Blue Growth

Scenarios and Drivers for Sustainable Growth from the Oceans, Seas and Coasts

Maritime Sub-Function Profile Report
Coastal Protection (5.1.)

Call for tenders No. MARE/2010/01

Client: European Commission, DG MARE

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The research for this profile report was carried out in the period April – August 2011. This report has served as an input to the main study findings and these have been validated by an Expert meeting held on 9/10th November 2011 in Brussels. The current report serves as a background to the Final Report on Blue Growth.

Content

Summary description

Risk of flooding and erosion threatens the performance of other maritime functions, and may even cause loss of life and of assets; coastal protection settles this threat.

Important external drivers affecting the performance of the sub-function are: global warming, events of erosion and/or flooding, high value economic activities in coastal regions, economical performance (for example an economic crises will result in public funding coming under pressure, hampering the execution of coastal protection works). In addition, better monitoring and implementation of ICZM policy and the Flood directive will affect the performance of the sub-function.

The micro-future most likely shows a slow but steady increase in coastal protection expenditures. The longer term development will be a function from three main drivers of change: 1) sea level rise (and related climate change conditions), 2) demographic trends and 3) world economy. A dual trend is visible: for areas that remain densely populated the need for coastal protection will rapidly increase. For the other areas the increase in adverse climatic conditions combined with reduced population numbers will probably lead to reduced protection levels or no protection at all. It remains difficult to determine the net effect of this dual trend on the overall European coastal protection efforts. Both trends could balance each other.

Public policy is very important in implementing sustainable coastal protection. Reasons for EU-involvement in coastal protection are:

- Linkages between regional and national actions for coastal protections and several EU political domains
- EU can play and through several projects is already playing an important role in knowledge distribution. Knowledge sharing among Europe is an important driver for further development.
- Physical impacts and relations easily cross international borders.
- Coastal protection is a worldwide issue. Europe is relatively well advanced; EU can promote this as a selling point.

Recommended policy action is to focus on integration, not only integration of sectoral interests, but also integration at different governance levels and integration at EU policy level. A point of improvement could be a better interaction between the different DG's, esp. MARE, ENVIRONMENT and RESEARCH. The marine and coastal policies should be integrated into a whole, because these domains are physically connected.

1 State of Play

1.1 Summary description of the nature of the sub-function

Coastal protection against flooding and erosion may be considered not as an economic sub-function like other maritime sub-functions, but rather as a condition sine qua non for the use of coastal areas and for allowing other functions to flourish. Risk of flooding and erosion threatens the performance of other maritime functions, and may even cause loss of life and of assets; coastal protection settles this threat.

Relative sea-level rise, caused through climate change, can lead to sediment deposition (sink) in tidal basins. The nearby coast can act as a sediment source leading to increased coastal erosion. In case of insufficient sediment trapping in the tidal basin, relative sea-level rise can result in loss of valuable eco-systems (submerging).

Protection against flooding and erosion starts with **monitoring** the risk of flooding, erosion and submerging (data collection). The next step is the **design** of coastal protection measures, followed by the **construction** of these measures. After construction, **monitoring** and **maintenance** is a prerequisite to guarantee the required protection level.

The role of the eco-system services

The coast is part of the marine eco-system. Eco-systems render services (resources and processes), resulting in (economic as well as non-monetised) benefits.

In the present study, the key is the functional approach. Eco-system services render to these functions. If such is the case, this is addressed in the relevant functional profiles, the eco-system service is not included as a separate sub-function. The impact of the coastal functions on the environment, *including eco-systems*, is also addressed per functional profile and in the overall second interim report (section 4.2 Environmental impacts). Complementary, in the first interim report the protection of natural habitats was drawn up (sub-function 5.3), but based on the assigned criteria not selected for further elaboration in the subsequent phase.

In literature three categories of eco-system services are distinguished[1]: Production services (food resources), Cultural services and Regulatory services. One of the Ecological services under the category Regulatory services is *Mitigation of natural hazards*. An economic benefit is the value of the eco-system preventing erosion, making additional coastal protection measures superfluous. In this sub-functional profile 5.1 *Coastal protection against flooding and erosion* this eco-system service is mentioned in the relevant sections.

1.2 Description of the current structures

Erosion and flooding vulnerability

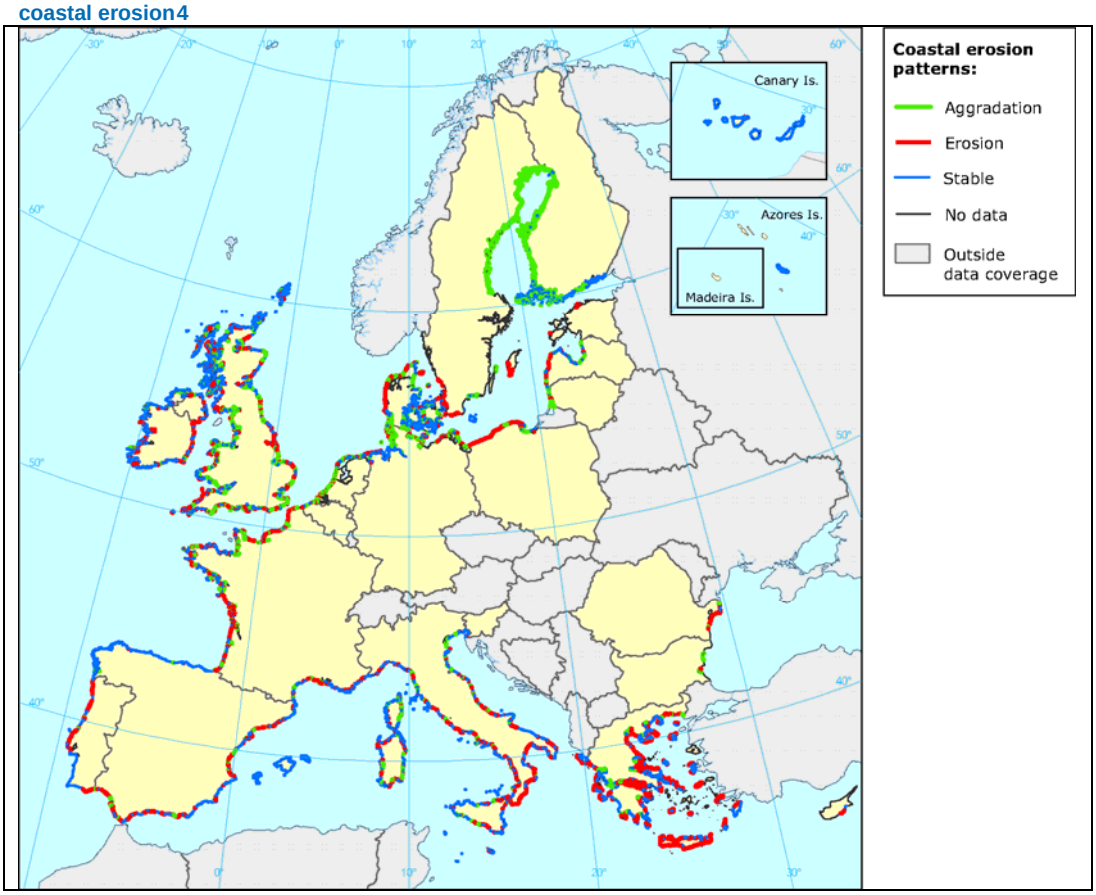
Coastal erosion and flooding have always existed and these processes have contributed to the shaping of the present coastlines. Protection against flooding and erosion has always been driven by:

[1] Amongst others Mangos, A. et al., 2010. The economic value of sustainable benefits from the Mediterranean marine ecosystem.

