" that is dominated by aquaculture

Source: DG MARE, "Blue Growth – scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts – third interim report" 2012

Figure 3-2 Value-added and employment level of specific marine energy and raw materials sectors in the EU.

Energy and raw materials



Source: DG MARE, "Blue Growth – scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts – third interim report" 2012

The map indicates the activities in the OSPAR area related to extraction of aggregates and maerl.

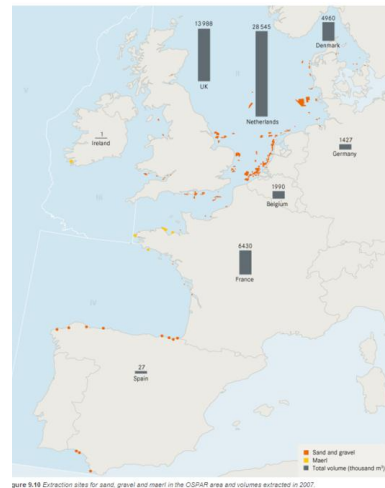
In Europe, marine mineral resource exploitation is concentrated in the North Sea, where the offshore oil and gas industry has been operating since the early 1960's. Activities in the Atlantic, on the other hand, have so far been very limited.

The potential for expanding these activities in a significant manner is very difficult to ascertain due to uncertainties in the availability, extent and accessibility of the resources.

Environmental conditions vary substantially between the different parts of the European Atlantic basin. Exploration technologies and research methodologies can thus not be applied equally across the whole basin. This is reflected in the level of knowledge available from different parts of the basin, which is particularly the case in areas further offshore, where great depths make exploration complex. Here, the level of knowledge about the presence of resources remains very limited. As a result, potential business cases worth exploring in more detail have not yet been identified. This makes estimations of the exploitable potential difficult,

The differences between the countries concerning availability and activity have not been explored in detail at this stage. It is uncertain whether such detailed knowledge is relevant to formulate an action plan due to the low level of activity in the sectors covered by this report. Identification of good, illustrative examples, such as those presented below, will allow the action plan to be inspired by flagship projects, however, this approach might leave out the potential for more local utilisation of resources. On the other hand, these national and local initiatives are expected to be given attention at national level. The importance is to avoid that they contradict the objective of a mutual Atlantic action plan.

Actions and projects related to marine natural resources are diverse and scattered, which support the indication of an early development stage with a potential. The boxes present examples of relevant initiatives.



Map: European aggregate and maerl production

Source: OSPAR QSR 2010

Orange: aggregates
Yellow: maerl

Research and development: French public private partnership on deep sea minerals

Research institutions in France (IFREMER (marine institute) and BRGM (geological survey)) cooperate with private partners (Technip, Areva and Eramet) with a view to developing the extraction process of massive sulphides. The project focuses on the French exclusive economic zone around the Pacific islands of Wallis and Futuna.

Figure 3-3 Example of public and privately funded project

Commercial projects: Pharmaceutical development of marine derived drugs; PharmaMar

Founded in Madrid in 1986, PharmaMar develops and markets drugs of marine origin. Small samples of marine organisms are analysed and processed in order to isolate relevant molecules that can later be synthesised chemically. The effort has led to 1,800 patents and 12,000 treatments of cancer patients worldwide.

Figure 3-4 Example of privately funded business

Cooperation: European network of macroalgae stakeholders (Netalgae)

Netalgae aims at creating a network of private and public institutions within the marine macroalgae sector. Actions include studying and assessing the European algae industry and regulation and establishing best practice.

Knowledge: Mapping of the seabed

In August 2012, the European Commission presented actions to map the European seabed in terms of topography, geology, habitats and ecosystems, which among other things can be used to monitor human activities. As one of several EU initiatives for enhancing synergies in deep-sea research, the project

EUROFLEETS provides access to European research vessels and associated equipment for marine scientists

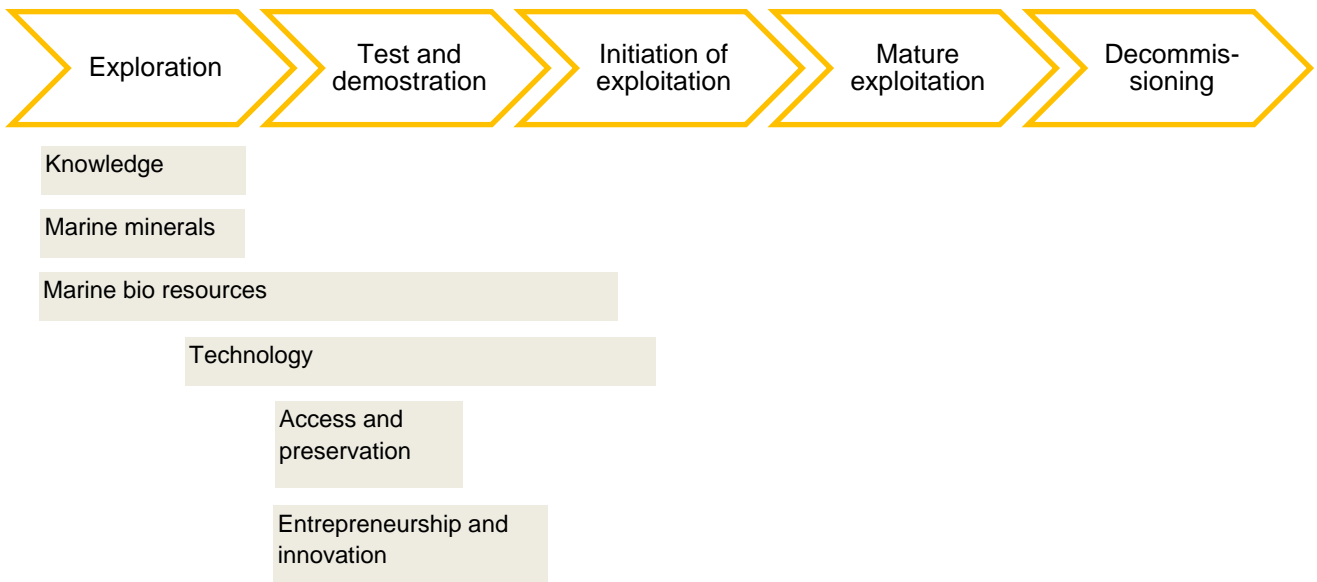
Figure 3-5 Example of EU funded initiative

In a recent, comprehensive study of the blue growth potential of marine sectors, exploitation of minerals and bio resources was grouped in the "pre-development stage: investing in jobs for tomorrow"⁵

As figure 3-7 illustrates, the level of exploitation of marine aggregates, mainly from coastal areas, in the five Atlantic countries is of little significance. Generally, the knowledge and utilization of marine natural resources from the deep sea remain in their early stages. Different aspects related to marine natural resources are, nonetheless, at varying stages of development, which is illustrated below.

Each subtheme that is a focus of discussion in the annex has been placed in the stage diagram indicating its level of maturity.

Figure 3-6 Stages of exploration and exploitation of marine natural resources in the Atlantic



This brief assessment illustrates the generally low level of maturity of developments in the marine biotechnology and mineral resources sectors. There is clearly a need to raise the general level of knowledge and especially of the presence of minerals and bio resources.

Academia and business collaboration

One of the challenges is to improve communication between academia and the business sector. This is a general issue common to many sectors, however, this does not mean that it should not be addressed in a specific context. Academia is asking the industry to point at their need for knowledge while industry is requiring an overview from the academia of the state-of-the-art knowledge. At all levels, the Action Plan should aim at improving collaboration between research institutions and businesses with a view to improving commercialisation of research results and market uptake.

⁵ The algae sector was, however, grouped with the much larger aquaculture industry as being in its "growth stage". DG MARE, 2012: Blue Growth, Final Report

Policy framework

EU2020 and resources

The EU has launched Europe 2020, which is a growth strategy aimed at making European societies global leaders in terms of competitiveness and sustainability. With the strategy, emphasis is put on three mutually reinforcing priorities; smart growth, sustainable growth and inclusive growth. To support the priorities, the Commission has put forward seven flagship initiatives, one of them being a resource-efficient Europe, another being an industrial policy for the globalisation era. The aim of the two initiatives is, on the one hand, to support the shift towards a resource efficient and low-carbon economy that is efficient in the way it uses all resources, and, on the other hand, to guide and help industry prepare to meet these challenges by inter alia promoting technologies and production methods that reduce efforts on natural resource use.

Integrated Maritime Policy

The Integrated Maritime Policy (IMP) aims at generating sustainable growth of maritime activities, in line with the objectives of the Europe 2020 Strategy for smart, sustainable and inclusive growth. The IMP has six pillars or priorities

- ▶ integrated Maritime Governance
- ▶ cross-cutting tools
- ▶ sustainability
- ▶ economic growth
- ▶ sea-basin strategies
- ▶ international dimension.

In drawing up the sea-basin strategies, priority has been given to the development of strategies to implement the IMP in the different European Seas and Oceans recognising their individual physical, socio-economic and environmental characteristics. The first implementation step is the development of strategies such as the one for the Atlantic Ocean.

Environmental policy framework

The environmental policy and legal framework seeks to protect the environment from the possible negative impacts, which human activities may cause. Often this is achieved through balancing environmental conservation needs with the operational requirements of industries, and, more generically, with aims relative to economic growth and human well-being. A number of policies need to be considered when contemplating exploring and exploiting resources from the coastal and deep-sea areas of the European part of the Atlantic Ocean.

This framework includes policies and legislation at different levels, including sector and issue-specific legislation, some of which might serve the implementation of EU directives. Other legislation might serve the protection of specific national interests. On a supranational level, the OSPAR Convention has provided a platform for countries bordering the North Atlantic to implement measures aiming at protecting and restoring its marine environment (note: OSPAR should not be termed "voluntary", it is, at least as a matter of principle, a mandatory instrument under international law, although it lacks clear enforcement and deterrence mechanisms). Activities taking place in international waters beyond the jurisdiction of coastal states are governed by UN legislation, chief among which the UN Convention on the Law of the Sea, under which the legal regime for the exploration and exploitation of the international seabed has evolved. The specific requirements found in all these instruments impose limits on the exploitation of resources from the seabed, as well as to how other marine activities may be carried out.

Especially the impact of the sea floor depending of the type of activities is likely to be in conflict with the objectives and target of the marine strategy framework directive. The same could be the case with the marine protected areas, which are appointed as a part of the implementation of the habitat directive.

Other sectors operating in the European part of the Atlantic Ocean might have other interests, such as tourism, which is very dependent on clean water and undisturbed coastal areas. The conflict of interest relating to the use of the space available is also important to consider in the formulation of the action plan.

On the other hand, there are policies in place to support such a development of the maritime area by providing an infrastructure, education of skilled employees and funding.

Infrastructure

Infrastructure on land to support maritime activities is well developed throughout the entire European Atlantic coast. Most of this infrastructure, in the form of ports and associated road and rail links is geared primarily towards maritime freight transport and fisheries, and, to a lesser extent, towards maritime tourism and related leisure activities. There is no infrastructure dedicated exclusively to the marine minerals and biotechnology sectors, firstly because the limited size of the sectors does not yet justify such investments, and second because the existing infrastructure is expected to cater for most of the specific needs of the respective activities. However, deep-sea exploration and exploitation activities rely on purpose-built equipment – vessels, remotely-operated vehicles, and extraction equipment. Required onshore infrastructure includes dedicated processing facilities and transport infrastructure, the development of which is being driven by citizen and freight mobility needs.

