

**Marine Board-ESF Response to the European Green Paper
*Adapting to climate change in Europe – options for EU actions***

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DG Environment Green Paper *Adapting to climate change in Europe* – options for EU actions

Marine Board-ESF Response

Background:

On 29 June, the European Commission (EC) initiated a consultation process on strategies required for adapting to the impacts of climate change. The Green Paper *Adapting to climate change in Europe - options for EU action* (COMM(2007) 354 final), builds upon the work and findings of the European Climate Change Programme and invites responses from stakeholders. Feedback on key questions is invited in written format or by replying to an on-line questionnaire with a deadline of 30th November 2007.

The EC climate change Green Paper sets out four lines of priority actions to be considered:

- 5.1. Early action to develop adaptation strategies in areas where current knowledge is sufficient;
- 5.2. Integrating global adaptation needs into the EU's external relations and building a new alliance with partners around the world;
- 5.3. Filling knowledge gaps on adaptation through EU-level research and exchange of information;
- 5.4. Setting up a European advisory group on adaptation to climate change to analyse coordinated strategies and actions.

The here presented document summarises the Marine Board's response to the EC Green Paper *Adapting to climate change in Europe – options for EU action*. It addresses the questions of relevance to the Marine Board's mandate and activities, focusing on marine research matters. The third pillar (5.3) of the EC Climate Change Green Paper, which focuses on research and proposes major regional seas research projects, is of greatest relevance to the Marine Board and therefore the focal point of this response. The response is elaborated from existing Marine Board Position Papers and Statements, in particular:

- Marine Board Position Paper 8 (2006) *Navigating the Future III*
- Marine Board Position Paper 9 (2007) *Impacts of Climate Change on the European Marine and Coastal Ecosystems*
- Marine Board Position Paper 11 (2007) *Response to the European Commission's Green Paper Towards a future Maritime Policy for the Union: A European vision for the oceans and seas*

The Marine Board Position Paper 9 (2007) *Impacts of Climate Change on the European Marine and Coastal Ecosystems* provides extensive information of relevance to this consultation.

The document presented here includes:

- I. Marine Board Response Statement to the EC Green Paper *Adapting to climate change in Europe – options for EU action*
- II. Summary response in accordance with the questions posed in the EC Green Paper
- III. Marine Board detailed response to Priority Action 5.3.

I. Marine Board – Response Statement

The Marine Board (representing 28 European Marine Research Institutes and Funding Agencies from 20 countries – see Annex I and II) welcomes the European Commission's proposals for priority actions in the field of adaptation to climate change in Europe, as put forward in its Green Paper *Adapting to climate change in Europe – options for EU action*. The Marine Board wishes to thank the European Commission for its initiative in this area and for the opportunity to comment on the Green Paper.

The Marine Board recognises that the global oceans and seas are a crucial component of the Earth's climate system and a driver of many important climate processes on a range of time and geographical scales. Furthermore, while the oceans and seas have a strong influence on climate change, they are also affected by it. The IPCC report (2007) states that sea levels will most likely rise by 3.1 cm every decade; the oceans have warmed to a depth of 3 km; Arctic summer sea-ice is likely to disappear in the second half of this century; up to 40% of species could face extinction; weather patterns will become more extreme - for example, hurricanes and storms will become more intense. The Stern Review (2006) estimates the social and economic cost of climate change to the global economy at € 5,500 billion by 2050. The Stern Review concludes that, provided we take strong action now, there is still time to avoid the worst impacts of climate change.

A two pronged approach to addressing and resolving climate change issues and challenges, involving both mitigation and adaptive strategies, is essential. The response detailed here deals only with the latter: adaptive strategies.