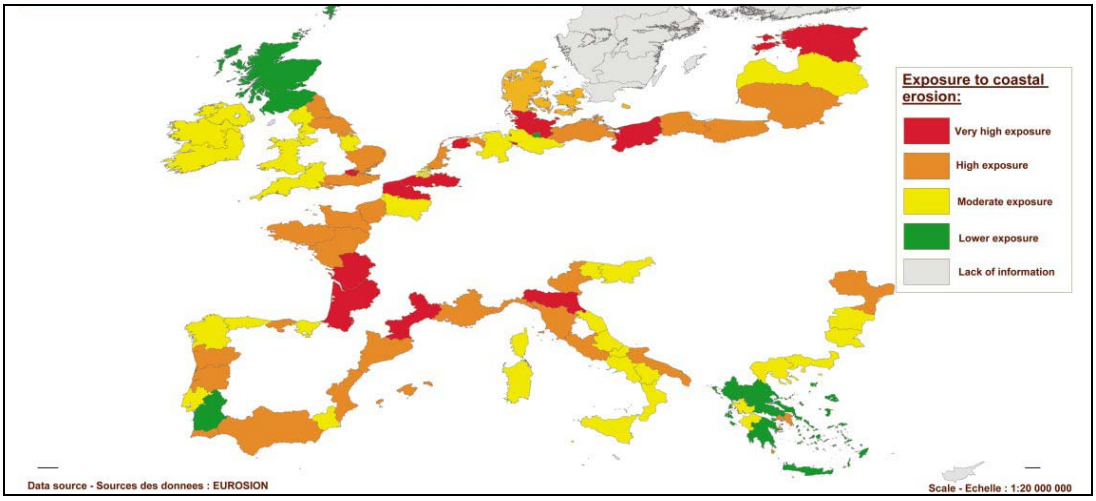
1. The exposure of coastal areas to
   a. flooding: **Coastal flooding** is strongly related to storm conditions with high water levels due to tides and sea waves[2].
   b. erosion: **Coastal erosion** (permanent loss of sediment) strongly depends on: Type of coast, Wave climate, Surge levels, Sediment composition, and Beach slope[1].
2. High value assets in the coastal region (i.e. people, houses, industry, ecosystems, freshwater supply).

In the EUROSION[3] project maps of the coastal erosion trends in the European Union and the exposure of European region to coastal erosion have been produced (Figure 1.1.). Maps with regard to flooding are to be made following the Flood Directive and are not available yet at EU level.

Figure 1.1 Coastal erosion trends in the European Union and the exposure of European region to coastal erosion4



[2] Van Rijn, L.C., 2011. Coastal erosion control based on the concept of sediment cells, Report Conscience. www.conscience-eu.net
Van Rijn, L.C., 2011. Coastal erosion and control, accepted by Journal for Ocean and Coastal Management
Van Rijn, L.C., 1998. Principles of coastal morphology. www.aquapublications.nl
[3] European commission, 2004. Results from the Eurosion Study.
[4] http://www.eea.europa.eu and http://www.eurosion.org



Coastal evolution, and hence coastal erosion and flooding, is strongly related to long-term **sea level rise** (relative to the land)[5].

The available options of shoreline management are:

- to accept retreat in areas where beaches and dunes are wide and high;
- to maintain the coastline at a fixed position by hard structures and/or by repeated soft nourishments;
- to bring the coastline at a more seaward position by reclaiming land from the sea.

Various types of hard structures and soft nourishment exist, all requiring different capital investment and different (regular) maintenance cost[1].

Coastal protection expenditures

Various actors respond to the risk of flooding and erosion by taking measures:

- o At EU level by directives and recommendations (for example Flood directive and ICZM recommendations)
- o At national /regional level (governments). An example of long term planning is the Delta Program in the Netherlands.
- o Other actors with interest in the local risk of flooding and erosion (for example house-owners or developers).

However, (government) budgets also depend on other factors (politics, short term priorities) and therefore annual spending on protection measures may not be stable and may not grow at the pace it should to mitigate erosion consistently.

The overview of the actual protection practices and related investments for Europe is limited. In the Eurosion[6] study commissioned by DG Environment, the following figures were presented. Public expenditure on protection of erosion has reached an estimated 3.2 billion euros in 2002 compared to 2.5 billion in 1986 (an increase of almost 30%, on average 4% per year). This expenditure only reflects the need to protect assets at imminent risk; it does not reflect the hidden costs in the long term. Earlier studies for the UN-IPCC estimate costs of 5.4 billion euro per year between 1990 and 2020 (based on predicted flooding and erosion risks).

[5] Bruun, P., 1962. Sea-level rise as a cause of shore erosion. American Society of Civil Engineers Proceedings, Journal of the Waterways and Harbors Division 88, 117–130.
[6] European commission, 2004. Results from the Eurosion Study.

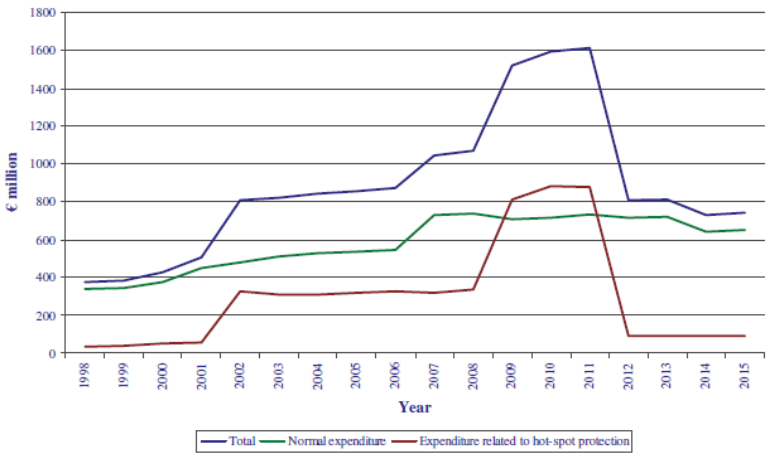
In 2009 an overview of coastal adaptation expenditure was made[7]. The figures represent expenditure by public and private actors to maintain and adapt their coastal zones. Over the period 1998-2015[8] Europe's total expenses to coastal protection is estimated to amount to 15.8 billion euros (on average 0.88 billion euros per year). In Table 1.1 the expenditure per marine basin is summarised. Figure 1.2 shows the (planned) spending per year, distinguishing regular from 'hotspot' expenditures.