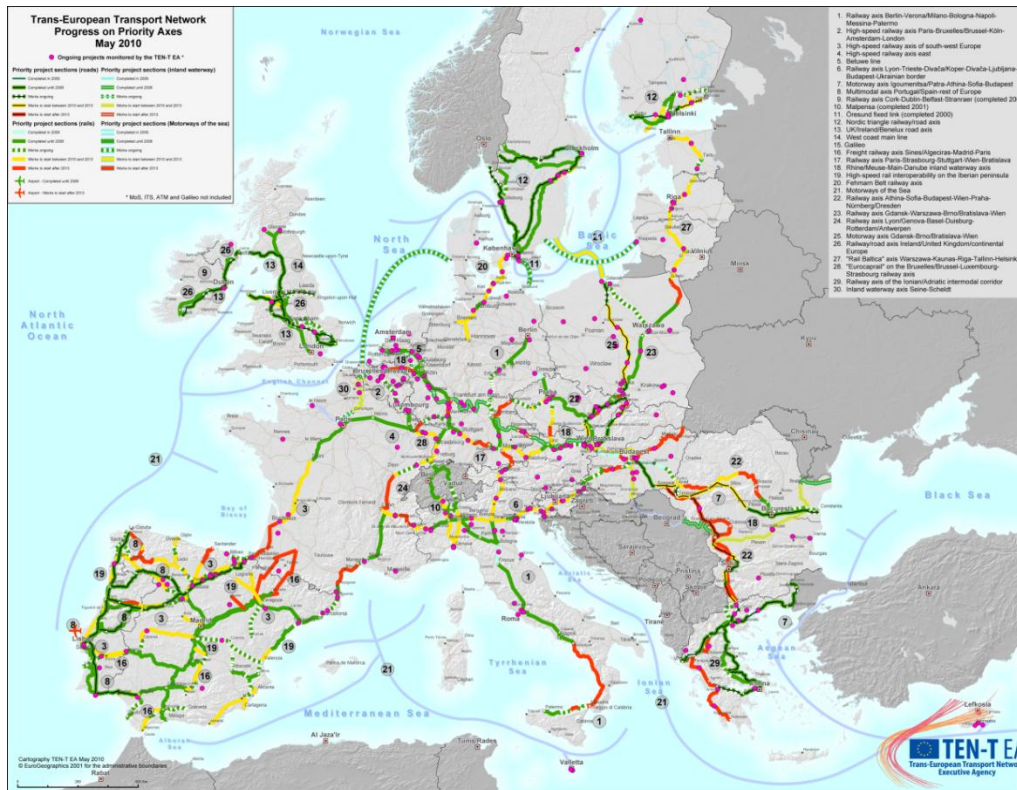
Large-scale investments in infrastructure development in Europe are framed by the EU transport policy, in particular by the Trans-European Transport Network programme (TEN-T). Of the recently approved 30 priority projects, (map beneath), close to 20 pertain directly to maritime links in the Atlantic Arc. In conjunction with these investments in large infrastructure, efforts are being directed at improving the integration of maritime with land-based modes of transport, involving, among other things, enhanced information exchange and simplified customs procedures. Because of the peripheral geographical position of the Atlantic region, investments such as these are seen as necessary for their integration with the larger EU industrial and consumer markets.

These developments, motivated today by the requirements of other sectors, will provide the marine minerals and biotechnology sectors with improved land-based infrastructure necessary for their future growth.

At this stage, the challenge might more be the hinterland to process facilities and the possibilities to locate these close to the ports.

It is important that all these facilities are sufficient making the location attractive to companies in order for them to establish themselves in the region.

Figure 3-7 Map of the 30 priority projects under the TEN-T programme (Source: TEN-T Executive Agency, online at http://tentea.ec.europa.eu/en/ten-t_projects/30_priority_projects)



Financing options

Various financing options are available to support R&D, the demonstration of new technologies or the market uptake of new products and services in the field of marine natural resources. Besides private financing options, both national and EU funding mechanisms are available.

, The following funding mechanisms can mentioned:

- grants,
- loans,
- equity investments
- leasing agreements
- interest subsidies.

The European Investment Bank (EIB) provides beneficial loans to projects at specific geographical locations or for specific challenges. However, these loans need to be paid back. The EIB are the only bank owned by and representing the interests of the European Union Member States. The EIB works closely with other EU institutions to implement EU policies.

Under its Europe 2020 strategy, the Commission has put forward seven flagship initiatives, one of them being Horizon 2020, the financial instrument to implement the Innovation Union in which all research and innovation funding of the current Framework Programmes will be bundled. Horizon 2020 aims at bringing more good ideas to market and promoting competitive industries based on scientific research. Under Horizon 2020, nearly €32 billion will be distributed to projects aiming at addressing major concerns shared by all Europeans, among them marine and maritime research and raw materials. Further €18 billion are dedicated to making European industries more competitive.

The table below presents relevant financing instruments of the EU.

The overview of the specific possibilities for support of activities in the Atlantic area still needs to be provided. Emphasis should be on the options for combining tools with a special view to fulfilling the ambitions of the European Framework Programme for Research and Innovation (Horizon 2020), which is a financial instrument targeted at creating growth and jobs by enhancing technology led innovation.

Financing instrument	Budget (2014-2020)	Specific relation to coastal and deep sea natural resources
European Regional Development Fund (ERDF)	€183.3 Billion	No specific relation to coastal and deep-sea natural resources, but the ERDF supports: Investments to contribute to creating and safeguarding sustainable jobs, through direct aid to investment in SMEs Development of endogenous potential by supporting regional and local development and research and innovation.
Horizon 2020	€80 Billion	Has a focus on raw materials under its Priority 3 on "Societal challenges" that has a budget of €31.7 Billion Priority 1 on "Excellent science" and Priority 2 on "Industrial Leadership" could both include financing of activities within marine resources.
Programme for the Competitiveness of Enterprises and small and medium-sized enterprises (COSME)	€2.5 Billion	No specific relation to coastal and deep sea natural resources, but COSME is an instrument aimed at facilitating access to finance for Small and Medium-sized Enterprises (SMEs)
JEREMIE	N/A	Allocation of contributions from the ERDF to loan, guarantee or venture capital funds to invest in enterprises. Covers SMEs in all sectors and focuses on development of new products, innovation, R&D and technological modernization.
European Social Fund (ESF)	€84 Billion	No specific relation to coastal and deep sea natural resources
Cohesion Fund	€68.7 Billion	No specific relation to coastal and deep sea natural resources
Connecting Europe Facility	€40 Billion	No specific relation to coastal and deep sea natural resources
European Maritime and Fisheries Fund (EMFF)	€6.6 Billion	No specific relation to coastal and deep sea natural resources
LIFE Programme	€3.2 Billion	No specific relation to coastal and deep sea natural resources
European Agricultural Guarantee Fund (EAGF)	€317.2 Billion	No specific relation to coastal and deep sea natural resources
European Agricultural Fund for Rural Development (EAFRD)	€101.2 Billion	No specific relation to coastal and deep sea natural resources
NER 300	Approx. €1.3-1.5 Billion	No specific relation to coastal and deep sea natural resources

Jobs and skills

As identified above, the number of people currently employed in the marine minerals and biotechnology sectors is relatively small compared with other maritime sectors. At the current initial stage of development of these two sectors, supply of and demand for workforce appear to be in balance; no salient cases of unemployment or lack of trained professionals are known. The anticipated future growth in the two sectors will require sufficient numbers of adequately skilled individuals. It must be borne in mind that both sectors require relatively high levels of education and training, as well as activity-specific competencies, often acquired in-house.

Different initiatives in the EU are relevant for preparing the future workforce for these sectors. At EU level, skills development is one of the means for achieving the aims of the Blue Growth strategy, and currently different funding mechanisms exist for training and career development at different levels that are applicable to the sectors. The Conference of Maritime Peripheral Regions of Europe is currently preparing the Vasco da Gama programme dedicated to training for the maritime sectors, with a particular focus on educational and labour mobility⁶. The Atlantic Arc Commission of the Conference, as well as individual European Atlantic countries have initiatives for strengthening marine culture and heritage that assist unemployed marine professionals to convert to other marine activities. Such mechanisms could be useful for securing sufficient numbers of skilled professionals for the marine minerals and biotechnology sectors in the future.

Initiatives

The focus of the initiatives is not limited to European countries and activities and internal cooperation. A number of projects have been identified; some directly concerned with exploring and exploiting natural resources, others with a more general and frame-setting character and others again more related to other issues, such as the challenge of the ecosystem. Naturally, there are differences in the level of maturity across the subthemes and different sectors. In some cases, the framework conditions are relatively well developed - for others, conditions are at a generic level.

A broader approach towards the Atlantic area is the INTERREG IVB and INTERREG IVB NEW, which are financial instruments of the European Union's Cohesion Policy. They fund projects that support transnational cooperation. The aim is to find innovative ways to make the most of territorial assets and tackle shared problems of Member States, regions and other authorities. One of the priorities is the protection and use of marine environmental resources. The following examples serve as mention:

- ▶ EnAlgae is a project financed by Interreg IVB North-West Europe that aims to reduce CO2 emissions and dependency on unsustainable energy sources.⁷ The project is developing sustainable technologies for algal biomass production, bioenergy and greenhouse gas (GHG) mitigation, taking them from pilot facilities through to market-place products and services.

Still, within the Interreg programme, the Interreg IVA applies to cross-border regions, and in some instances it has been supporting projects with direct relevance to the theme of this report. Illustrative examples include:

- ▶ The two RAIA projects supported by the Spain-Portugal Interreg IVa programme, aiming at enhancing ocean observation and operational oceanography across the North Portugal-Galicia region;⁸
- ▶ The IBEROMARE project, supported by the same programme, dedicated to the identification of high-value marine resources and the development of processes for (re-)utilisation of byproducts of the fish processing industry
- ▶ The MEDON project, financed by Interreg IVa Manche (France-United Kingdom) programme, to establish novel real-time coastal observatories, and involving the strengthening of regional clusters and centres of excellence in marine science and technology, together with local companies
- ▶ Under the same funding programme, project CHARM 3 aims at expanding knowledge about maritime activities and the marine environment in the Channel, to enable better management of those activities and protection of the environment;

⁶ More information at <http://www.crpm.org/index.php?act=13,33>.

⁷ <http://www.enalgae.eu/>

⁸ <http://www.observatorioraia.org>

- ▶ Also in the Channel, the Plymouth University-led project VALMER to investigate social, economic and environmental values of marine and coastal ecosystem services;
- ▶ Finally, project SETARMS aiming at improving the management of dredging activities in Channel ports.

A large number of cross-border projects to stimulate partnerships between different stakeholders have also been created. It is not known to which extent companies active in the exploration and exploitation of marine resources have participated in those.

Initiatives have also been taken to strengthen collaboration across the Atlantic Ocean and to improve marine governance in national and international waters. As the impact of climate change on our oceans and coasts and our global demand for marine resources increase, the need to develop an integrated holistic marine governance framework between the US and the EU has become increasingly important. An example of a project in this vein is the CALAMAR (Cooperation Across the Atlantic for Marine Governance Integration), which initiated a transatlantic stakeholder dialogue.⁹

Another example is the BASIN, which is a research programme in the field of ocean ecosystems in support of the Global Earth Observation System initiative.¹⁰

The research activities and knowledge are focused on the mapping of resources and the interactions between environment and activities. The more mature research is undertaken in the biotechnology sector, and there is a tradition here for a deeper involvement of the private sector. Important lessons might be derived on how to get closer to the market.

Baseline assessment

From a generally modest activity level of today, trends in research, technology and market can drive the development in the area forward. Relevant baseline trends can be seen in table 3-1, and the role of the Atlantic Action Plan can be regarded as aiding an intensification of the baseline development. The examples of trends in the table are based on the information available at a generic level.

For each of the six themes the examples have as far as possible been divided into current activities, research trends, technology trends and market trends. For some of the themes, not all categories are relevant and there will be overlaps between some of the subthemes.

The table shows that a number of trends overlap for several subthemes.