To plan for, and implement, appropriate and innovative adaptive strategies demands an integrated and co-ordinated research initiative to better understand marine and coastal processes, how they influence climate and whether there are any feedback mechanisms in play. Such a research initiative will provide: a better understanding of climate change impacts (scenarios) at both regional and local levels; the development of improved methods to quantify the uncertainty of climate change projections and the provision of usable climate change indicators. An improvement in the interface between science and policy formulation in terms of risk assessment will be essential to formulate and inform better adaptive strategies (see Marine Board Position Paper 9 *Impacts of Climate Change on the European Marine and Coastal Ecosystems*). Mobilising existing and establishing new ocean observatory and data collection systems to better understand the pace and impact of climate change on the oceans and impacts on the wider earth system will be critical. This knowledge is essential to improve prediction and scenario modelling and the development of appropriate adaptive strategies at European, regional, national and local levels to offset and cope with the negative socio-economic impacts of climate change (Aberdeen Declaration, 2007).

The Marine Board confirms its broad support for the research priorities outlined in Section 5.3 of the Green Paper and has elaborated on these in its detailed response. The Marine Board further supports the proposal for the establishment of a European Advisory Group on Adaptation to Climate Change, which it considers should be established along the lines of the IPCC model.

II. Adapting to Climate Change in Europe - Options for EU Actions

Response to the Consultative Process: the 28 Questions

In presenting the Green Paper on Adapting to Climate Change in Europe, the European Commission poses 28 specific questions under 5 broad headings. The following summarises the Marine Board's perspectives, detailed according to these 5 headings:

1. Putting adaptation and mitigation into perspective

In response to the broad list of questions (Q1-Q7) under this heading, the Marine Board notes that:

- To address and resolve climate change issues and challenges, a two pronged approach involving a balanced and equal emphasis to mitigation and adaptive strategies is essential (Q4).
- The anticipated impacts of global climate change on the marine environment include sea-level rise, increased coastal inundation, geographical displacement of commercial species, alteration of biogeochemical cycles and food webs, accelerated establishment of non-native species, etc. These changes have the potential to cause serious environmental and socio-economic impacts at both regional and local levels. Thus, the marine aspects of global change must be taken into account in any proposed European Climate Change Adaptive Strategy (Q1-Q3).

2. Focusing EU action - the First Pillar: early action in the EU

In response to the 10 questions (Q8-Q17) posed under this heading, the Marine Board notes that:

- European policies related to maritime transport, ocean energy, fisheries and aquaculture, marine spatial planning and integrated coastal zone management (including coastal protection), environmental management and conservation must be "climate proofed" to take account of the potential and predicted impacts on climate change. In this way, the more negative aspects of climate change may be avoided, while benefiting from the more positive ones.
- The proposed Integrated Maritime Policy for the European Union (COM(2007)575 final) provides a very appropriate mechanism to integrate climate issues related to the marine environment and the sustainable development of marine resources.

3. Focusing EU action - the second pillar: integrating adaptation into EU external actions

In response to the 5 questions (Q18-Q22) posed under this heading, the Marine Board notes that:

- The global nature and scale of the environmental and socio-economic impacts of climate change demand that Europe plays an active and constructive role in global initiatives addressing mitigation and adaptation.
- In the context of international ocean observations (monitoring) and supportive research, Europe must be an active partner in key international programmes (e.g. CLIVAR, CoML, GLOBEC, GOOS, IMBER, etc.) and relevant organisations/panels (IPCC).

4. Focusing EU action - the third pillar: reducing uncertainty by expanding the knowledge base through integrated climate research

In response to the 3 questions (Q23-Q25) posed under this heading, the Marine Board notes that:

- It is in broad agreement with the views and priorities outlined in this Section (5.3) of the Green Paper and has elaborated its view on related research and monitoring needs in its detailed response to the Green Paper Consultation Process.
- Understanding the ocean's role in climate regulation is critical to develop appropriate and necessary adaptive strategies. In this context, priority research areas and actions include:
 - better evaluation of the impact of climate change on Europe's marine and coastal environments;
 - improved quantification of the nature and rate of consequences of climate change in European marine and coastal waters and marine environments;
 - predict the response and feedback of marine environments and ecosystems to climate change;
 - predict the impact on climate change on the distribution of marine organisms and on marine food webs;
 - refine the spatial and temporal resolution of data on the oceans and regional seas through the design and establishment of a European Ocean Observing System.