Table 1.1 Overview of the expenditure per marine basin

Marine basin	Expenditure 1998-2015	Remarks
Baltic Sea	€ 0.7 billion	DE, SE and PL account for the majority of total expenditure
North Sea	€ 7.6 billion	NL, DE, and the UK account for the majority of total expenditure
Atlantic Ocean	€ 1.2 billion	UK and ES account for the majority of total expenditure
Mediterranean Sea	€ 5.8 billion	Much higher amounts are invested in freshwater, but this can not be one-to-one related tot coastal zones.
Black Sea	€ 0.3 billion	
Outermost regions	€ 13.18 million	

Source: European Commission (2009), The economics of climate change adaptation in EU coastal areas – Summary report.

Figure 1.2 Normal versus hot-spot (exceptional cities or single eco-systems) coastal protection expenditure in coastal member states



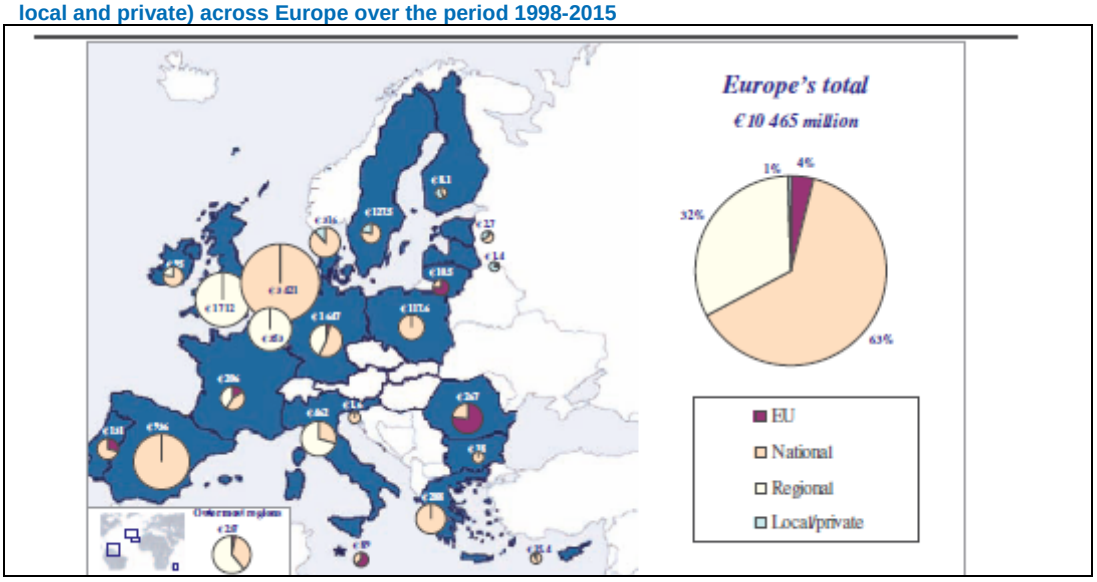
Year	Total expenditure (€million)	Hot-spot expenditure (% total)
1998	375	9%
1999	384	10%
2000	427	12%
2001	507	12%
2002	809	40%
2003	821	38%
2004	843	37%
2005	857	37%
2006	873	38%
2007	1046	30%
2008	1072	31%
2009	1522	53%
2010	1597	55%
2011	1611	54%
2012	807	11%
2013	813	12%
2014	731	12%
2015	741	12%
1998-2015	*15837*	*34%*

Source: Policy Research Corporation (2009)

Figure 1.3 presents the coastal protection expenditure at European, national and sub-national level (regional, local and private) across Europe over the period 1998-2015.

[7] European commission, 2009 The economics of climate change adaptation in EU coastal areas – Summary report.
[8] This includes the committed expenditures in the coming years taken from national Multi-year program budgets

Figure 1.3 Normal coastal protection expenditure at European, national and sub-national level (regional, local and private) across Europe over the period 1998-2015



Source: Policy Research Corporation (2009)

Only an estimated 1% of capital comes from private funds. In Denmark private landowners pay for coastal protection, but for Europe this is rather the exception than the rule.

Several factors determine the costs of coastal protection against flooding[9]:

- Planning and engineering costs
- Material costs
- Labour costs
- Costs of implementation in the environment
- Costs of management and maintenance

The share of each component will vary per country (e.g. labour costs) but also per coastal location because of physical differences. Beside the function of protection against flooding, other functions will influence the design and therefore the costs. In general multifunctional and integrated approaches (which are currently an increasing trend) raise the costs.

Employment data on this sub-function was not found, we estimate this in the order of 10,000 to 50,000 FTE.

Role of supplier industry

Coastal protection works are generally performed by marine construction companies, mainly dredger firms. This sector is highly concentrated with 4 players dominating the market having some 80 % market share (Van Oord, Boskalis, DEME, Jan de Nul). Furthermore there is one dominant shipyard building large size/high quality dredging vessels (IHC Merwede). At the side of engineering and research, more institutes are involved, but activity is highly concentrated among several large engineering firms, with research institutes like Deltares, Hydraulic Research Wallingford and Danish Hydraulic Institute and Universities. Because of erosion pressures and asset protection needs, these are highly concentrated in north west Europe.

The dredging industry has traditionally been characterized by conservatism. Innovations over the last century were in general due to immediate market advantage over relatively short term.

[9] Hillen, M.M., et al., 2010. Coastal defense cost estimates – case study of the Netherlands, New Orleans and Vietnam.

Given pressures on coastal regions, both from increased exposure to erosion and flooding because of climate change, and from the increased value of assets, industry as well as governments expect an increased need for investment in coastal protection. Main underlying drivers are assessed in Ch.3.