⁹ <http://www.calamar-dialogue.org/>

¹⁰ <http://www.globec.org/index.php?id=250>

Table 3-1 Examples of baseline trends for each subtheme

Subtheme	Current overall activity	Research trend	Technology trend	Market trend	Other
Subtheme 1: Knowledge	Medium - when compared to other areas of marine research	Structure and functioning of deep-sea marine environments; Assessment of impacts of human activities and global change; Mapping and characterisation of deep-sea resources.	Development of instruments for deep-sea exploration; Integration of data repositories; Technologies for multi-layer high-resolution mapping.		EU-wide high-resolution seabed mapping launched in 2012. Fulfilment of MSFD requirements; Understanding and predicting climate change impacts; Strengthening collaborations with USA and Canada.
Subtheme 2: Minerals	Very low	Low level of initiatives; publically funded	Adapt well-developed offshore hydrocarbon technology to greater depths; ensure environmental sustainability	Emerging private companies; increasing prices of minerals	
Subtheme 3: Bio resources	Low	Numerous initiatives both private and public	More cost effective methods for DNA-sequencing	Sizeable and growing global market, but high production costs	
Subtheme 4: Research and technology	Medium	Availability and commercial viability of deep-sea resources; Discovery and investigation of novel organisms for marine biotech.	Instruments for deep-sea exploration; Genomics analysis methods; Cultivation of marine organisms for research and industry.	Reduction of exploration and production costs; Novel biotech products from marine organisms; Environmentally-friendly exploitation.	Models for public-private partnerships in research funding.
Subtheme 5: Access and preservation	High - many general policy initiatives present	Need for overview of the framework and interpretation of them in the context of maritime resources	To prevent negative impact from operation - focus at this stage on the challenge of utilising the resources		Infrastructure is being improved. National implementation and interpretation in ongoing
Subtheme 6: Entrepreneurship and innovation	Low	Need for more on the market uptake and demonstration	Adaption of technologies used in the offshore hydrocarbon sector.	Emerging private companies; increasing prices of minerals	Secure supply of resources. Increased impact of land based mining

4. Gap analysis

This chapter gives an overview of the gaps identified in the analysis of the individual subthemes. To provide an overview more related to the suggestion for actions to be given later they have been categorised into the following areas::

- ▶ research
- ▶ funding
- ▶ policy framework
- ▶ coordination and cooperation.

The gaps were identified based on the background analysis, the information gathered at the workshop in the Azores and through a number of target interviews.

The gap analysis was made individually for each of the four groups above allowing for a systematic assessment of the development of initiatives at this stage. The gaps or shortcomings differ widely across groups, and the level of detail for each gap varies accordingly. The summarisation of gaps for each group attempts to provide an overview of the gaps in the appropriate context.

Research

The following gaps within the area of research were identified:

- ▶ Research not sufficiently directed towards the commercial feasibility of deep-sea resource exploitation, in particular market uptake:
 - ▶ Distribution, size and accessibility of deep-sea resources, in particular as regards minerals
 - ▶ Impacts of exploitation on marine ecosystems, in particular in the deep sea
 - ▶ Knowledge of the cost and benefits of the exploitation of resources.
- ▶ Insufficient pooling of national resources and assets to address topics of regional concern
- ▶ Limited development of new products and services based on marine biological and mineral resources
- ▶ Absence of systematic and standardised mechanisms for the harmonisation and sharing of research data in general, and of data on marine biological and mineral resources in particular
- ▶ Very low number of research consortia combining experts from academia, businesses and policy institutions
- ▶ Absence of a multidisciplinary research centre for investigating the multiple societal benefits from deep-sea biological and mineral resources
- ▶ Limited public outreach activities related to marine research in general and deep-sea research in particular.
- ▶ Insufficient research focus on processes and technology for exploiting deep-sea resources in a manner that is simultaneously cost-effective and protective of the environment
- ▶ Insufficient experience of appropriate business models for activities in these sectors, including public-private partnerships.
- ▶ Insufficient understanding of the processes for overcoming the uncertainty associated with new commercial explorations of deep-sea biological and mineral resources, so that these sectors may become attractive to new businesses
- ▶ Insufficient experience of appropriate business models for activities in these sectors, including public-private partnerships.

In general, the lack of research is not just a lack of activity in general, but rather a lack of a common guiding objective for the research for the area of the European part of the Atlantic area combined with specific knowledge gaps. To allow for a sharing of results and assets, a close relationship between researchers

would be beneficial. There are few cross-country initiatives and a clear tendency to work for national objectives and rather than for the sea basin of the Atlantic as a whole.

Further knowledge of the resources of the deep sea requires targeted research. One area of research covers determination of seabed properties, which is very well in line with the needs of companies trying to assess the possibilities of developing a proper business plan.

Further research of technologies to explore and exploit at deep sea is needed, and a mutual effort would speed up this process. In addition, sharing of existing technology such as robotic equipment would e.g. help the process of mapping the seabed and marine resources in general.

The final general trend, which will be overlapping with cooperation and coordination below, is the ability of research to move closer to the market, including shortening product maturing time. To achieve this, the research community and businesses need to improve their ability to communicate together. Other initiatives to bring about this change could be the sharing of information through publicly available databases.

Funding

Initially, the following gaps within the existing funding mechanisms were identified:

- ▶ EU and national funding not sufficiently directed towards the exploitation and utilisation of marine biological and mineral resources
- ▶ Generalised absence of funding mechanisms specifically targeting regional research and technological development activities in the Atlantic area (the SEAs-ERA FPT consortium has started doing this, with a dedicated call earlier this year, and this will probably become clearer when their maritime research plan for the Atlantic is adopted)
- ▶ Relatively low levels of funding, and low diversity of mechanisms to support business-academia collaborations and market uptake of research findings e.g. incubator platforms, research vouchers
- ▶ In addition to the funding of specific research activities, support should also be granted to actions enabling collaborations between research centres, coordination of research activities, pooling of facilities and equipments, and sharing and harmonisation of data

At this stage, many funding mechanisms are available to improve knowledge of marine waters, develop the infrastructure, improve the skills of workers etc. The challenge might be to create an overview of options and mobilise the resources necessary for applying for funds.

From the business perspective, the sectors vary a lot in how they express their needs. In general, they are very likely to be able to find private funding if the business case is reliable. They combine different mechanisms and use the mix to finance the development project. Again, the challenge is creating an overview and maybe to initiate to combine smaller projects into larger interventions. The bigger scale projects would open up for other funding possibilities.

Researchers mainly receive public funding from national or EU sources. Today, there is no coordination among researchers even at the national level. Therefore, efforts could be made to make sure that more results are communicated to a wider audience. In addition, to move research activities closer to the market, it could be made obligatory for a research project seeking to approach the market that a business plan is prepared. This trend is also seen in the HORIZON2020 objectives.

Policy framework

Initially, the following gaps in the policy framework were been identified:

- ▶ Uncertainties relative to the constraints that the Marine Strategy Framework Directives and the EU nature conservation directives might impose on future marine resource exploration and exploitation, in particular in the deep sea
- ▶ Absence of a comprehensive, harmonised and clear legal and institutional framework for exploration and exploitation of deep-sea resources in the European Atlantic basin, both within and beyond national maritime jurisdictions

- ▶ Uncertainty as to the policy, legal and economic implications for current and future proposed extensions of continental shelf areas in the European Atlantic basin
- ▶ Absence of a full and flexible framework for exploration/exploitation, including licensing nationally and across Member States
- ▶ Need for clarification of the policy and legal frameworks for deep-sea resources exploration and exploitation in the Atlantic sea basin, in particularly beyond national jurisdictions

While the general marine policy framework is very comprehensive and well developed, there is a need to clarify some issues relating to the implementation of the policies at national level and the interpretation of legislation. Clarity on these issues would give researchers, authorities and businesses the necessary foundation that can inspire further development in the Atlantic region

Need for a well-functioning administration procedure that can handle applications for licensing when the framework is in place, e.g. one single access point for businesses.

Coordination and cooperation

Initially, the following gaps within coordination and cooperation were identified:

- ▶ Relatively low levels of cooperation and coordination between different research efforts in the fields of marine mineral and biotechnological resources
- ▶ Insufficient exchange and coordination between different sectors and business organisations
- ▶ Limited uptake of research results by companies for development of new businesses
- ▶ Poor coordination of research and technological development efforts at regional level in the European Atlantic area, including insufficient pooling of national research funds to address regional issues
- ▶ Insufficient trans-Atlantic cooperation with academia and businesses in North America in fields related to marine mineral and biotechnological resources
- ▶ Underdeveloped science-policy interface to enable better evidence-based policy-making in these sectors

There is much to gain from a close cooperation within the European area of the Atlantic Ocean but also in the entire Atlantic region as such. This being between researchers, authorities and companies. This need calls for initiatives focused on facilitation and process so the different stakeholders can get involved and benefit from the cooperation. It will be important to allow the communication of concrete ideas to inspire stakeholders.

Again, sharing of information through databases could initiate closer cooperation.

5. Options for the Atlantic Action Plan

From the gap analysis, a number of initiatives might be proposed in order to provide the optimal framework for the development of exploration and exploitation activities concerning natural resources from the coastal and deep-sea areas of the European part of the Atlantic Ocean. These initiatives only address the kind of frameworks national or EU initiatives can affect. Other factors, such as the market prices of the resources cannot be affected from these, but are still very likely to have a major impact on the prospects of success of the utilisation of the resources, and indirectly on the success of these initiatives.

The table below presents an overview of the suggestions for research priorities and investment/policy priorities to be considered in the further work on the development of the Atlantic Action Plan. Furthermore, a number of actions have been formulated to inspire the development of the action plan. The actions are formulated more comprehensively and, to some extent, choose a focus for the further development of the action plan whereas the priorities are at a lower level of detail and go in many directions.

The recommendations originate from (1) the stakeholder process (the workshop) and (2) the background documentation work (reported by the subthemes in the annexes).

The table summarises the priorities identified during the assessment of each of the subthemes. They are divided into research priorities and investment/policy priorities. For each subtheme, the research priorities attempt to summarise the needs and the focus areas to promote utilisation of resources. The investment/policy priorities point at framework needs at a generic level.

Table 5-1 Recommendations for an Atlantic Action Plan based on the background documentation (see subthemes in annexes)

Subtheme	Research priorities	Investment/policy priorities
Subtheme 1: Knowledge	<ul style="list-style-type: none"> ▶ Mapping of minerals and bio resources ▶ Environmental change 	<ul style="list-style-type: none"> ▶ Increase scientific production ▶ Strengthen cross-border and regional scientific cooperation ▶ Strengthen business-academia partnerships, inter alia involving maritime clusters ▶ Improve dissemination of scientific knowledge, including to policy-makers ▶ Cluster initiatives to strengthen academia-industry partnership
Subtheme 2: Minerals	<ul style="list-style-type: none"> ▶ Mapping of minerals and development of cost-effective technology ▶ Creation of overview of knowledge, technological and institutional barriers 	<ul style="list-style-type: none"> ▶ Facilitate stakeholder process ▶ Take appropriate actions to fill gaps identified in research and stakeholder consultation. ▶ Multidisciplinary research centres
Subtheme 3: Bio resources	<ul style="list-style-type: none"> ▶ Specify needs to ensure cooperation and value chain development. 	<ul style="list-style-type: none"> ▶ Facilitate stakeholder process ▶ Take appropriate actions to fill gaps identified in research and stakeholder consultation.
Subtheme 4: Research and technology	<ul style="list-style-type: none"> ▶ Fill key knowledge gaps within marine biotechnology, minerals, and hydrocarbons 	<ul style="list-style-type: none"> ▶ Increase scientific production ▶ Strengthen regional cooperation in technology development ▶ Initiate pre-process of test and demonstration in specific areas ▶ Cluster development, including support business-academia partnerships for technological and infrastructure development
Subtheme 5: Access and preservation	<ul style="list-style-type: none"> ▶ Evaluate the EU and national framework ▶ Strategic oversight of infrastructure 	<ul style="list-style-type: none"> ▶ Align industry interaction across member states. ▶ Initiate appropriate infrastructure development ▶ Develop public private partnership concept e.g. through business associations ▶ Inspire through sector organisations to develop new markets
Subtheme 6: Entrepreneurship and innovation	<ul style="list-style-type: none"> ▶ Increase and disseminate knowledge 	<ul style="list-style-type: none"> ▶ Facilitate stakeholder process ▶ Improve cooperation ▶ Concrete overview of necessary funding tools and mechanisms ▶ Industrial symbioses in maritime clusters

When linking recommendations with the assessment of the maturity of the subthemes, it seems evident that the actions of the Action Plan need to be taken in sequence to allow all aspects (subthemes) to develop optimally. To attract private investors, the pace and direction of this development is crucial in order for them to be able to make decisions on the level of involvement and the activities that will be economically viable from a business perspective.