5. Focusing EU action - the fourth pillar: involving European society, business and public sector in the preparation of coordinated and comprehensive adaptation strategies.

In response to the 3 questions (Q26-Q27) posed under this heading, the Marine Board:

- Welcomes the proposal that mechanisms be put in place to ensure the **widest stakeholder participation** in issues related to the design and implementation of adaptive strategies.
- Agrees that in designing adaptive strategies the **views and concerns on non-EU neighbouring countries** need to be taken into account.
- Welcomes the establishment of a **European Advisory Group on Adaptation to Climate Change (EAGACC)** which would have a key role in interpreting and advising on the latest scientific information. The EAGACC should be established along the lines of the IPCC model.

III. Marine Board-ESF Detailed Response to Priority Action 5.3:

Filling *knowledge* gaps on adaptation through EU-level research and exchange of information

This response is based on the following Marine Board publications:

- Marine Board Position Paper 8 (2006) *Navigating the Future III*
- Marine Board Position Paper 9 (2007) *Impacts of Climate Change on the European Marine and Coastal Ecosystems*
- Marine Board Position Paper 11 (2007) *Response to the European Commission's Green Paper Towards a future Maritime Policy for the Union: A European vision for the oceans and seas*

1 Introduction

“Global climate change will affect the physical, biological and biogeochemical characteristics of the oceans and coasts, modifying their ecological structure, their functions and the goods and services that they provide” (IPCC 2001).

The scientific evidence is now overwhelming that climate change is a serious global threat which requires an urgent global response, and that climate change is driven by human activity. The ocean is a crucial component of the Earth's climate system. It is the driver of many important climate processes on a range of time and geographical scales. While the oceans and seas have a strong influence on climate change, they are also affected by it. The IPCC (2007) report states that sea levels will most likely rise by 3.1 cm every decade; the oceans have warmed to a depth of 3 km; Arctic summer sea-ice is likely to disappear in the second half of this century; up to 40% of species could face extinction; weather patterns will become more extreme - for example, hurricanes and storms will become more intense. The Stern Review (2006) estimates the social and economic cost of climate change to the global economy at € 5,500 billion by 2050. The Stern Review concludes that, provided we take strong action now, there is still time to avoid the worst impacts of climate change.

Although marine ecosystems are also influenced by many anthropogenic factors such as eutrophication and overfishing, every European region has shown at least some changes that are likely to be attributable to recent climate change. Recent research, including the examination of ice cores and growth rings of ancient trees, shows that the Northern Hemisphere has been warmer since 1980 than at any other time during the last 2000 years. The observed increase in temperature under climate change was generally higher in northern than in southern European seas. For the most northern seas, such as the Arctic and the Barents Sea, the most obvious temperature-related change is the decline in sea-ice cover.

For most open seas there is evidence of geographic displacement of species populations northwards, with northern species being replaced by more southern species. Such changes not only impact on local ecosystems but also impact on the activities of the international fishing fleet when commercial species are affected. In the future, it is expected that within open systems there will generally be (further) northward movement of species, e.g. Atlantic species moving to more northern seas such as the Arctic, Barents Sea and the Nordic Seas, and subtropical species moving northward to temperate region such as the Iberian upwelling margin.

During the past decades, it has also been observed that enclosed European seas have noticeably undergone far more dramatic changes than the more open seas. Relatively small changes in the frequency of inflow (as in the Baltic Sea) or in temperature (as in the Eastern Mediterranean and Black Sea) had a strong effect on large parts of the ecosystem, indicating the high sensitivity of these enclosed systems to climate change. For seas that are highly influenced by river runoff, such as the Baltic Sea, an increase in freshwater due to enhanced rainfall will lead to a shift from marine to more

brackish and even freshwater species. If enclosed systems such as the Mediterranean and the Black Sea lose their endemic species, the associated niches will probably be filled by species originating from adjacent waters and, possibly, with species transported from one region to another via ballast water.