1.3 Regulatory environment

In the domain of coastal protection plans, the following EU Directives are considered most relevant[10]:

- EU **ICZM** Recommendation, which calls for a strategic approach to coastal zone planning and management in order to achieve sustainable development. Several projects were started (amongst others EUROSION, SAFECOAST, CONSCIENCE, OURCOAST) to develop indicators and data on measuring this approach. The PEGASO project[11], for instance, will refine the tools for making sustainability assessments in the coastal zone and implement a Spatial Data Infrastructure (SDI) to standardise spatial data to support information sharing.
- EU **Flood** Directive, which requires Member States to assess the watersheds and coastal areas that are at risk from flooding (by 2011); to map the flood extent and assets and humans at risk in these areas (by 2013); and to take adequate and coordinated measures to reduce this flood risk (by 2015). The outcomes of project Safecoast may serve as a (coastal flood risk) reference framework for the implementation of the directive (Safecoast, 2008).
- The renewed **Sustainable** Development Strategy adopted by the European Council, which – while covering a much wider scope than just coastal protection activities – is used in several countries as a guidance to the design of coastal protection plans.

Besides the above, EU directives targeting environmental protection also affect coastal protection plans and activities. The following are considered most relevant[18]:

- EU Birds and Habitat Directives: The EU Birds Directive places great emphasis on the protection of habitats for endangered as well as migratory species, especially through the establishment of a coherent network of Special Protection Areas (SPAs) comprising all the most suitable territories for these species. The EU Habitats Directive (together with the Birds Directive) is built around two pillars: the Natura 2000 network of protected sites and the strict system of species protection.
- EU Water Framework Directive, which aims to obtain a 'good status' for all European waters in 2015 and a sustainable approach throughout Europe.
- EU EIA Directive (Environmental Impact Assessment) is in force since 1985 and applies to a wide range of defined public and private projects. In order to protect the environment an assessment of the possible positive or negative impact that a proposed project may have on the environment is obliged. Environmental assessment can be undertaken for individual projects on the basis of the EU EIA Directive or for public plans or programmes on the basis of the EU SEA Directive (Strategic Environmental Assessment).
- EU Marine Strategy Framework Directive aims to achieve good environmental status of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend.
- The Pan-European Ecological Network (PEEN) is one of the most important implementation tools of the Pan-European Biological and Landscape Diversity Strategy (PEBLDS).

[10] http://ec.europa.eu

[11] PEGASO is a major EU funded project in the field of Integrated Coastal Zone Management (ICZM), which will last until Jan. 2014. It is part of the FP7 Collaborative Projects - large-scale integrating project. More information: http://www.pegasoproject.eu/

- The EU Waste Directive establishes a legal framework for the treatment of and aims at protecting the environment and human health through the prevention of the harmful effects of waste generation and waste management. As a result of this directive all dredged material was regarded as waste and could not always be freely dumped or nourished. This is now being changed, but implementation in member states seems to be still insufficient and knowledge of this lacking among national governments.

1.4 Strengths and weaknesses for the sub-function

Strengths:

- Long history of coastal protection activities, providing high skills level and top players in executing works, both within Europe and as an export product.
- Awareness among governments concerning long term planning of coastal protection and development of integrated plans.
- Available techniques and knowledge allow a design that takes the impacts on other functions and on eco-systems into account. In addition, the knowledge to use ecosystems' natural processes for realising protection measures (one of the eco-system services).

Weaknesses:

- Coastal protection is liable to political priorities.
- Ineffective governance of coastal zones. Long and tedious planning procedures.
- High capital investments required for developing equipment.
- Responsibility for coastal protection is, for most basins, not clearly organised or not optimized.

Constraints

- Strict regulations with regard to coastal works (e.g. sand mining), especially in environmental sensitive areas present constraints to the further economic development of the coastal protection sector.[12]
- Knowledge about ecological impacts as well as of legislation weak among many policy makers, resulting in the risk of untailored interpretation of rules. At present, the knowledge on ecological criteria is not always sufficient to formulate widely accepted sustainable development objectives and implementation strategies to reach these objectives. This would clarify the latitude towards the industry.
- Most spots (on a global scale) lack a sufficient sediment deposit (stock) to apply soft nourishments.

[12] Albeit, it is necessary to underline, that from an environmental and coastal protection angle, coastal works per se are also threaten the preservation of the sustainable development of the coastlines. Hence, in that sense, strict regulations may also be beneficial to coastal protection itself.

2 Research and technology

2.1 Research & technology mining patterns

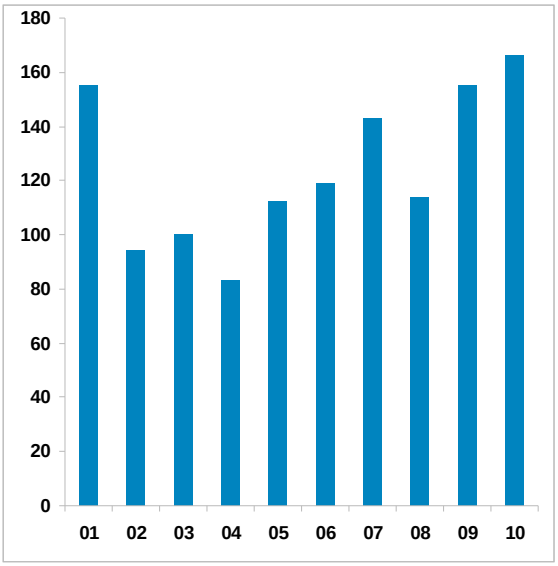
Patents and publications

An overview of relevant publications and/or patent information has been drawn-up by Thomson Reuters supervised by IDEA Consult using the following terms: *Coastal erosion-Coastal flooding-Coastal protection-Coastal management-Effects of sea level rise-Effects of climate change on coastal areas-Dredging technology-Dredging vessels-Sand nourishments-Nourishment technology-Dikes-Dams-Building with nature-Sediment balance-Economics of climate change*.

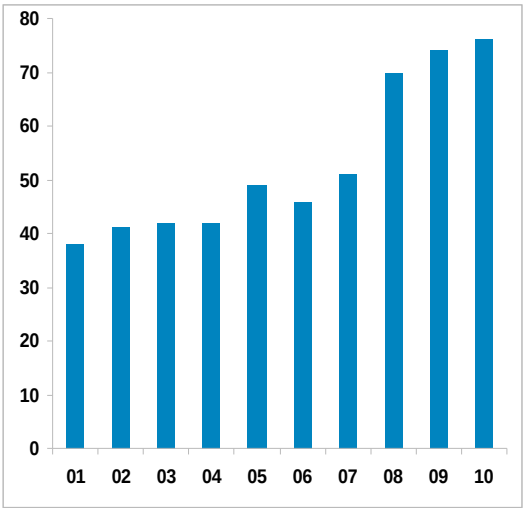
The overview shows an increase in both patents (from 94 in 2002 to 166 in 2010) and publications (from 41 in 2002 to 76 in 2010). The type of inventions for which these patents were registered cover development such as dredging techniques, cutter design and hydraulics. In a few cases also working practices developed by operators are known to be patented, but these are the exceptions. By far the most patents originate from Japan. Publications are mainly from USA, China and Europe. This is remarkable since the EU is considered leading in terms of designing and executing coastal works.