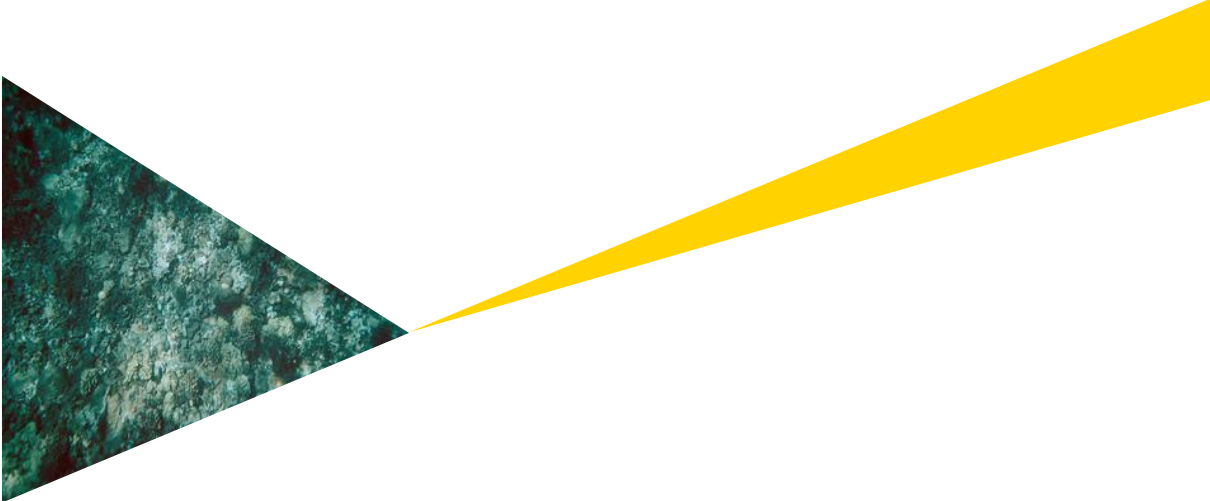
In the following, suggestions for actions have been formulated and arranged according to the structure of the strategy for the Atlantic Ocean, which the action plan is likely also to follow. These suggestions are concentrated on Strategic Objective 3, which is the one that the theme of this report pertains to. Each suggestion addresses several of the priorities indicated above in the form of possible flagship actions around which the Action Plan might be structured. This proposal combines the analyses conducted for this report and specific input from the workshop.

Table 5-2 Workshop conclusions and key existing initiatives

Objective of the Atlantic Strategy*	Action	Ongoing initiative
Strategic objective 1: Implementing the ecosystem approach	No actions identified during workshop discussion	
Strategic objective 2: Reducing Europe's carbon footprint	No actions identified during workshop discussion	
Strategic objective 3: Sustainable exploitation of the Atlantic seafloor's natural resources	<p><u>Sea bed mapping</u></p> <ul style="list-style-type: none"> → Centre of excellence within seabed mapping. Its purpose would be to coordinate research among MS, including sharing of data and assets (including competencies from private sector, public sector and academics). <p><u>Environmental data</u></p> <ul style="list-style-type: none"> → Establish and maintain long-term datasets, and allow for sharing of data → Knowledge to be built up on selected areas related to deep-sea natural resources. <p><u>Legal framework</u></p> <ul style="list-style-type: none"> → Create common economic, legal and environmental framework (licensing standards and guidelines) for exploration and exploitation in EU waters. → Create a one-stop shop for getting access to knowledge of the legislation requirements and funding possibilities <p><u>Commercialising knowledge</u></p> <ul style="list-style-type: none"> → Initiate deep sea mining test and demonstration facility → Promote broader application of biotechnologies involving basic knowledge from academia and biotech industry → Cost benefits analysis comparing pros and cons of developing a European industrial sector based on deep-sea resources; enabling trade-offs and strategic focus on strongholds. <p><u>Funding</u></p> <ul style="list-style-type: none"> → Investigate the potential for an EIB dedicated budget allocation to the Atlantic area → Create better possibilities for venture capital and develop innovative funding mechanisms to support public private projects (based on existing initiative at national/ local level) → Make use of the financial engineering instruments supported by the EU structural funds <p><u>Cooperation and coordination</u></p> <ul style="list-style-type: none"> → Strengthen business development across the board by developing a strong network between the maritime clusters. Strengthen relations between business and between business and academics. 	<ul style="list-style-type: none"> ▶ EMODNET, Marine knowledge 2020 ▶ Marine knowledge towards 2020; SEAS-ERA project (FP7) ▶ MSFD, Nagoya, extension of the continental shelf, raw material communication ▶ Horizon 2020 ▶ Regional and national clusters
Strategic objective 4: Responding to threats and emergencies	No actions identified during workshop discussion	
Strategic objective 5: Socially inclusive growth	→ Skills development	

Each of these actions will be assessed further to determine its feasibility. This assessment will be undertaken as a part of the preparation of the general document that supports the development of the Atlantic action plan.

6. Annexes



A Workshop report

This annex reports from the workshop on deep sea and coastal resources held in Horta, Portugal, on 21 September 2012. The annex includes:

- ▶ List of topics discussed at the workshop
- ▶ Short wrap-up of texts from workshop sessions (incomplete)
- ▶ Questions for discussion posed in the background report preceding the workshop.

Topics discussed

Subtheme 1: KNOWLEDGE

Priorities identified for the Atlantic area:

- Facilitation of cooperation in the establishment of European Atlantic Seabed Mapping / High-resolution map of seabed morphology and habitats - seafloor mapping
- Facilitation of Environmental Impact Assessment
- Maintenance and sharing of long-term data sets
- Research on the identification of vulnerable marine ecosystems
- Assessment and mitigation of impacts from exploration and exploitation of marine natural resources
- Increased knowledge about connectivity, ecosystem functioning and services.
- Sharing of observation and research assets between MS.
- Training/development of specific skills (will be discussed during workshop 5)
- Partnerships between academia and companies for deep sea exploration (Marine Knowledge and Innovation Communities or "KIC")
- Establishment of a centre of excellence for seabed mapping.

Subtheme 2: MINERAL RESOURCES

Priorities identified for the Atlantic area:

- Cost-Benefit analysis of deep-sea mining
- Analysis of social and environmental benefits and the use of these analyses to improve public perception
- Facilitation of European cooperation on exploration and assessment of its environmental impact
- Development of a clear regulatory framework: common economic, legal and environmental framework
- Training/development of specific skills (will be discussed during workshop 5).

Subtheme 3: BIOLOGICAL RESOURCES

Priorities identified for the Atlantic area:

- Clarify regulation on access to and ownership of resources under the Nagoya Protocol
- Venture-capital for blue biotech industry
- Assist in getting samples to the surface using robotics and other technologies
- Share technologies, data, sample analyses
- Promote biotechnologies beyond pharmaceutical industry.

Subtheme 4: RESEARCH AND TECHNOLOGY

Priorities identified for the Atlantic area:

- Socio-economic data
- Trans/pan-Atlantic cooperation: sharing of scientific assets, observation infrastructures, exchange on findings and processes...
- Development of a deep-sea mining test facility

- Marine KIC
- Develop standards (environmental, safety, technology).

Note: Get inspiration from the Sea's era project! The Atlantic Action Plan will be an opportunity to make priority actions happen (with clear goals).

Subtheme 5: ACCESS and PRESERVATION

Priorities identified for the Atlantic area:

- Development of synergies in the implementation of the MSFD in Atlantic areas (data collection/initial evaluation, surveillance programmes, GES definition, etc.)
- Common implementation of the Nagoya Protocol.

Subtheme 6: INNOVATION

Priorities identified for the Atlantic area:

- Create better possibilities for venture capital
- Develop innovative funding mechanisms to support public private projects (based on existing initiative at national/ local level)
- Make use of the financial engineering instruments supported by the EU structural funds.

On a general note, Mr O'Sullivan of SEA-ERA recommended that the Atlantic Action Plan be elaborated based on the following guiding principles:

Components of an Atlantic Action Plan:

- Create a Vision
- Agree on Geographic context
- Apply economic, environmental and social goals (SMART: Specific – Measurable – Achievable – Relevant - Timebound)
- Implementation Plan
Political commitment Stakeholder, Engagement Research, Enabling Actions, Supporting Infrastructures, Other decisions/actions necessary for successful implementation, Annual Conference to review progress of the Action Plan and introduce modifications where necessary

Likewise, Mr Jan-Stefan Fritz from the German Marine Research Consortium suggested an overarching and value based approach to formulate the action plan:

- What is really at stake in the deep seas is that we need to decide:
- What it is we want?
- What is important to us? On that basis, we need to take an integrated approach:
- Newest technologies
- Best possible understanding
- Highest standards (environmental, safety, technology)
- Economic strategy
- Legal clarity.

General recommendations for the format of the Atlantic Action Plan

Workshop sessions: Wrap up

Mineral resources - exploration and exploitation

In subtheme 2 on "Mineral resources - exploration and exploitation", two presentations were given by representatives of private mining companies operating in the deep sea. The three mineral forms that are usually referred to when talking about deep-sea mineral resources are manganese nodules, manganese crusts and sulphites. Manganese crusts are located at 800-2500 m of depth in rough terrains, and it might take some

decades before mining can become commercial. There are sulphite deposits south of the Azores and in many other Atlantic locations.

During the session the following recommendations were developed:

- Deep-sea mining requires a clear regulatory framework, both for exploration and monitoring, in order for mining and dredging companies to get commercially interested.
- Deep-sea mining currently has a very bad reputation, and the Atlantic Forum could help address this negative public perception, e.g. by mentioning positive sides of deep-sea mining in publications.
- Cost-efficient cooperation through the entire value chain (EIAs, site selection, exploration etc.) should be facilitated and issues approached from a European perspective.
- There is a strong need for more detailed mapping of the sea floor and of the ecosystems and such data need to be shared more openly.

Bio resources - exploration and exploitation

Oceans represent about 70% of the Earth's surface but their biodiversity is only used in less than 5% of products and services. The oceans are a top spot for bioactive compounds, and chemical diversity in the oceans is higher than on land.

However, most of this diversity is unexplored and there are supply limitations that need to be overcome. Sourcing is difficult, there are political hurdles and legal uncertainty and still major technological and scientific difficulties in the use of marine bio resources. To overcome these challenges, academia-industry partnerships as well as multi-disciplinary research and development are needed. Furthermore, there is a need for more awareness and visibility of marine bio resources and for clear regulatory frameworks.

Research and technology

The European Atlantic area is rich in knowledge, both in science and in technology and innovation. There are 340 research institutes (in the wider Atlantic area including e.g. Germany and Norway) and 66 AUVs and ROVs.

There are many opportunities in new and emerging science that should be pursued, but the traditional sectors (fisheries, tourism etc) have been and continue to be the main drivers of the marine economy. In order to stimulate new marine technologies, political commitment and stakeholder engagement are critical. Crucial is nevertheless the generation of long-term data sets and collaboration on and free access to marine knowledge.

Questions posed prior to the workshop

Introduction

- ▶ Illustrative examples of exploration and exploitation of resources from the deep sea and coastal areas
- ▶ National legislation affecting the exploitation of resources from the deep sea or coastal areas
- ▶ Examples of projects, actions or initiatives including actors from several countries
- ▶ Examples of actions with potential for increased utilization of marine natural resources
- ▶ What are the bottlenecks limiting the utilisation of resources from the coastal area and the deep sea?

Subtheme 1: KNOWLEDGE

- ▶ What are key knowledge needs relative to coastal and deep-sea natural resources for researchers, businesses, policy-makers and other stakeholders, including the general public in the Atlantic?
- ▶ What should be the role of the EU and of Atlantic member states in the production and dissemination of this knowledge?
- ▶ What measures should the future Action Plan contain in this regard?
- ▶ What are the key requirements for deep-sea mining to be regarded as environmentally friendly?
- ▶ In what way should public and private funding of research on the exploration of marine natural resources be combined?

Subtheme 2: MINERAL RESOURCES

- ▶ Is the present common and national regulatory framework adequate for sustainable utilization?
- ▶ What major barriers in terms of stakeholder interaction, policies, infrastructure, skills and technology prevail?
- ▶ What are the key environmental issues to address?
- ▶ Is there a commercially viable resource base? What is the future demand for these resources?
- ▶ What is the situation in 5-10 years in terms of mineral exploration and exploitation?
- ▶ What good examples of deep sea and coastal mineral exploitation exist?
- ▶ What do the industries require from R&D?

Subtheme 3: BIOLOGICAL RESOURCES

- ▶ How can sustainable deep-sea exploitation be carried out with the present-day knowledge?
- ▶ What kind of support by Atlantic Member States and the EU can promote utilization of bio resources?
- ▶ What gaps exist in funding and cooperation related to research and business activities?