On a global scale, the oceans are the only sink for CO₂ and have taken up ca. 50% of the anthropogenic CO₂ so far. There are strong indications that this sequestration of CO₂ will slow down causing a more rapid increase of atmospheric CO₂ than anticipated. Furthermore, this uptake of CO₂ has already resulted in the acidification of the surface oceans and the seas. The consequences of future increasing acidification are unknown but will severely impact biodiversity, biogeochemical cycles and future climate change in one way or the other.

Although there can be no certainty regarding the precise nature and rates of change in the marine environment due to alterations in climate, in the absence of policies and measures to prepare for these changes, even the more moderate of the predicted scenarios indicate major social and economic impacts. Boelens et al (2005).

Enough is now known to make addressing climate change the principal socio-economic challenge of the 21st century, and the marine research community is poised to address this challenge. The need for enhanced detection and assessment of the impacts of climate change on the oceans and their ecosystems is well recognised. Europe is warming at a faster rate than the global average, and the physical attributes of our seas are changing accordingly, with implications for the functioning of our regional climate and our marine environment. Therefore, in addressing the impacts of climate change on the oceans, Europe must pay particular attention to its regional seas. The diverse nature of Europe's regional seas, with the attendant diversity of expression of climate change impacts, represents a particular challenge for monitoring and management of climate change at the pan-European, regional and local levels. The changes in the marine environment will have a profound impact on the daily life of Europe's inhabitants, requiring forward planning in preparation for the changes.

2 The Monitoring and Research Agenda

While on-going national and international actions to curtail and reduce greenhouse gas emissions are essential, the levels of greenhouse gases currently in the atmosphere, and their impact, are likely to persist for several decades. On-going and increased efforts to mitigate climate change through reduction in greenhouse gases are therefore crucial.

In parallel, a better understanding of potential climate change impacts (scenarios) at both regional and local levels, the development of improved methods to quantify the uncertainty of climate change projections, the construction of usable climate change indicators, and an improvement of the interface between science and policy formulation in terms of risk assessment will be essential to formulate and inform better adaptive strategies to address the inevitable consequences of climate change.

The Marine Board Working Group on climate change identified specific recommendations on future monitoring and indicators and with regard to future research needs. **General recommendations** were to:

1. **Enhance evaluation of the impact of climate change on the European marine and coastal environment:** this will require a concerted effort to gather, store and analyse previously and currently collected marine environmental data (e.g. common open access database and annual pan-European reporting based on national contributions);
2. **Identify the nature and rate of consequences of climate change in European marine and coastal waters:** this will require the maintenance of sustained monitoring efforts and use of new technologies to increase their spatial and temporal resolution;

3. **Predict the consequences of climate change for our marine environment:** this will require the development and measurement of parameters (e.g. indicators) which are indicative of the underlying mechanisms of climate-induced changes;
4. **Predict the response and feedback of marine environments and ecosystems to climate change:** this will require the improvement of regional climate models and the development of biophysical models;
5. **Predict the impact on climate change on the distribution of marine organisms and on marine food webs:** this will require the inclusion of knowledge on species' physiology, bioenergetics and behaviour in biophysical and ecosystem models.

Arising from the analysis of climate change impacts on European marine and coastal waters, carried out by the Marine Board Working Group on climate change, a number of monitoring and research needs were identified, which are further elaborated in the Marine Board Position Papers referred to above (2006, 2007). These **research priorities**, broadly consistent with the research priorities outlined in Section 5.3 of the Green Paper, include:

Sustained Observations and Monitoring

1. Support for the **continuation and linking of existing monitoring and time series programmes** and improvement in the spatial and temporal resolution of the variables. This would include, for example, the extension of Continuous Plankton Recorder (CPR) surveys to all European Seas and establishment of new sustained observations in important regions (e.g. the Iberian upwelling margin, Alboran Sea, Inner Bay of Biscay) by means of historical and new techniques (e.g. moorings and cabled networks). Oceanographic observations need to be integrated with observations of biodiversity and ecological processes in both the pelagic and offshore benthos as well as the littoral zones (intertidal and subtidal).