Table 2.1. Total number of global inventions and publications related to Coastal Protection (2001 – 2010)

Inventions



Publications



Source: Thomson Reuters

The rising number of global inventions and publications in the course of the last decade gives a clear outlook of the increasing importance of Research and Technology in this function.

The table below compares EU-27 countries in terms of patents filed on their grounds, with competing countries (2001–2010). Priority country means the place where the invention was invented and filed.[13]

[13] Priority country is used in the absence of an inventor country within the patent statistics. The particular field is not present across a good amount of authorities

Table 2.2. Country score in inventions related to Coastal Protection

Priority countries	Total inventions (2001 - 2011)	% of global
Japan	842	42%
South Korea	374	19%
EU-27	207	10%
US	185	9%
China	109	5%
Global	1983	

Source: Thomson Reuters

Figures above indicate that in terms of Coastal Protection, Japan is leading in terms of inventions, with 42 % of global inventions in this subfunction. South-Korea is equally a strong player with nearly one 5th of global inventions filed on their grounds. The EU-27 is ranking 3rd before US and China.

Table 2.3. Country score in scientific citations related to Coastal Protection

Priority countries	Total citations (2001 - 2011)	% of global
EU-27	2107	39%
US	1050	20%
China	532	10%
Japan	100	2%
South Korea	23	0%
Global	5367	

Source: Thomson Reuters

Table 2.4. Country score in published papers related to Coastal Protection

Priority countries	Total published papers (2001 - 2011	% of global
EU-27	271	34%
US	166	21%
China	99	12%
Japan	24	3%
South Korea	6	1%
Global	808	

Source: Thomson Reuters

Despite the Japanese and South-Korean favourable position in terms of inventions, the EU-27 is nevertheless leading in total published papers and total number of scientific citations related to them. Since published papers and scientific citations can be considered a certain indicator for future inventions, the table above can be also interpreted as a comparable sound basis for future growth.

Table 2.5. Top 20 global patent assignees - organizations or individual owners of the patent's invention - are presented in the table below in Coastal Protection:

Top assignees	Total number of patents filed (2001- 2011)
GOYO KENSETSU KK	23
MAEDA KOSEN KK	18
MITSUBISHI GROUP OF COMPANIES	18
KANKYO KOGAKU KK	17
NISHIMATSU CONSTRUCTION CO LTD	17
HITACHI	16
KOBE STEEL LTD	13
NIPPON SHOKUSEI KK	12
KAWASAKI HEAVY IND LTD	11
NIKKEN KOGAKU KK	11
KAJIMA CORP	10
SAMSUNG	10
KOREA ENVIRONMENTAL TECHNOLOGY	9
KYOWA CONCRETE KOGYO KK	9
NIPPON TETRAPOD CO LTD	9
GAN EI CONCRETE KOGYO KK	8
SETOUCHI KANAAMI SHOKO KK	8
SHIMIZU CONSTR CO LTD	8
KABARDINO-BALKARSK AGRIC ACAD	7
KAM YG	7

Source: Thomson Reuters

2.2 Key technological developments

Recent and ongoing R&D has focused on the following themes:

- Soft nourishments in addition to / instead of hard structures.
- Using natural processes in coastal protection measures (an eco-system service).
- Using the eco-system instead of / as part of other measures (an eco-system services).
- Increasing capacity of dredging vessels makes large scale nourishments as well as sand mining at larger distances possible.
- Restoring the overall sediment balance of coastal cells instead of ad hoc measures when coastal problems are urgent.

In the EUROSION[2] project it is recommended to maintain the coastline by restoring the overall sediment balance on the scale of coastal cells. To compensate sea-level rise effects and human-induced erosional effects, nourishments can be carried out to lead to an overall favourable sediment status.

In the CONSCIENCE project[14] the coastal cell concept to deal with coastal erosion has been further explored. The effectiveness of soft and hard remedial measures for sandy beaches is assessed based on laboratory, field and modelling experiences.

The trend (technology) that restoring sediment balances by soft measures (if applicable) is preferred to hard measures is likely to continue.

[14] Marchand, M (Editor), 2010. Concepts and Science for Coastal Erosion Management. Concise report for policy makers.

In the last years to decades, the interest in measures that pay attention to the ecosystem has increased. Two types of interest can be distinguished: Interest in measures that less harm (or in an ideal case even improve) the ecosystem. Explicit examples are measures that apply the concept of Building with Nature (i.e. using natural processes and / or increasing the natural quality of the measure). In general this concept is applied when using soft nourishments and restoring the sediment balance. In addition, the interest in using the 'ecosystem service' is rising: Marine and coastal ecosystems are generally recognised as providing protection to flooding and erosion[15]. The presence of certain ecosystems (in particular Posedonia meadows) secure the durability of infrastructures and can make (expensive) measures against flooding and erosion superfluous. Increasing the knowledge on the occurrence of such eco-system, their contribution to coastal protection and the economic evaluation of their benefits results in optimization of the use of eco-system services.

On these themes, a number of EU funded projects was conducted, see table 2.1 below.

Table 2.6. Overview of EU projects related to coastal protection

Acronym	Title / Focus	Funding
Conscience	Concepts and Science for Coastal Erosion Management	FP6
Encora	European Network for Coastal Research and Extension	FP6
Spicosa	Science and Policy Integration for Coastal System Assessment	FP6
PEGASO[16]	People for Ecosystem-based Governance in Assessing Sustainable development of Ocean and coast	FP7 – ENV 2009.2.2.1.4 Integrated Coastal Zone Management
ANCORIM	Atlantic Network for Coastal Risk Management	INTERREG
BLAST	Bringing Land And Sea Together	INTERREG
CoastAdapt	The Sea as Our Neighbour: Sustainable Adaptation to Climate Change in Coastal Communities and Habitats on Europe's Northern Periphery	INTERREG
SUSCOD	Sustainable Coastal Development in Practise	INTERREG
TIDE	Tidal River Development	INTERREG
OURCOAST	To support and ensure the exchange of experiences and best practices in coastal planning and management.	DG-ENV
Coastview	Coastal monitoring	FP5-FP6
Conscience	Coastal erosion & sediment behaviour	FP5-FP6
Dinas Coast	Coastal vulnerability	FP5-FP6
Encora	Coordinated knowledge network	FP5-FP6
Eranet-Crue	Science & Policy integration	FP5-FP6
Erogras	Flood defence stability	FP5-FP6
EuroGoos	Marine monitoring	FP5-FP6
Eurosion	Coastal erosion management in EU	FP5-FP6
Floodsite	Flood risk science and management	FP5-FP6