Subtheme 4: RESEARCH AND TECHNOLOGY

- ▶ What are the key research and technological development needs relative to the exploration of marine mineral and biotechnological resources in the Atlantic?
- ▶ What role should the future Action Plan play in addressing these needs?
- ▶ In what way should public and private funding of research on the exploration of marine natural resources be combined?
- ▶ How can closer coordination between researchers be orchestrated?
- ▶ How can R&D be converted into first mover initiatives providing jobs and new possibilities?

Subtheme 5: ACCESS and PRESERVATION

- ▶ What are the key research and technological development needs relative to the exploration of marine mineral and biotechnological resources in the Atlantic?
- ▶ Are there differences between the five Atlantic countries that have an impact on the possibility for businesses to operate in another country – create blue growth?

- ▶ Is there a need for research in this field to accumulate wider knowledge of the trade-offs between activities that exclude other users of the resources? This includes non-commercial uses.
- ▶ Are the EU frameworks applicable and sufficient for seabed activities?
- ▶ To what extent are the tools used to regulate the oil and gas extraction applicable to other offshore resources?

Subtheme 6: INNOVATION

- ▶ Have national differences been experienced as a barrier to expanding activities?
- ▶ What are the experiences with cooperation between the researchers and the maritime clusters?
- ▶ How can maritime clusters develop to have greater influence in aligning industry interests with the Atlantic Forum's outputs/the Atlantic strategy?
- ▶ What funding mechanisms are being used at this stage? – is it one instrument or a combination of more instruments?
- ▶ How can private funding complement public funding?

B. Subtheme 1 - Coastal and Deep Sea Natural Resources knowledge

This section provides an overview of the status of knowledge relative to biotic and abiotic resources in coastal and deep-sea areas of the European Atlantic basin. Based on this status assessment, recommendations are made for future research and investment/policy actions.

Context

European coastal zones are among the most well studied in the world. There is substantial accumulated knowledge about species, habitats and ecological functions, and progress is being made relative to ecosystem structure and dynamics. There is also a generally good understanding of the environmental impacts of human activities, in particular of the input of nutrients and pollutants, on species and habitats. Recent years have witnessed a growing interest for better understanding whole ecosystem processes, partly in response to the requirements of the Marine Strategy Framework Directive. The characterisation of whole-ecosystem dynamics, their response to multiple natural and anthropogenic forces, including climate change, and issues of ecosystem resilience have received increasing attention in recent years.

Deep-sea environments remain, despite remarkable advances in the last two decades, largely unexplored. Progress has concentrated on specific habitats such as hydrothermal vents and seamounts, primarily for their richness and uniqueness, as well as for their vulnerability to disturbances. Progress in molecular analysis techniques has enabled the characterisation of novel deep-sea microbial communities. High-resolution geomorphologic and geochemical mapping is advancing at increasing pace, with the EU recently launching an initiative for high-resolution seabed mapping of all European waters. Knowledge about the availability and distribution of mineral resources in the deep sea remains patchy, with current exploration efforts concentrated on the more easily detectable systems (e.g. hydrothermal vents), as well as on areas where earlier exploratory work had been done and where current exploitation is more advanced (e.g. the Clarion Clipperton Zone in the Pacific). Uncertainties as to the response of deep-sea ecosystems to large-scale transformations are prompting a growing interest for studies of long-term temporal and spatial dynamics.

Baseline - trends

The mounting evidence of non-linear responses of marine ecosystems to multiple stressors requires much improved knowledge about whole-system dynamics and their ability to maintain key functions and services. Anticipating climate change impacts at this level is of particular concern. Implementation of the MSFD will require continued investments in understanding the cumulative impacts of human activities on marine biotic and abiotic systems, both in coastal and deep-sea areas. Harmonisation and sharing of monitoring data at EU level is expected to support these efforts. With respect to deep-sea environments, there is mounting concern with lack of knowledge of impacts of extractive activities, as well as of the adequacy of management measures. In general, there is limited understanding of the effectiveness of policy measures for protecting marine natural resources.

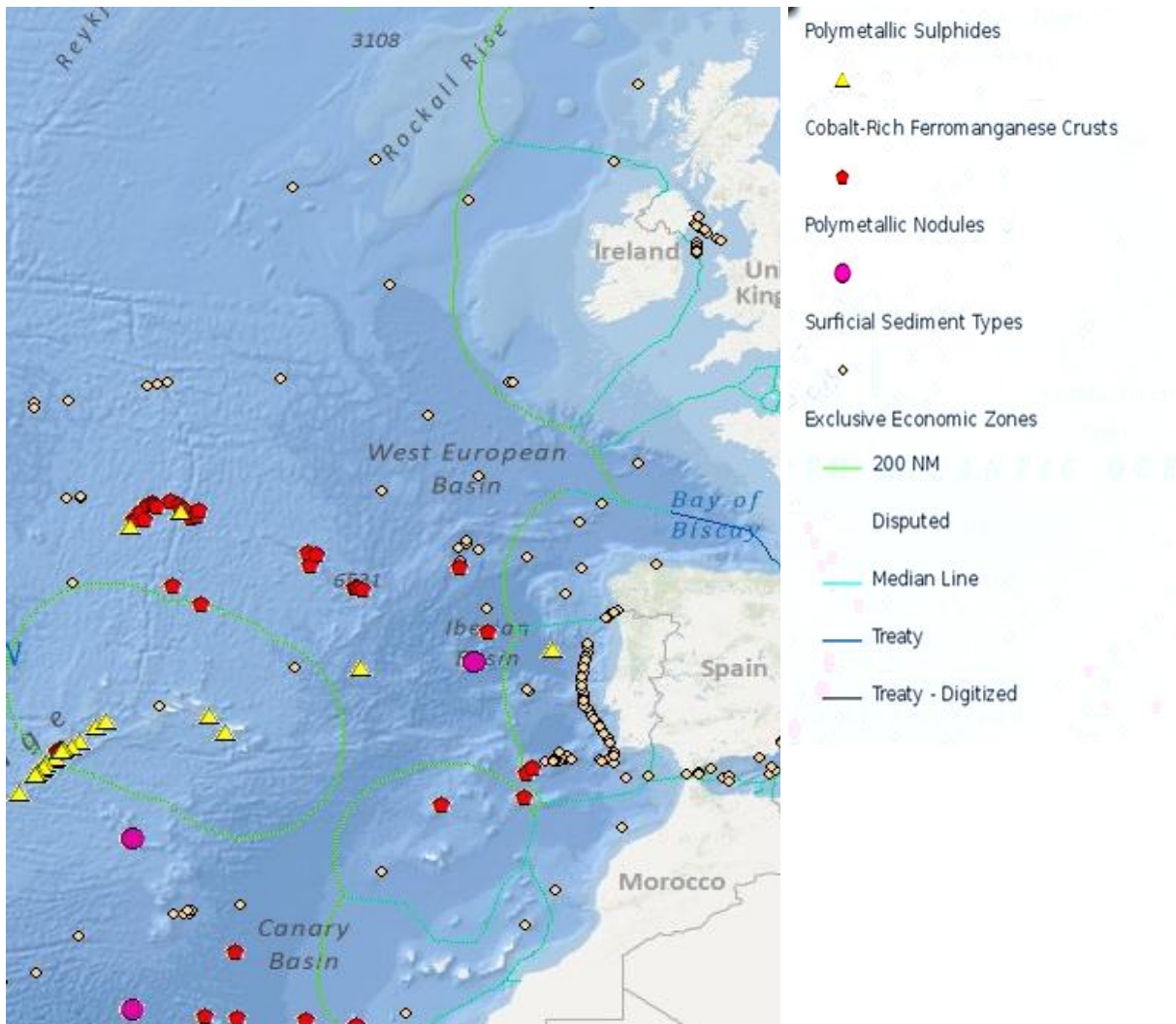
Assessment

Important knowledge gaps exist in relation to whole-ecosystem dynamics, resilience and response to natural and anthropogenic change. These exist for all marine ecosystems, but are particularly large for deep-sea environments. With technological advances enabling ever greater appropriation of marine spaces and resources by humans; and with economic interests increasingly turning to opportunities offered by those resources; it is necessary to tackle those gaps in order for political institutions to be able to balance the benefits brought about by deep-sea resource exploitation - in terms not only of wealth generation, but also environmental and social benefits in relation to mining activities on land - with social and environmental concerns.

Exploration and exploitation of deep-sea mineral resources in the Atlantic is currently hampered by uncertainties relative to the applicable legal framework, and, to a lesser extent, by important gaps in knowledge about the location, type and size of these resources. While specific deposits have been identified in the European Atlantic basin (see figure below),¹¹ most of the area remains uncharted as to possible exploitable deposits. Sampling of mineral deposits is scattered over large seafloor areas, and consequently estimations of the size of the resource as a whole are currently not possible.

¹¹ See for example International Seabed Authority, Web GIS Application, <http://www.mapserver.isa.org/jm/GIS/>.

Map representing the type and location of known mineral deposits in the European Atlantic basin. (Source: International Seabed Authority, Web GIS Application, <http://www.mapserver.isa.org/jm/GIS>).



Possible recommendations

Research priorities

Research efforts should support improved integrated governance and management of marine areas, with a particular focus on challenges posed by large-scale environmental change. Cross-cutting priority issues include 1) ocean and climate change feedbacks; 2) impacts of natural and anthropogenic events, including pollutants (incl. land-based), habitat alteration, and exploitation of living and non-living resources; 3) uptake of scientific knowledge by private companies for the improvement and development of new businesses; 4) improving the science-policy to strengthen the scientific evidence base of marine policies; and 5) the impact of policy and management measures.

In support of the exploration and exploitation of deep-sea marine mineral resources, efforts are needed to 1) produce high-resolution maps of the seafloor to identify possible deposit sites; 2) assess the type and abundance of mineral resources on a larger scale; 3) assess the commercial viability of detected deposits; 4) assess the broad range of benefits and costs of deep-sea resource exploration, also in relation to mining on land; and 5) develop regulations and standards for deep-sea mining operations.

Investment/policy actions

Investment/policy actions may include:

- ▶ increasing scientific production related to the Atlantic marine environment and its resources
- ▶ expanding collaborations between research initiatives in different Atlantic countries, as well as with other EU member states
- ▶ strengthening industry-research collaborations
- ▶ synthesising research results and accumulated knowledge to improve uptake by the public, businesses and policy makers
- ▶ pilot project on seabed mineral mining.

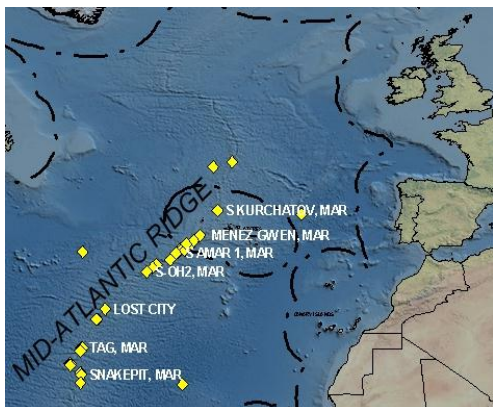
C. Subtheme 2 – Mineral resources – Exploration and Exploitation

Deep sea minerals include polymetallic manganese nodules that usually occur on the abyssal plains at depths commonly below 4 000 metres, cobalt-rich crusts that occur along the flanks of undersea extinct volcanic edifices (between 600 and 7 000 metres), and massive sulphide deposits that form at hydrothermal vents in areas of volcanic activity at depths ranging from 400 to 5 000 metres. The deposits, mined at volcanically inactive sites, contain valuable metals such as cobalt, gold, zinc, copper, nickel, and manganese and rare earth elements. In addition, large amounts of sand, gravel and maerl are being exploited in coastal areas, often in association with dredging activities. In addition, marine hydro carbons can prove to be commercially viable for instance off the coast of Ireland, Portugal (Madeira and Azores) and the Canary Islands where exploration is taking place.¹²

Context

There is no current exploitation of deep-sea minerals off the European coasts and no established viable deep-sea mining worldwide. Dredging of material for construction purposes is widespread, but the marine areas contribute with only a couple of percent of Europe's total production of 3,500 Mt¹³. This activity is almost entirely based in the North Sea, and will not be addressed further here.