The establishment and resourcing of a **European Marine Observation and Data Network (EMODN)** is essential to managing our on-going relationship with the oceans and seas. This action would see the establishment of permanent, sustained monitoring and observation structures, networks and the underpinning data provision, curation, information management and dissemination needed to support good ocean governance (including risk assessment, modelling and prediction), good science, a better understanding of ocean dynamics (including climate change and geodynamics), improved resource utilisation and the protection of the marine environment. Such data collection and management infrastructures and regimes must be harmonised and their long-term viability (funding) ensured by the European Commission and the Member States.

Aberdeen Declaration (2007)

2. **Use of new technologies** to increase spatial and temporal resolution of measurements through for example Argo floats, ferry boxes, gliders and remote sensing (aerial and satellite). The development of more cost-effective profilers would help to extend the Argo array of profiling floats and to implement the Argo system in European waters extensively (EURO-Argo).
3. Participation in and contribution to **international climate change research programmes:** As part of the global ecosystem, European observation and research programmes on the marine environment must be integral to international research programmes with a climate component, for example, CLIVAR, GLOBEC, IMBER, and SOLAS. Through EURO-Argo Europe should actively contribute to the global Argo experiment to provide hydrographic observations in the long term, both for operational oceanography and for monitoring climate change.
4. **Synthesis and overview of climate change in European marine waters:** The compilation of pan-European annual reports based on national contributions and the compilation of **Regional**

European Reports using a similar approach to that of ACIA (Arctic Climate Impact Assessment) and the Baltic BACC (Baltex Assessment of Climate Change).

5. **Development of both general large-scale and specific regional indicators.** New indicators are needed to fill in gaps in knowledge on particular state variables and processes. There is a real need to develop a benthic habitat indicator at the scale of the European shelf. This could be achieved by using new technology based on multi-beam side-scan sonar (in combination with in situ measurements).
6. Observing networks provide crucial contributions to **monitoring and forecasting extreme events**. One of the potential effects of climate change is the change in intensity, frequency and location of extreme events, such as storms, tidal surges and extreme wave heights. Improved definition of extreme events, their statistical analysis, definition of proxies for past events, identification of processes at play in their generation, and the identification of their variability and trends, all need to be developed.

Harnessing historic and existing data

7. **Reconstructing past climates** (Palaeoceanography): Further research is needed to identify and analyse proxy data sets (ice and sediment cores, growth rings, etc) of climate change to recreate past ocean climate scenarios with the finest possible spatial and temporal resolution to better understand geographic variations and their causes under natural conditions.
8. **Harnessing existing environmental data:** Increased effort is needed to identify, assess, quality control and make available the wealth of existing environmental data collected as part of regional seas monitoring programmes and annual fish stock assessment surveys, to better detect and quantify climate induced changes to ecosystem.

Drivers and Ecosystem Responses

9. **Large-scale climate forcing:** European seas are strongly influenced by large-scale atmospheric variability as reflected in different air pressure patterns through indices such as the North Atlantic Oscillation and the Arctic Oscillation. Research is needed to address the relationships between the different pressure patterns and their interactions, the temporal variability in the strength of the patterns, the mechanisms responsible for their generation and variability, including far-field effects and teleconnection (e.g. the effects of the Aleutian low pressure variability on the NAO) and the relative importance of these far-field effects compared to local processes.
10. **Ocean circulation and hydrodynamics:** Research is needed to better understand how ocean circulation and hydrodynamic conditions (temperature, salinity and stratification) will respond to predicted climate change, with particular emphasis on regional responses, time to measurable response, variability and possible feed back mechanisms.
11. **Sea ice and albedo:** Sea ice plays an important role in climate change through feedback mechanisms, e.g. as the result of the high reflectivity of ice-covered surfaces compared to open ocean surfaces. Research is needed on the relationships between air-sea heat fluxes and sea ice concentrations, leads and melt ponds.
12. **Biogeochemical fluxes:** Research is needed on the influence of climate change on microbially-driven biogeochemical fluxes between ocean and atmosphere in coastal and in open waters, the influences of changes in the carbon and other cycles on sedimentation, and subsequently benthic-pelagic coupling. There is a need to define the importance of the nitrogen cycle (including nitrogen fixation) and atmospheric iron fertilisation for the element cycling in the ocean under the aspects of climate change, and to know how these changes affect the ratios between elements such as carbon, nitrogen, and phosphorus in the water. Much is still unknown on the impact of climate