[15] Mangos, A. et al., 2010. The economic value of sustainable benefits from the meditteranean marin ecosystem.
[16] PEGASO is a major EU funded project in the field of Integrated Coastal Zone Management (ICZM), starting in Feb. 2010, the project will last until Jan. 2014. It is part of the FP7 Collaborative Projects - large-scale integrating project. More information: http://www.pegasoproject.eu/

Acronym	Title / Focus	Funding
Motiive	Data Harmonisation	FP5-FP6
Newater	Adaptive water management	FP5-FP6
Spicosa	Science & Policy integration	FP5-FP6
Chain of Safety	Transnational crisis management	INTERREG North Sea Programme
Comcoast	Coastal management concept	INTERREG North Sea Programme
Comrisk	Coastal flood risk management	INTERREG North Sea Programme
Flows	Flood plain land use	INTERREG North Sea Programme
Frame	Flood risk in estuaries	INTERREG North Sea Programme
Lancewadplan	Wadden sea cultural heritage	INTERREG North Sea Programme
Norvision	Spatial planning	INTERREG North Sea Programme
Response	Coastal erosion and climate change	INTERREG North Sea Programme
Safecoast	Future coastal risk management	INTERREG North Sea Programme
BAR	Coastal erosion	INTERREG North West Programme
Branch	Land use and climate change	INTERREG North West Programme
Copranet	Practitioners network	INTERREG North West Programme
Corepoint	ICZM	INTERREG North West Programme
Espace	Space for water	INTERREG North West Programme
Flapp	Flood awareness and prevention	INTERREG North West Programme
Floodscape	Space for water	INTERREG North West Programme
Messina	Monitoring and valuation	INTERREG North West Programme
Nofdp	Nature and flood prevention	INTERREG North West Programme
Sail	ICZM	INTERREG North West Programme
Scaldit	Scheldt estuary integrated vision	INTERREG North West Programme

The Eco-Shape initiative

In the Netherlands, the organisation Eco-shape has been established by the industry and co-funded from the Dutch government (Rijkswaterstaat,), the municipality authority of Dordrecht and the Water Innovation Chain) as well as the EFRO (the European Fund for Regional Development). Their aim is to do research targeting the environmental impacts of dredging and additional coastal protection works and to develop techniques that support both efficient operations and lowering the

environmental impacts. Moreover, the organisation focuses on the “Building with Nature” principles, in which natural processes such as siltation and erosion as well as the role of life organisms is used in planning and designing protection works (*Ecodynamic design*).

Another example fitting the building with nature line of thinking is the Envicop project.

ENVICOP

Environmentally Friendly Coastal Protection in a Changing Climate

(2012 – 2015)

The project will arise public awareness and exchanging of information on the risks of sea-level raise and on the importance of coastal protection.

Project Description:

Based on previous collaboration, a group of 3 EU research organizations (from Italy, Portugal and Bulgaria) and 2 non-EU research organizations (from USA and Brazil), experienced in the area of research on environmentally friendly (soft) coastal protection methods, decided to bring together their expertise in an IRSES network - the project EnviCOP (Environmentally Friendly Coastal Protection in a Changing Climate).

EnviCOP aims at strengthening research partnerships between the above organizations, primarily through short period staff exchanges of 14 Early stage and 7 Experienced researchers, as well as through various networking activities. Research activities of the project will focus on work-out/improve/coordinate advanced tools (numerical simulation and physical models) that are able to forecast short term and long term phenomena with respect to coastal protection in a changing climate.

Projects results:

The project is expected to provide improved process understanding, new knowledge, methods, new and improved numerical and physical model tools, resulting in introducing new and improved environmentally friendly coastal protection structures. Project objectives will be pursued by exploring the available experience and scientific potential of all partners, using complementarities and creating synergies, based on existing previous collaboration.

Project output should finally serve decision makers in strengthening emergency planning arrangements, improving co-ordination of coastal erosion and surface water flood risk; managing the investment of significant levels of public funding, and helping coastal communities adapt to climate change.

3 Future developments

3.1 External drivers affecting the performance of the cluster

3.1.1 External drivers

- **Global warming** may lead to the increase of rainfall in winter periods (larger river flows), storm intensity and sea-level rise *leading to increased flooding and erosion*. According to IPCC (2007) global warming will be about two to four degrees Celsius in this century. Recent studies[17] point out that the expected sea level rise is likely to exceed the values from the IPCC – for more details see next textbox[5]. Global warming is a global driver, though the effect on flooding and erosion is different for each of the European coastal basins (depending on tidal range, storm set-up, coastal type etc.). In Figure x the expected trend of vulnerability to flooding, erosion, species and the importance of sea level rise is presented per marine basin[18].

Key finding 5 from SWIPA2011: *Model projections reported by the Intergovernmental Panel on Climate Change (IPCC) in 2007 underestimate the rates of change now observed in sea ice*. The study predicts an increase between 3 and 6 C by 2080.
Key finding 13: *Melting glaciers and ice sheets worldwide have become the biggest contributor to global sea level rise (Arctic glaciers, ice caps, and the Greenland Ice Sheet contributed 1.3 mm of the total 3.1 mm observed every year between 2003 and 2008), The rate of future global sea level rise is surrounded with high uncertainty; models predict a rise of 0.9 to 1.6 m above the 1990 level by 2100.* The SWIPA study further states: *Higher average sea level and more damaging storm surges will directly affect millions of people in low-lying coastal flood plains. Sea level rise increases the risk of inundation in coastal cities such as Shanghai and New York.*

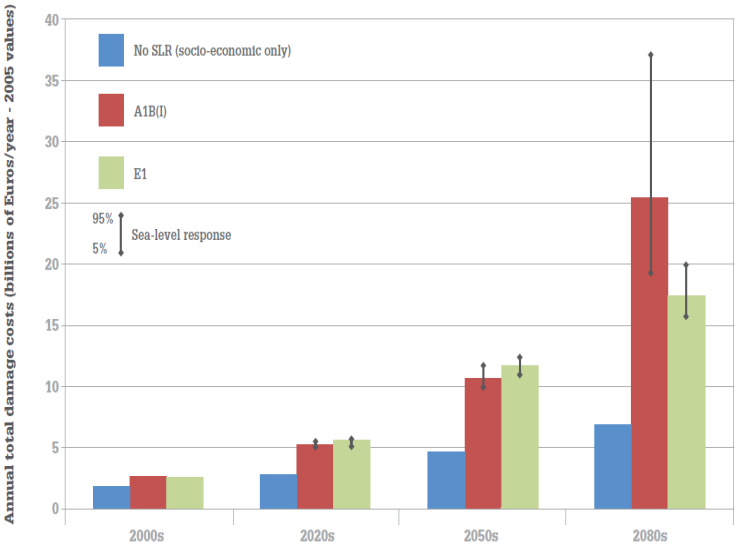
The FP7 funded project ClimateCost is providing estimations on the impacts of climate change in Europe, including the implications for sea level rise, and coastal protection. See box below.