Map indicating known and suspected hydrothermal activity in the Atlantic (yellow squares) and economic exclusive zones (Source: International Seabed Authority)



Deposits are often found in international waters, and thereby outside the jurisdiction of Member States and the EU. The International Seabed Authority organises and controls mining activities in international waters. In May 2012, the French research institution, IFREMER, submitted an exploration plan for approval by the Authority. The exploration targets polymetallic sulphides in an area located on the seabed of the Mid-Atlantic Ridge (cf. map below). Other European interests, both private and public, have been granted areas for exploration of polymetallic nodules in the Clarion Clipperton Zone in the Pacific.

Already in 2013, exploitation of Pacific deposits of copper and gold in sulphide deposits was supposed to be initiated by Nautilus Minerals, a Canadian company, at a water depth of 1,600 metres. However, the current financial crisis is apparently delaying mining the activities off the coast of Papua New Guinea to at least 2014.

Research focus is on basic research into geological, biological and oceanographic studies, financed through public European and national funding rather than commercially driven exploration. The table below summarises some of the activities supported by the EU's 6th and 7th framework programmes related to exploration of the Atlantic seabed.

¹² Marine diamond mining is big business in certain areas, but there is no known activity off the European Atlantic Coast. One example of undergoing diamond mining is off the coast of Namibia where 90 % of the country's diamonds are expected to be situated in the sea (<http://www.debeersgroup.com/Operations/Mining/Mining-Operations/Namdeb/De-Beers-Marine-Namibia/>)

¹³ 2009-data; IFREMER, http://www.ifremer.fr/drogm_eng/Mineral-resources/Marine-materials/Economie/Production-europeenne

Overview of FP6 and FP7 projects related to the study of the Atlantic seabed (Source: EurOcean Marine Knowledge Gate [<http://www.kg.eurocean.org>])

Project	Lead partner	Duration
MESH – Development of a framework for mapping European seabed habitats	JNCC, UK (Interreg IIIB NW Europe)	2003-07
ESONIM – European seafloor observatory network implementation	Marine Institute, Ireland	2004-06
EXOCET/D – Extreme ecosystems studies in the deep ocean: technological developments	Ifremer, France	2004-06
MOMARNET – Monitoring deep seafloor hydrothermal environments on the Mid-Atlantic Ridge	Inst. Physique du Globe de Paris, France	2004-08
BIODEM – Biogeochemical and physical drivers of deep European margin ecosystems	CNRS, France	2006-08
EuroSITES – Integration and enhancement of key existing European deep-ocean observatories	NERC, UK	2008-11
EMSO-PP – European multidisciplinary seafloor observation – preparatory phase	INGV, Italy	2008-12
HERMIONE – Hotspot ecosystem research and Man's impact on European seas	NERC, UK	2009-12
DS3F – The deep sea and sub-seafloor frontier	Bremen Univ., Germany	2010-12
TRIDENT – Marine robots and dexterous manipulation for enabling autonomous underwater multipurpose intervention missions	Jaume I Univ., Spain	2010-12
ISOBAB – Isotope constraints on the contribution of metal-rich magmatic fluids to back-arc seafloor hydrothermal systems	Ifremer, France	2011-13
MEDEA – Microbial ecology of the deep Atlantic pelagic realm	Univ. Vienna, Austria	2011-16

For the purpose of commercial exploitation, technology may not yet be mature and ready for large-scale activities at great depth. Much has been learned from the offshore hydrocarbon sector, though, and commercial marine mining companies are presently developing dedicated equipment for operations in the deep sea.

Baseline - trends

Knowledge of the distribution and amounts of minerals in the Atlantic is limited, an area where most activities are driven by public funds. In the 1970's, many resources were directed into the development of deep sea mining in the Pacific Ocean, but uncertainties as to the applicable legal regime compromised the longer-term viability of these investments. Currently, public and private investments are being directed at areas in international waters, primarily in the Clarion Copperton Zone in the Pacific, but also to a minor extent in the Indian Ocean and the mid-Atlantic Ridge in the European Atlantic basin. Future developments in this sector will depend on a combination of factors. First, the demand for minerals and the respective prices will have to attain a high-enough level to justify the initial investments and the operational costs of deep-sea mining. In this regard, despite fluctuations in the recent past, the demand for and prices of copper, zinc and manganese in the world market are expected to continue to rise. Second, exploring new reserves at sea will depend on the evolution of existing and future reserves on land. As mining on land moves to increasingly marginal reserves, deep-sea reserves might prove

more attractive not only from an economic, but also from an environmental and social perspective. Third, the regulatory framework for mining activities in deep-sea international waters is expected to continue evolving towards greater legal clarity and predictability, thereby providing greater certainty for investments. Finally, it should be borne in mind that many of the metals found in the deep-sea are currently imported into the EU from land mines. Considering that e.g. 49% of new copper mining projects are in countries with political risk¹⁴, questions pertaining to supply reliability are likely to arise and justify the shift to other sources such as the deep sea.

Assessment

The utilization of marine mineral resources is still in its early stages when it comes to deep-sea exploration and exploitation. Critical mass is necessary, and technology, skills and infrastructure have to improve in order to cope with technical challenges such as those posed by the great depths at which operations take place, as well as with issues of a social and environmental nature. It has been put forward that a full-fledged mining project requires financing of at least €500 million, a value that may be considered low in comparison to the development of a new mine on land, which might cost up to ten times more. However, the price of metals, available technology from the offshore hydrocarbon sector and recent activity point at greater future activity. On the other hand, strategic work relating to the currently intensified exploration to subsequent phases of extraction, transportation and processing is still missing in the main. Although industrial activity is already seen in these domains, there is room for an improved regulatory and managerial framework, for example with regard to environmental and safety standards.

Possible recommendations

Research priorities

- ▶ Mapping of resources and development of cost-effective technology for exploration and exploitation
- ▶ Produce an overview of knowledge, technological and institutional barriers and potential policy vacuums that slows or prevents sector progress
- ▶ Clarify the policy and legal frameworks for deep-sea resources exploration and exploitation in the European Atlantic basin, in particular in areas beyond national jurisdiction
- ▶ Facilitate exchange between industry, policy and academia for the formulation of operational standards and regulations for deep-sea mining.

Investment/policy actions

- ▶ Create mechanisms and structures for stimulating debate and cooperation between different stakeholders in industry, policy, academia and civil society in view of addressing the development constraints of the sector
Establish a funding mechanism to support marine research and technological development specifically for the European Atlantic basin, addressing regional priorities and including deep-sea mineral resource exploration
- ▶ On a continuous basis, implement appropriate and timely actions to fill gaps in knowledge, institutional and legal framework, stakeholder involvement etc. that may hamper development of the sector.

¹⁴ McKinsey Global Institute, 2011: Resource Revolution: Meeting the World's energy, materials, food, and water needs

D. Subtheme 3 - Bio Resources – Exploration and Exploitation

Marine bio resources include products and processes from sea organisms, including cultivation of algae as well as biotechnological utilization at cellular or molecular levels. Uses span from healthcare, food, cosmetics to bio-energy and many others.

Context

Biodiversity of oceans is high but largely unknown. The global market for biotechnological use of the marine organisms was estimated at €2.8 billion in 2010¹⁵. Harvest of algae remains on a small scale across Europe; it has been reported that the European production of macro algae ranges from 30-60 tonnes per year, which is minute in comparison to Japanese and Chinese counterparts. Algae extraction is at some 73,000 tonnes annually declining from more than 120,000 tonnes in the late 1990's.¹⁶

Both biotechnological use of marine organisms and algae harvest can be seen as immature industries with development potential. However, the field is highly diverse implying that subsectors are at very different levels of development.

Bio resources are the focus of both an active European group of public research institution and correspondingly numerous start-up and small companies with niche specialisation and a few larger companies within e.g. the cosmetic and pharmaceutical industries.¹⁷

During the last decade, more than 500 European patents in marine biotechnology have been taken out, which is 12% of global patents, whereas 36% of published scientific papers in the field worldwide have origins in EU-27.¹⁸

Baseline - trends

The global market for marine biotechnology is forecast to reach €3.3 billion by 2015. However, products based on marine bio resources are still expensive to develop and produce. This is for instance the case for plastics such as polyethylene, which is three to five times more expensive than traditional products based on petrochemicals¹⁹. Increasing oil prices will thus have an impact on the bio resource sector.

One example of costly and timely product development is a drug of marine origin to fight cancer, which is marketed by the Spanish pharmaceutical Pharmamar. The target species was identified in 1929, and an anti-tumour effect was reported in 1969. However, clinical trials only commenced in the 1990's, and the product was not put on the market until in 2007. Altogether, only three marine natural products have been approved in the last 30 years²⁰

Assessment

Bio resources are of large genetic and biomass potential. Few players have the capacity to go into deep-sea and mid-ocean habitats.

¹⁵ Marine Board, 2010: Marine Biotechnology: A new vision and strategy for Europe

¹⁶ Marine Board, 2010: Marine Biotechnology: A new vision and strategy for Europe

¹⁷ DG MARE, 2012: Blue Growth, sub-function 2.4: Blue Biotechnology

¹⁸ DG MARE, 2012: Blue Growth, sub-function 2.3: Marine Aquatic Products

¹⁹ Global Industry Analyst, 2012 [report not fully available] <http://www.prweb.com/releases/2011/1/prweb8041141.htm>

²⁰ Presentation of Dr. Simon Munt, Pharmamar, at the European Marine Day 2012

To ensure market uptake and further development, there is a need to bring research, start-up companies and major businesses together. Further, small companies have difficulties in attracting funding in order to reach critical size.

Possible recommendations

Specifically, the Marine Board under the European Science Foundation²¹ calls for actions that strengthen²²:

- ▶ Awareness and identity of the sector
- ▶ Research strategies and programmes
- ▶ Technology transfer between academia and industry
- ▶ Education and training.

Research priorities

More detailed knowledge of infrastructure and funding needs, intellectual property rights, gaps in industry and research cooperation must be collected.

Investment/policy actions

- ▶ Facilitate process to involve stakeholders to speed up development in the sector.
- ▶ Take appropriate actions to fill gaps identified in research and stakeholder consultation.
- ▶ Cluster initiatives to strengthen academia-industry partnerships
- ▶ Take multi-disciplinary actions; e.g. Atlantic research centres focusing on integrated drug discovery.

²¹ The Marine Board unites European research institutions within marine science in order to develop common positions on research priorities and strategies for European marine science, facilitating enhanced cooperation between stakeholders involved in supporting, delivering and using marine research and technology.

²² Marine Board, 2010: Marine Biotechnology: A new vision and strategy for Europe

E. Subtheme 4 – Research and Technology

This section assesses research and technological development relative to the exploration and exploitation of marine resources (excluding fisheries and aquaculture) in coastal and deep-sea areas, with particular focus on the European Atlantic basin.

Both at European and at Atlantic level, work has been conducted on the research and technology state of play. This section builds directly on available sources from e.g. SEA-ERA, ESF-Marine Board and DG MARE.

Context

Europe is a world-leader in research on marine biotechnology and marine mineral resources, including marine hydrocarbons. In all of these domains, European institutions lead over their American and Asian counterparts in terms of scientific output. However, non-European institutions are dominant in terms of number of patents and inventions, in particular from Japan and China in the field of marine biotechnology, and the US in marine minerals, suggesting greater involvement in research and uptake of its results by industry in these countries²³. Reasons for this are multiple, but might include bottlenecks in the European patent system.

Research on marine hydrocarbons is a mature field, and is largely driven and funded by private companies involved in commercial exploration and exploitation. In Europe, activities concentrate on the North Sea, with lesser expression in the Atlantic basin. Technologies from hydrocarbon exploration have been increasingly adapted to the exploration of other seabed minerals in the last three decades. Current technological developments focus on equipment for exploration and mining in the deep sea, usually involving private companies and public research centres.