change on oxygen levels and anoxic areas (in particular in enclosed seas such as the Baltic Sea and the Black Sea).

13. **Ecosystem structure and functioning:** To understand and predict the effects of climate change on marine ecosystem structure and functioning, it is necessary to examine how climate change will affect structural and functional biodiversity, how the structure (e.g. food web lengths, size distribution) and functioning (e.g. biomass, production and decomposition processes) of marine ecosystem will change under current predictions of climate change, how changes in the chemical composition of elements in the ocean will influence food web dynamics. Research is needed on the possible consequences of climate change for the nature and strength of the interactions between the various trophic levels of the system, and predicting when and under what conditions climate-induced regime shifts of the ecosystem will occur, and if such changes will be reversible (and if so, what are the recovery dynamics).
14. **Adaptation and evolution:** Climate change will result in a change in the physical and biological environment for many marine organisms. However, it is not known to what extent individuals change their physical or biochemical (phenotypic) characteristics in order to acclimatise to these changes (e.g. faster growth at higher temperatures), how populations will respond genetically to the changes in selection pressure (e.g. shifts in timing of spawning), how climate change will modify the reproductive potential of marine organisms. Part of this information may be derived from using existing information on latitudinal differences in life-history patterns.
15. **Coastal habitats:** Current models of climate change predict sea-level rise and increased frequency and intensity of storminess that will impact on the coastal zone. There is a need to derive more accurate regional predictions of sea level rise in Europe taking into account ice cap and glacial melting, alteration in the strength of ocean circulation, heating and freshening of the water column and the rising or sinking of coastlines. This will facilitate research on the socio-economic and ecological implications for coastal protection and the development of adaptive strategies.

Predictive Models

16. **Improvement of regional climate models is necessary:** In particular, with respect to the hydrological cycle, e.g. river run-off and the role of clouds on evaporation.
17. **Development and validation of biophysical models:** Biophysical models are being developed to investigate the effects of physical forcing on primary production, zooplankton distribution and advection, fish and invertebrate larval drift, and fish migration. Improvements in and validation of such models need to be encouraged.
18. **Species loss:** Modelling the effects of climate change on species distribution and competition, and mapping potential local and larger scale extinction, is required.
19. **Triggers of biological events:** Little is known about the mechanisms that trigger events such as spawning, diapause, migration, temperature tolerance for most species. Some of these trigger mechanisms are temperature dependent while others are light dependent. Since temperature will rise under climate change, while light will more or less stay the same (except for changes in cloud cover), there is a large potential for a mismatch between some species and their prey or predators. In order to make reliable ecosystem predictions, knowledge of the trigger mechanisms is absolutely essential.
20. **Food webs and species connections in ecosystems:** Research is needed on predator-prey relationships and functional groups. This information is necessary to determine the energy flows in the ecosystem (i.e. balancing production, consumption and mortality of species or species groups), and the influence of hydrology. To accurately assess impacts of climate change on ecosystem, will require enhanced understanding of the interactions among different species.