Box 3.1 ClimateCost project

The ClimateCost project, which has been running under the FP7 Framework, is providing estimations over the impacts of Climate Change in Europe. The analysis is based on a Dynamic interactive Vulnerability Assessment (DIVA) Model and considers future climate and socio-economic changes to derive expected annual undiscounted values for a) flood damages if no measures are taken, b) estimated costs of adaptation and c) projected number of directly affected people. Two climate-change scenarios are considered (A1B1 and E1) for different temperature increase levels and a base-case scenario is also provided for the improbable situation that no increase in the sea-level occurs. The findings of the analysis for the medium-high emissions scenario for the 2050s account for € 11bln of damages and € 1,5bln of adaptation costs as well as 55,000 directly affected people annually. However these values are expected to strongly increase at the 2080s to about € 25bln, € 1,6bln and 250,000 respectively. As seen at Figure 1 the difference of the impact for the different scenarios is only slight until the 2050s, a fact that is attributed to ocean inertia, nevertheless in the 2080s, the 2 scenarios deviate significantly. The expected damages in this case include, direct impacts, salination, cost of moving and land loss while ecosystem loss and damage on the existing supply chains is considered to be of unquantifiable extent.

[17] SWIPA 2011, Snow, Water, Ice and Permafrost in the Arctic.
[18] Policy Research Corporation, 2009. The Economics of climate change adaptation in EU coastal areas.

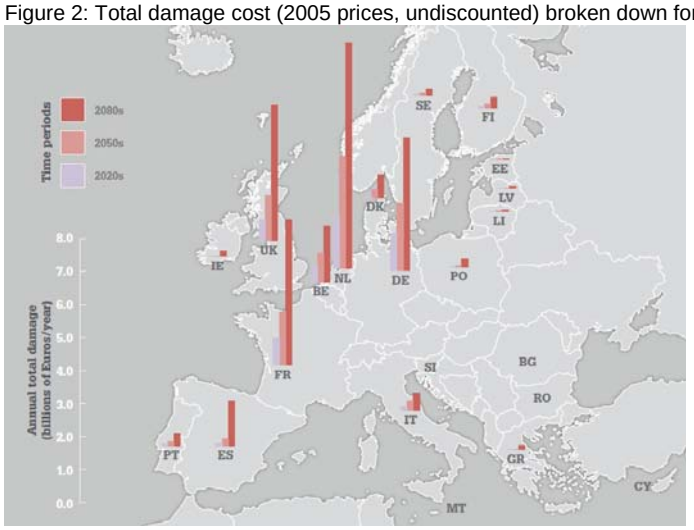
Figure 1: Total damage cost (2005 prices, undiscounted) for the EU for the A1B(I), E1 and No SLR scenarios throughout the 21st century assuming no upgrade in protection.



The expected distribution of damage cost between the EU member countries is , According to Figure 2, not proportional as some member countries face greater threats from rising sea levels than the others, especially the counties laying at the North Sea are expected to face considerable damages proportionally to the length of their coastline. Despite thought the high expected damages the report strains the fact that going forward with proper and in-time adaptation projects may prove to be an excellent investment as the benefit-to-cost ratio for these investments approaches 17:1 in the extreme case scenarios.

For the worst case scenario that was used, a mean 46cm sea level rise was accounted for although there are some existing scenarios that estimate sea level rise of up to a metre, in this extreme case the damages bore would account to € 158bln annually by the 2080s.

Figure 2: Total damage cost (2005 prices, undiscounted) broken down for each EU country



Source: ClimateCost, www.climatecost.cc

Figure 3.1. Expected trends per marine basin13.

Baltic Sea: Overall vulnerability low, most impact projected for marine species

- Low SLR expectations, projected land-uplift along major parts of the coastline and many uninhabited areas minimise the vulnerability to coastal flooding;
- Projected increase in sea surface temperature in the semi-enclosed Baltic marine basin threatens marine species as migration is difficult;
- Ice-cover reduction resulting in a different exposure of the coast to winter storms (erosion and sediment transport)[14].

North Sea: Mainly vulnerable to coastal flooding

- Significant SLR expectations, storm surges, many low-lying areas (more than 85% in BE and NL) and high economic and population concentrations make flood-risk a major concern;
- Significant erosion problems (20% of the coastline).

Atlantic Ocean: Coastal flooding is the main climate threat

- Main climate risk is flooding due to SLR and changes in both the direction and th power of waves;
- Southern countries could become more exposed to freshwater shortage in the future du to prolonged and more intense periods of droughts.

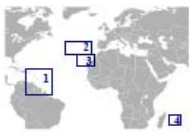
Mediterranean Sea: Mainly at risk of freshwater shortage

- Medium SLR and few parts of the coastline situated below 5 m elevation result in modest risk of coastal flooding, with the exception of hot-spot Venice;
- Longest stretch of coastline affected by erosion (30%);
- Large areas affected by saltwater intrusion; dry periods projected to increase in lengt and frequency putting additional pressure on freshwater availability.

Black Sea: Erosion is at present the most significant problem

- Considerable presence of coastal erosion (13% of the coastline);
- Vulnerable to the impact of SLR on intertidal habitats and eco-systems due to lo intertidal range and limited scope for on-shore migration;
- Dry periods are projected to increase in length and frequency putting pressure o freshwater availability.

Outermost regions[15]: Vulnerable to a variety of extreme weather events



- Highly sensitive to different extreme weather conditions (e.g. cyclones, drought an floods);
- The specific characteristics of the Outermost regions aggravate vulnerability to climat change and complicate adaptation, these include the high concentration of populatio and socio-economic activities along the coastline, remoteness from the mainland insularity, small size, difficult topography and economic dependence on a few product and sectors (often tourist related);
- For some of the regions, also the loss of biodiversity is a major concern.