Marine biotechnology research has progressed along three lines. Firstly, exploration of the marine environment for new organisms with potentially valuable molecules. This has concentrated primarily on coastal waters, due to ease of access, but is increasingly exploring remote environments in the deep-sea, in particular near hydrothermal vents. Secondly, identification and extraction of interesting molecules, aided by developments of molecular analysis technologies in the last 15 years. Finally, large-scale commercial production of molecules, either by culturing the organisms or by chemical synthesis. The latter in particular remains a bottleneck, and so far only a minute fraction of molecules of marine origin has reached commercial exploitation.²⁴

Baseline - trends

Issues to overcome for the future development of the marine minerals exploitation includes the location of deposits; the determination of their type and abundance; and the assessment of commercial viability, in particular in view of resource uncertainties and current technological barriers. The uncertain future regulatory framework for deep-sea mining activities is another factor hampering development, as are concerns by the public and the scientific community as to the possible negative environmental impacts of deep-sea mining.²⁵ The environmental framework includes policies at different levels, including specific national legislation, which may be the implementation of an EU directive, or which may be the wish to protect special national interests. Together with OSPAR, a voluntary cooperation between the countries bordering on the North Sea or the Atlantic Ocean, these

²³ DG MARE, 2012: Blue Growth, sub-function 2.4: Blue Biotechnology

²⁴ ESF-Marine Board. Marine biotechnology: A new vision and strategy for Europe. Position Paper 15. Brussels; Anonymous: A new dawn for marine biotechnology in Europe. *Biotechnological Advances* 2011; 29: 453-456

²⁵ Pfannkuche O, Camerlenghi A et al. The deep-sea frontier: Sustainable use of Europe's deep-sea resources. Scientific needs and strategies. Foresight document. [www.deep-sea-frontier.eu]; DS3F. Infrastructure and synergies. Workshop report. Deep-Sea and Sub-Seafloor Frontier. [<http://www.deep-sea-frontier.eu>]

legislative instruments provide the guidelines for the use of national waters. In international waters, the UN has launched a number of initiatives, such as conventions that guide the right to operate in those waters.

The activities vary between the sectors exploiting the resources, e.g. extraction of oil and gas from under the seabed and only affecting a limited area, where on the other hand, much attention needs to be given to the content of oil when discharging production water. An example that has a more severe impact on the seabed is the extraction of sand and gravel.

Research needs in marine biotechnology have been found to include the fundamental biology of interesting marine organisms to enable their cultivation; genome sequencing of individual organisms; techniques for culturing and harvesting of algae; and development of laboratory production techniques.²⁶

Research domains of current interest in marine hydrocarbons exploration include reduction of installation and operation costs; enhanced exploration techniques; recovery methods and carbon capture and storage; and exploration of ultra-deep (>2,000m) reservoirs.²⁷

Marine KIC

In 2010, European Institute of Innovation and Technology launched the Marine KIC that works towards a more focused and strategic approach to strengthen maritime economic development.

The Marine KIC aims at linking education, research and industry as well as identifying products and services needed to grow competitive marine sectors. The community addresses technology for bioprospecting and mining (ships and AUV, etc.)

The Marine Knowledge and Innovation Community (www.marinekic-initiative.eu)

Assessment

Both marine biotechnology and non-hydrocarbon mineral resource exploitation have yet to demonstrate their full commercial potential although smaller scale projects within biotechnology do exist and marine mineral exploitation took place already decades ago in the Pacific. Future research and technological development should continue to focus on improving exploration and production methods for greater efficiency. Earlier environmental concerns relative to bioprospecting in coastal areas have largely been addressed, but these subsist with respect to deep-sea organisms. This is a particularly relevant issue that deep-sea mining will have to contend with to ensure its commercial viability.

Possible recommendations

A synthesis is given of possible recommendations relative to research priorities topics and actions in marine resource exploration and marine biotechnology made by different authors and organisations.²⁸ Of particular relevance to the Atlantic Action Plan is the Draft Marine Research Plan for the European Atlantic Sea Basin, currently under finalisation, which proposes a shared vision for future investments in research and technological development in the region. It is based on common objectives and on the attempt to strengthen synergies between organisations in the different countries not only with the purpose of advancing scientific knowledge, but also with a view to fostering socio-economic development in the region.

A general challenge is to establish close cooperation between research undertaken in different countries at different institutions, and in particular to use research results for the establishment of new businesses and the

²⁶ Anonymous: A new dawn for marine biotechnology in Europe. *Biotechnological Advances* 2011; 29: 453-456; ESF-Marine Board.

Marine biotechnology: A new vision and strategy for Europe. Position Paper 15. Brussels; Leary D, Viero M et al. Marine genetic resources: A review of scientific and commercial interest. *Marine Policy* 2009; 33: 183-194

²⁷ DG MARE, 2012: Blue Growth, sub-function 2.4: Blue Biotechnology

²⁸ Synthesis of ESF-Marine Board, 2010; Pfannkuche and Camerlenghi et al.; DG MARE, 2012; Leary D, Viero M et al., 2009; DS3F; and O'Sullivan and Evrard M. A draft Marine Research Plan for the European Atlantic Sea Basin. Discussion document. SEAS-ERA WP 6.1. [<http://www.seas-era.eu>].

design of better policies. Although regional collaborations already exist, especially in the field of deep-sea research, a sustained effort is needed to coordinate the research done in different institutions to allow for a better regional transfer of knowledge and the exploitation of synergies.

A recent survey of national research programmes in Europe has shown that four of the five countries of the Atlantic Strategy have dedicated marine research strategies, Spain currently being the only exception.²⁹ However, all five countries did have provisions in their programmes for funding of research and technological development related specifically to deep-sea research, including habitat mapping; all except for Spain had provisions for blue biotechnology; and all except the UK had provisions for marine bioprospecting.

The current framework for research and technological development funding, either at national or at European level thus appears to cover the needs of the two sectors, at least thematically. This does not imply that funds will be available for all research in these areas; indeed, given the current financial crisis affecting all Atlantic countries, constraints on research funds are already being felt, a situation that is expected to persist in the foreseeable future.

Research priorities

Subtheme	Investment/policy actions
Marine biotechnology	<ul style="list-style-type: none"> ▶ Genomics and meta-genomics analyses of marine organisms, incl. Micro-organisms; ▶ Culture methods for interesting marine (micro-)organisms; ▶ Bio-engineering of marine organisms for biomass production for industrial applications; ▶ Identification and investigation of new marine model organisms for research and industrial purposes; ▶ Non-commercial value of marine genetic resources (e.g. relevance to biodiversity); ▶ Effects of bioprospecting on marine ecosystems, in particular in the deep-sea; and ▶ Policy context and implications of bioprospecting, in particular in areas beyond national jurisdiction.
Marine minerals	<ul style="list-style-type: none"> ▶ Impacts of exploitation on the deep-sea marine environment (both relative impacts of individual activities and cumulative impacts), and mitigations techniques; ▶ Cumulative impacts (benefit and costs) of deep sea mining as compared to land based supply ▶ Resource and risk assessment techniques, incl. systems for exploration of the deep-sea; ▶ Deep-sea geological processes driving ecosystem structure and dynamics; ▶ Measures and institutions for sustainable deep-sea governance and management; ▶ Standards for seabed mapping data acquisition, archiving and dissemination, and deep-sea monitoring programme for MSFD implementation; ▶ Study of low impact processing of marine minerals and European potentials ▶ Non-commercial values of deep-sea resources.
Marine hydrocarbons	<ul style="list-style-type: none"> ▶ Resource and risk assessment techniques, in particular for small and marginal fields; ▶ Assessment of carbon capture and storage, in particular environmental impacts; ▶ Exploration of marine gas hydrates (e.g. methane hydrates).

²⁹ Evrard M. Synthesis report on existing (sub)national (marine) science and technology strategies. SEAS-ERA Del.1.1.1.; 2011. [www.seas-era.eu].

Investment/policy actions

Subtheme	Investment/policy actions
Marine biotechnology	<ul style="list-style-type: none">▶ Environmental change▶ Strengthening the identity and creating a communication strategy for European marine biotechnology research;▶ Establishing strategies and programmes for marine biotechnology research and aligning these with national and pan-European plans;▶ Improving technology transfer and academia-industry partnerships;▶ Improving education and training in marine biotechnology▶ Initiating pre-process of test and demonstration in specific areas
Marine minerals	<ul style="list-style-type: none">▶ Integrating deep-sea research communities, incl. strengthening networks with Canada and the USA to coordinate research effort;▶ Establishing a long-term network of deep-sea observatories;▶ Establishing a mapping programme for the European Atlantic basin;▶ Conducting preliminary assessments and re-assessments of mineral resources in the European Atlantic basin;▶ Establishing interdisciplinary networks of natural and social scientists to investigate the values of deep-sea resources, in particular non-commercial values.▶ Initiating pre-process of test and demonstration in specific areas

No specific Investment/policy actions are proposed for marine hydrocarbon exploration and exploitation.

F. Subtheme 5 – Access and Preservation

This Subtheme concerns the legal, regulatory and policy framework under which projects and initiatives have to operate.

Context

At this stage, there is no EU legislation to control the utilisation of coastal and deep-sea natural resources. There are national level regulations directed towards specific resources to limit or to control exploitation (e.g. sand, gravel, oil and gas).

Many legislative instruments will affect the possibilities of utilising natural resources in coastal areas and the deep sea in the Atlantic Ocean. The figure below gives an overview of these taking its point of departure in the 2020 strategy.



European marine legislative instruments

Note: Other policies include e.g. research and technology (Horizon 2020), transportation (TEN-T) that overlaps the marine sphere.

Current regulations are directed towards e.g. minimising environmental impacts, licensing and taxation of activities. The instruments vary between the different legislative tools where some ban all activities and others set requirements as to how the resources are exploited. The choice of instrument is mostly a national decision except for funding tools, which are just as likely to be EU funded and designed. Above that, the different sectors might also have to observe sector-specific regulation. Of specific initiatives can be mentioned the IMP sea-basin approach under the IMP closely linked to the macro regional strategy. There is no specific allocation of funding through regional funds but the task is to find ways to use existing resources, legislation and structures to be better used for the benefit of the whole region.

Under the EU macro-region, concept strategies can be developed for areas "including territory from a number of different countries or regions associated with one or more common features or challenges"³⁰ The Atlantic Arc Commission has been promoting the set-up of such a macro-region in the Atlantic with an integrated territorial management strategy. In September 2012, the European Parliament passed a resolution on the EU Cohesion Policy Strategy for the Atlantic Area to be further developed under the Atlantic Forum.

³⁰ http://ec.europa.eu/regional_policy/cooperate/baltic/pdf/macregion_strategies_2009.pdf

The present infrastructure and the already planned expansions to obtain comprehensive access to the Atlantic are crucial to the possibilities of attracting new activities or expand existing.

Baseline - trends

The current framework for the activities in the Atlantic area is expected to evolve nationally and internationally in the coming years. At EU level, the Marine Strategy Framework Directive will be developed and implemented, and in response to the potential development of coastal and deep sea natural resources, national policies will evolve. There is no ongoing European process to harmonize the framework for these marine resources. An overview of current framework pillars in the area is given in the table below.

Each directive and policy will be implemented at national level to reflect the national interests. That will lead to possible differences between the countries in the legislative framework. Most of the legislative framework in place addresses the preservation or protection of areas or species.

Below is a list of the most important policy and legislative initiatives to apply to when extraction or exploiting resources from the deep sea or coastal areas.