21. **The roles of fishing, eutrophication and climate change:** Climate change is occurring in combination with other anthropogenic impacts such as fishing and eutrophication. Research is needed on what impacts can be assigned to each cause; including potential synergistic effects (e.g. can fishing cause fish stocks to be more vulnerable to climate change?).
22. **Impacts of climate change on coastal areas:** With coastal development continuing at a rapid pace, society is increasingly vulnerable to rising sea-level, and climate is predicted to storm surges and flooding, thus erosion. Research is required towards an improved understanding of sea-level rise and variability, which would help to reduce the associated uncertainties, resulting in more effective management. To complete our understanding of vulnerability of coastal areas to impacts of climate change, there is a need for high quality economic and social data for e.g. the estimation of damage from floods, for adaptation and mitigation in general.

Enabling Technologies & Supporting Initiatives

23. **Development of new technologies:** Research is needed to design new observational and measurement systems (e.g. sensors for air-sea interactions of specific substances for identifying long-term changes in hydrodynamic regimes and changes in deep-water temperatures) to support climate change research.
24. **Participation in and contribution to international climate change research programmes and projects** should be supported.
25. **Reliable and fast data access:** Including pictures of changes in plankton assemblage composition and ocean colour data (data centres, real time data, basic processing and computer programs), is essential.

3 Conclusion

In conclusion, the Marine Board welcomes and supports the outline research agenda on adaptation and climate change, proposed by the European Commission in section 5.3 of the Green Paper, which is broadly consistent with the priorities identified above, which includes the following:

1. Develop comprehensive and integrated methodologies for the assessment of impacts, vulnerabilities and cost effective adaptation.
2. Improve the basic understanding and prediction of impacts in Europe, including in the North Atlantic, the Arctic, the Mediterranean and the Black Sea.
3. Clarify the expected impacts of climate change and ozone layer depletion on ecosystems and explore ways to enhance their resilience.
4. Develop long term comprehensive and Europe-wide high resolution datasets and models.
5. Improve access to existing data and integrate data relevant for adaptation.
6. Provide up-to-date synthesis reports on climate impacts, adaptation and vulnerabilities every 4-5 years.
7. In cooperation with the private sector, support research on adaptation for businesses, services and industries.
8. Launch Europe-wide studies on the present and future plans of coastal regions to strengthen coastal protection, the environmental and economic costs involved in these plans.
9. Promote co-operation, partnerships and networking with the scientific community in EU and non-EU countries, particularly neighbouring countries.
10. Provide support through guidance on existing scientific knowledge and adaptation measures, options and cost-benefit analysis of these options.

Finally, the Marine Board, fully endorses the proposal (Section 5.4) to establish a **European Advisory Group on Adaptation to Climate Change** which would operate as the Commission's Expert Group and consist of representative policy-makers, leading scientists and civil society organizations. The Marine Board further proposes that this Advisory Board be established along the lines of the IPCC.

Annex I - Marine Board- ESF

The increasing interdependence of marine research policies and programmes at national and at European levels, as well as the rapidly changing environment of European marine sciences, call for a new approach to the development of European research strategies. To this end, the Marine Board, established in 1995 by its Member Organisations, facilitates enhanced co-ordination between the directors of European marine science organisations (research institutes, funding agencies and research councils) and the development of strategies for marine science in Europe. The Marine Board operates within the European Science Foundation.

As an independent non-governmental advisory body, the Marine Board is motivated by, and dedicated to the unique opportunity of building collaboration in marine research. The Marine Board develops insight, recognising opportunities and trends, presenting compelling and persuasive arguments that shape the future of marine research in Europe.

The Marine Board provides the essential components for transferring knowledge for leadership in marine research in Europe. Adopting a strategic role, the Marine Board serves its Member Organisations by providing a forum within which policy advice to national agencies and to the European Commission is developed, with the objective of providing comparable research strategies at the European level. In seeking to develop and enhance the understanding and management of marine research, the Marine Board delivers a balanced, consistent and effective programme of foresight initiatives, delivered as topic specific position papers, which provide information for policy makers at national and European level. As a major science policy think-tank, the Marine Board:

- *Unites the outputs* of advanced marine research;
- *Provides insights* necessary to transfer research to knowledge for leadership and decision making;
- *Develops foresight* initiatives to secure future research capability and to support informed policy making;
- *Places marine research* within the European socio-political and economic issues that profoundly affect Europe.

The Marine Board operates via four principal approaches:

- **Voice:** Expressing a collective vision of the future for European marine science in relation to developments in Europe and world-wide, and improving the public understanding of science in these fields;
- **Forum:** Bringing together 28 marine research organisations (four of which are new associated members) from 20 European countries to share information, to identify common problems and, as appropriate, find solutions, to develop common positions, and to co-operate;
- **Strategy:** Identifying and prioritising emergent disciplinary and interdisciplinary marine scientific issues of strategic European importance, initiating analysis and studies (where relevant, in close association with the European Commission) in order to develop a European strategy for marine research;
- **Synergy:** Fostering European added value to component national programmes, facilitating access and shared use of national marine research facilities, and promoting synergy with international programmes and organisations.

“Vision is the art of seeing what’s invisible to others” (Johnathan Swift, Class of 1686, Trinity College Dublin). The Marine Board, recognizing that the challenges associated with the development of a vision for marine science throughout Europe requires extensive collaboration, works with its Member Organisations and with agencies at the European level, to contribute to the development of this multifaceted vision for marine science.

Annex II - Marine Board – ESF Member Organisations

BELGIUM

Fonds National de la Recherche Scientifique (FNRS)
National Fund for Scientific Research

Fonds voor Wetenschappelijk Onderzoek - Vlaanderen (FWO)
Fund for Scientific Research - Flanders

DENMARK

Forskningsrådet for Natur og Univers (FNU)
Natural Science Research Council

FINLAND

Suomen Akatemia / Finlands Akademi
Academy of Finland

FRANCE

Centre National de la Recherche Scientifique (CNRS)
National Centre for Scientific Research

Institut Français de Recherche pour l'Exploitation de la Mer (Ifremer)
French Sea Research Institute

GERMANY

Deutsche Forschungsgemeinschaft (DFG)
German Research Society

Hermann-von-Helmholtz-Gemeinschaft deutscher Forschungszentren (HGF)
Association of National Research Centres

GREECE

Hellenic Centre for Marine Research (HCMR)

IRELAND

Marine Institute

ITALY

Consiglio Nazionale delle Ricerche (CNR)
National Research Council

Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS)
National Institute of Oceanography and Experimental Geophysics

THE NETHERLANDS

Koninklijke Nederlandse Akademie van Wetenschappen (KNAW)
Royal Netherlands Academy of Arts and Sciences

Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO)
Netherlands Organisation for Scientific Research

NORWAY

Havforskningsinstituttet
Institute of Marine Research

Norges Forskningsradet
The Research Council of Norway

POLAND

Polska Akademia Nauk (PAN)
Polish Academy of Sciences

PORTUGAL

Gabinete de Relações Internacionais Da Ciência e do Ensino Superior (GRICES)
Portuguese International Relations Cabinet for Science and Higher Education (FCT)

SPAIN

Consejo Superior de Investigaciones Científicas (CSIC)
Council for Scientific Research

Instituto Español de Oceanografía (IEO)
Spanish Institute of Oceanography

SWEDEN

Vetenskapsrådet
Swedish Research Council

TURKEY

Türkiye Bilimsel ve Teknolojik Arastırma Kurumu (TUBITAK)
The Scientific and Technical Research Council of Turkey

UNITED KINGDOM

Natural Environment Research Council (NERC)

National Oceanography Centre, Southampton (NOCS)

Marine Board ESF - Associated Members
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CYPRUS

Cyprus Oceanography Center

ESTONIA

Eesti Teaduste Akadeemia
Estonian Academy of Sciences

MALTA

Malta Council for Science and Technology

ROMANIA

Consiliul National al Cercetării Științifice din Învățământul Superior
National University Research Council (NURC)