Marine policy overview

Policy	Description
Integrated Maritime Policy	<ul style="list-style-type: none"> ▶ The Integrated Maritime Policy (IMP) for the European Union recognises that there is a maritime dimension to virtually every major issue facing Europe today, including energy, climate change, environmental protection and conservation, research and innovation, competitiveness and job creation, international trade, transport and logistics. ▶ The IMP integrates these so-called marine sector policies (energy, climate change, environmental protection and conservation, research and innovation, competitiveness and job creation, international trade, transport and logistics) with the aim to provide “an effective means of achieving coinciding policy goals and cost-efficient solutions”* ▶ The sea-basin strategies contribute to the success of the IMP. They enable the priorities and tools of the policy to be adapted to the specific geographic, economic and political context of each large European sea-basin.
Marine Strategy and Water Framework directives	<ul style="list-style-type: none"> ▶ The Marine Strategic Framework and the Water Framework Directive have the objective to secure a good ecological or environmental status of the waters. Together they cover the marine waters from the coast into the deep sea. Each one of them has set up a number of criteria that need to be fulfilled in order for the objectives to be researched. The criteria for the Marine Strategy Framework Directive still need to be further processed at national level, which means that the interpretation is not final yet. This can have a major impact on the possibilities to exploit resources from the coastal and deep sea areas.
Habitats directive	<ul style="list-style-type: none"> ▶ The nature directives (including Natura 2000, Habitats and the Birds directives) set out a framework to restring the impact from activities that can influence the nature negatively. The main tool used to implement these directives are to define protected areas, where many activities are banned or the use of them or specific activities are restricted at a certain time of the year. The protected areas are appointed at national level; an example is the Azores deep-sea vents, which are protected against future exploitation, as a marine park.
UN framework	<ul style="list-style-type: none"> ▶ There are strong links between “the United Nations Convention on Law of the Sea” (UNCLOS), “the Convention on Biodiversity” (CBD) and the Atlantic Ocean. The main objective of the UNCLOS is to assign the right and responsibilities to the marine areas. The former mainly focuses on the international coordination of monitoring activities for the oceans/marine waters, but it also coordinates socio-economic information. The latter has an important overview of studies of benefits of marine biodiversity (and the goods and services it provides). ▶ The International Seabed Authority is established under UNCLOS. It organizes and controls all mineral-related activities in the international seabed area beyond the limits of national jurisdiction, ▶ The international protocol Nagoya on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity is a supplementary agreement to the Convention on Biological Diversity. It provides a transparent legal framework for the effective implementation of one of the three objectives of the CBD: the fair and equitable sharing of benefits arising out of the utilization of genetic resources. ▶ The International Convention Relating to Intervention on the High Seas in the Cases of Oil Pollution Casualties was established under the IMO in 1969 and affirms the right of coastal States to take measures on the high seas necessary to prevent, mitigate or eliminate danger to their coastlines or related interests from pollution by oil or the threat thereof. In 1973, it was amended to include substances other than oil.

Policy	Description
Integrated coastal zone management	<p>► In 2002, the European Parliament and the Council adopted a Recommendation on Integrated Coastal Zone Management. The recommendation defines the principles sound coastal planning and management. These include the need to base planning on sound and shared knowledge, the need to take a long-term and cross-sector perspective, to proactively involve stakeholders and the need to take into account both the terrestrial and the marine components of the coastal zone.³¹</p>

* COM(2008)395 final, Guidelines for an integrated approach to Maritime Policy: Towards best practice in integrated maritime governance and stakeholder consultation

Uncertainties regarding the regulatory regime, in particular in the face of growing concerns about environmental consequences for deep-sea communities add to the difficulties faced by commercial mining interests. Sand and gravel mining, occurring mainly in coastal waters, is a mature activity of relatively small expression in the area.

Political decisions need to be made based on many considerations, namely including the opinion of EU institutions, Member States, concerned regions and other stakeholders. To assess these opinions, values are attached to non-traded goods and services. These are non-monetary values and can be assessed by the use of methods to reveal the willingness to pay for different alternatives or by determining the trade-off between alternatives. The results can be used when assessing the cost and benefit be specific alternatives.

Infrastructure plays an important role when activities and actions are planned.³² The level of infrastructure is more or less proportional with the growth in an area. Many activities related to exploitation require a good infrastructure, e.g. sand and gravel is very heavy and will need to be transported to the construction sites, whereas exploitation of less heavy resources from e.g. bio resources might require smaller but more specialized infrastructure less. To support the overall economic development of different regions, the EU has developed a policy framework that aim at meeting the needs of the industries and transport users while at the same time reducing the impact on the environment. One of the initiatives is the Trans-European Transport Networks (TEN T) which are a planned set of road, rail, air and water transport networks designed to serve the entire continent of Europe.

Overview of the priority infrastructure



Assessment

The framework has been created to support blue growth while at the same time protecting scarce resources and the environment.

The national implementation and interpretation is not finalised for all initiatives. This creates some uncertainty about the possibilities for new activities or expansion of existing.

Knowledge of the concrete national or regional framework conditions needs to be made available to allow possible action/initiatives to be developed. The national implementation and interpretation might differ across countries and pose a challenge to operators wishing to expand into other regions. At this stage, national implementation of the MSFD has yet to be finalised, which might bring about challenges to operators who can only adapt to existing legislation.

³¹ <http://ec.europa.eu/environment/iczm/home.htm>

³²

Land-based infrastructure in the coastal regions is a European priority and significant improvements in terms of access to the Atlantic have already been made, and further investments are planned in the a near future. However, this development does not mean that access to the coastline is easy and sufficient in all areas.

Possible recommendations

Research priorities

- ▶ Map the framework set by the EU and combine it with the national initiatives and interpretation implementation strategies.
- ▶ Strategic oversight of existing and necessary infrastructure that can support a full value chain related to deep-sea natural resource utilization.
- ▶ What options for exploitation of resources does the existing framework offer?

Investment/policy actions

- ▶ Design a common approach between the member states to negotiate and interact with the industries.
- ▶ Develop licensing framework for exploitation and exploration of deep-sea resources with inspiration from other extractive industries. Consider the possibility of a single access point for businesses.
- ▶ Initiate appropriate infrastructure development that supports the evolution of the coastal and deep sea natural resource sectors.
- ▶ Involve business, clusters and the research community, e.g. trough development of public private partnerships, or sector facilitation to develop new business opportunities such as new markets, products and services.

G. Subtheme 6 - Support to innovation and entrepreneurship

By this theme is understood the development and possibilities seen from the business perspective. In other words, how are the framework conditions for creating growth through business activities and actions? The focus in this annex will be on the possibilities for businesses to develop in the Atlantic area.

In order for the framework conditions to be in place, the four major pillars are the legal requirements, funding possibilities, availability of skilled employees and the availability of information. In addition, depending on the activities, infrastructure is very important in order to attract and retain businesses in a certain area.

Context

Legal instruments

The discussion on the legal instrument is included in Subtheme 5 and will not be further elaborated here.

Measures to support new business and support to existing industries and activities – financial instruments³³

To make investment in new markets or areas, funding is needed. There are three main sources of funding. Often, the concrete project or action will be funded by a mix of instruments. The three are own investments, loans, funds/subsidies. How the mix is made will depend on the concrete project.

The EU has a number of funding instruments, but also national funds with the same requirements are available. An overview of the instruments will be developed as part of the project in a way that allows the user to make a first screening of the possibility of funding for a concrete project. At national or regional level, there are also examples of programmes designed to support innovation.

EIB - potential support to investments

Loans for SME's

The EIB grants loans to SMEs through financial intermediaries (local partner banks). It requires the intermediaries to match the EIB loan with funds of at least the same amount, creating a leverage effect. SMEs from all Member States and with fewer than 250 employees are eligible for loans as well as MidCap autonomous enterprises with less than 3000 employees. Excluded are activities that are unacceptable in environmental and social terms, such as activities in protected areas or without adequate mitigation.

Venture capital

The EIB furthermore provides funds for SMEs that need venture capital or private equity to kick-start or boost their growth through the European Investment Fund (EIF). These funds can be provided in the seed or initial development phase, for family transmission or secondary LBOs, to build up strategies, for internationalisation or as mezzanine finance. In 2011, the EIF provided €1.1 billion through 49 new venture and growth funds with overall target fund sizes amounting to €6 billion.

Risk Sharing Finance Facility (RSFF)

The Risk Sharing Finance Facility supports complex, long-term research, development and innovation (RDI) projects that are risky by improving access to debt financing for all types and size of private company and public institution undertaking RDI projects. The RSFF lowers these risks, facilitating investment that will boost competitiveness, growth and job creation. It supports research, experimental and pre-competitive development, feasibility studies, pilot and demonstration activities and European Research Initiatives.

³³http://ec.europa.eu/maritimeaffairs/policy/sea_basins/atlantic_ocean/atlanticforum/funds_en.pdf

There are large variations across sectors as to how easy they have access to loans and other funding mechanisms. Therefore, a specific analysis will always be necessary.

Besides the financing instruments of the EU, private sector funding is also available. Especially some sectors which are very well established in economic terms. Further, the EU has launched an initiative "A European Economic Interest Grouping" The purpose of the grouping is to facilitate or develop the economic activities of its members by a pooling of resources, activities or skills.

Public and private funding opportunities are a topic in the General document supporting the process of developing an Atlantic Action Plan.

Promotion of maritime research and business - Maritime clusters

The European Network of Maritime Clusters³⁴ was founded in 2005. Of the five countries involved in the development of the Atlantic Action Plan, only France, Spain and the UK participates. Experiences are exchanged to some extent during meetings. It seems that activities across countries vary significantly; however, this assumption is only made based on the level of activity on the webpage.

The French maritime cluster, *Cluster Maritime Français*, has about 240 members, including ship owners, ports, manufacturers, research institutes, shipping brokers and fisheries operators. Its main goal is to promote the maritime industry and to identify synergies between actors, to improve data and communication on maritime activities and to lobby for the French maritime industry.

The British industry association *Maritime UK* represents shipping, port and marine businesses by uniting seven British trade associations working across the maritime sector in the UK. In Spain, the Galician *Campus do Mar* is a joint project by four universities, the Spanish Council of Scientific Research and the Spanish Institute of Oceanography. Its goal is to generate quality research and to provide the marine industry with knowledge and tools to compete on a global scale by training professionals and researchers in the field of Marine Science.

Portugal has a similar national activity called *Oceano XXI*³⁵, and in Ireland there is an initiative called IMERC (Irish Maritime and Energy Resource Cluster)³⁶. The purpose of the cluster is similar to the other initiatives, and they work to orchestrate growth in the maritime sector through attracting businesses and skilled employees.

The general availability of information and knowledge is discussed in Subtheme 1.

Baseline - trends

The European Commission has launched two major initiatives that will affect the baseline:

- ▶ Horizon 2020 is the EU's new framework programme for research and innovation. Running from 2014 to 2020, HORIZON replaces the EU's 7th framework programme for research.

The programme will support research and innovation projects throughout the EU. HORIZON 2020 breaks with current priorities in that it will not only fund projects in certain technology tracks, but also projects that tackle societal challenges, such as health, energy and food security, green transport, climate change and the ageing population.

- ▶ Europe 2020 includes a number for flagship initiatives, among these one on resource efficiency. The objective is to achieve a resource-efficient and low-carbon economy. To achieve a resource-efficient Europe, technological improvements are required translating into a significant transition in energy, industrial, agricultural and transport systems, and changes in behaviour of producers and consumers.

These two initiatives will set the framework criteria to be fulfilled to make use of the instrument supplied by the Commission. The national programmes are more likely to have more local interest to maintain.

³⁴ <http://www.european-network-of-maritime-clusters.eu/>

³⁵ <http://www.oceano21.org/default.asp?LN=EN>

³⁶ <http://www.imerc.ie/>

A wide range of financial instruments can be used to support the development of businesses in these areas. The limitations might first of all be the challenge of creating an overview of the possibilities of each of the instruments and possible combinations. Many of the catalogues are developed with a general focus, which makes it less easy to use them directly in the context of marine resources.

The national marine clusters are well organised, however, some of them are more active than others. At this stage, the international activities are limited; there is some exchange of knowledge but no concrete initiatives with an international focus have been identified.

Due to the limited activities with exploitation of resources from the deep sea and the coastal areas, a limited number of people are employed, which might also be the reason why no general workforce shortcomings have been detected.

Assessment

It is difficult to make a general assessment at this stage with the knowledge available. It seems that the sectors directly involved in exploiting natural resources from the deep sea and from the coastal areas in the Atlantic Ocean from the five Member States are limited at this stage³⁷.

The policy framework focuses on the use of resources and looks at the period up to 2020 in the attempt to change some of the approaches used today and to diminish some of the barriers to achieving a resource-efficient economy.

Possible recommendations

To be further developed and elaborated at the workshop, the following recommendations within research, investment and policy actions have been found to be possible elements of the Atlantic Action Plan.

Research priorities

- ▶ The knowledge of the availability of resources that can be exploited in a cost-efficient way needs to be made available to operations.

Investment/policy actions

- ▶ A concrete overview of the funding tools and mechanisms are needed for businesses to see the possibilities directed towards the exploitation of resources. Such an overview will be developed as part of project.
- ▶ Closer coordination between all levels of stakeholders to achieve the greatest impact from the investments made.
- ▶ Large-scale and international exploitation need to be facilitated by an international authority, such as the EU, or by a closer relationship between the maritime clusters.
- ▶ Development of industrial symbioses to create more dynamic and attractive locations for business development. The regional authorities will need to play a role in the local implementation but the concept could be developed centrally.

³⁷ OSPAR status report 2010