(1) Martinique, Guadeloupe and Guyana (FR); (2) Azores and Madeira (PT); (3) Canaries (ES); (4) Reunion Island (FR)

- **Flooding and erosion events** leading to an increase in sense of urgency. This strongly relates to climate change and could lead to pressure from coastal inhabitants, industries, insurance companies etc. to put coastal protection higher on the political agenda. Example: The severe floods in 2006/2007 in Denmark showed that the country is currently underprotected. It made the landowners and insurance companies aware of the risk of flooding. Especially with large coastal infrastructure projects (such as closure of tidal inlets with barriers, sea walls) an extreme event, such as a major flooding or erosion could act as the decisive tipping point for its implementation. For example the Delta works in the Netherlands were quickly decided after the 1953 flood disaster, although the plans existed already for many years on the drawing table. Such events, working as a tipping point for action, could also work in the opposite direction: external conditions (e.g. sea level rise) could become too adverse which make protection extremely expensive. This could trigger a radical alternative strategy, for instance retreat from the coast. On the short term this is rather unlikely.
- **High value economic activities in coastal regions.** Expected tourism development and forecasted population growth in European coastal zones will increase the need for coastal protection. Furthermore it will contribute to land and properties values increase, which improves the cost-benefit ratio of protection measures. Moreover with the rise of income levels in developing coastal regions their desired protection level may also increase.
- **Economic crisis** leading to public funding coming under pressure will hamper the implementation of coastal protection. It can lead to postponement of necessary protection works.

3.1.2 Key factors

- **Better and more continuous monitoring**. Monitoring is a driver in the sense that it might convince the politicians that coastal protection is needed.
- **Implementation of ICZM policy and Flood Directive** on national and EU level will increase the awareness for the need of coastal protection. Formulation of sustainable development objectives and implementation strategies to reach these objectives can mobilize or prioritize funds for coastal protection. Strict interpretation of this legislation (e.g. Natura2000) has led and will likely continue leading to conflicts between protection of nature and protection of buildings and infrastructure. On the one hand it may hamper action, but on the other hand legal obligations to protect a nature area can also be an impetus for coastal protection.
- **Availability of sediments** (constraint) demanding for a search for alternative options.
- **Oil demands** affects the subfunction, directly by rising dredging costs (as fuel makes up a substantial part of operational cost), but indirectly as well as a new source of income from oil industry works offshore and in ports. Especially in the latter case often also a coastal protection component is involved.

3.2 Assessment of response capacity and commercialisation potential

Coastal protection cannot be viewed as an economic opportunity such as for instance wind energy or shipping. Typical market mechanisms, such as cyclic behaviour, competition, commercialization do not work. This is because it is largely a government based activity dealing with public interests. Therefore, the response capacity to future opportunities and threats is largely dependent on government policy making, existing legislation and governance procedures.

Governments tend to be slow in response, because of political mores, administrative bureaucracies and existing regulations and legislation. The time between awareness raising, policy formulation and the eventual implementation can easily extend to 5 or 10 years. Privatization and public private partnerships of coastal management could lead to a more flexible and rapid response capacity, but presently hardly exists in this sub-function.

Responses visible in the market already for some years, and likely to continue, are the following:

- **Scale effects**: The global pressure on coastal zones increased the amount of nourishments and land reclamation work. Frequently, sand had to be dredged at larger distances from the coast. This gave impulse to increasingly larger dredging vessels.
- Industry accepted the **ecosystem approach** with open arms, keeping the potential market development in mind. Latest developments are the mindset *Building with Nature* and in addition *Building for Nature*. As a result the traditional 'physical' orientated industry has extended to more biological and chemical aspects. Innovations such as the "sand engine" have emerged from this (see box below). The organisation Ecoshape is founded as a response to the customer demand for durable, integrated solutions (market-driven). The Dutch dredging industry, founders of the organisation, expect to maintain (increase) their lead in the world market by delivering high quality, ecological sound solutions.
- New **PPP structures** for coastal protection management. Instead of an annual fixed budget it gives budget flexibility to anticipate on the weather. It promotes innovations and enables / guarantees a look at a longer term perspective.

Sand Motor – An example of Building with nature and multifunctional coastal protection (source http://www.dezandmotor.nl)

Along most of the Dutch coast every five years shoreface and beach nourishments are carried out to compensate the loss of sediment due to sea-level rise. The five yearly operations do the job, but can we protect the coast in more sustainable and natural ways? Between March 2011 and October 2011, Rijkswaterstaat (Dutch government) and the provincial authority of South Holland will create *The Sand Motor*, a hook-shaped peninsula, the first experiment of its kind (21.5 million cubic metres of sand – 100 ha). Nature will take the sand to the right place: if expectations are fullfilled, nourishments off the Delfland Coast will be unnecessary for the next 20 years. Scientists will be studying how the Sand Motor develops to see whether this innovative method for coastal protection does indeed work. The Sand Motor provides a new option for anybody looking for space, and peace and quiet, as a refuge.

3.3 Most likely future developments (the Micro-future)

Most likely future is a **slow but steady increase** in coastal protection. Reasons for this are:

- Most important external driver (climate change and sea level rise) requires many decades to show an effect.
- Government policies change slowly.
- Countries where the need for protection is highest (e.g. around the Northsea) are already active in coastal protection for many years (e.g. Netherlands, UK). Other countries will increase their efforts gradually where needed.
- The benefits of coastal protection are hardly visible to the wider public or to politicians. It is only a lack of sufficient protection that makes this visible in terms of negative benefits. But in many cases this only occurs during relatively infrequent (extreme) events. Better and more continuous monitoring systems could alleviate this situation somewhat, making (potential) benefits and need for protection more visible.
- In Europe there is no real drive for land reclamation and major infrastructure, such as can be seen in parts of Asia. Population growth in Europe is declining and economic foresights probably do not warrant big public investments.

Relative position of EU as regards development worldwide: EU has advanced technologies and moderate growth potential. Largest growth is expected in Asia (Singapore, Shanghai, Jakarta, Korea, etc.).

The only radically different future imaginable is a retreat from coastal zones, making protection not any longer necessary. This is very unlikely (at least on the short to medium term) because of the many benefits coastal zones will continue to provide (tourism, harbours, fertile soils etc.) and the huge amount of capital already invested in the coastal zone.

Most likely long term development will be a function from three main drivers of change: sea level rise (and related climate change conditions), demographic trends and the world economy. SLR scenarios for the next century are in the range of 90 cm to 1.60m[12]. Increase in storminess is difficult to predict, but could also become a major factor in coastal protection. Rates of coastal population growth will probably show a large regional variation. Worldwide economic developments will determine hotspots of economic activity (both in terms of harbours and industry and in terms of tourism). This will result in some areas that continue to be heavily populated, while others will show a decline. Combined with the climate change we see a dual trend: for areas that remain densely populated the need for coastal protection will rapidly increase. For the other areas the increase in adverse climatic conditions combined with reduced population numbers will probably lead to reduced protection levels or no protection at all. It remains difficult to determine the net effect of this dual trend on the overall European coastal protection efforts. Both trends could balance each other.

Projects[19] on the prediction of required expenditures have been carried out, not pretending to forecast the impact of scenarios in large detail, but to simulate with alternative future climate scenario's. Adaptation costs are estimated between 2.6 (0.005% of GDP) and 3.5 billion euros per year (0.009% of GDP). Amongst others the lack of accurate data, current scientific results on future scenarios and the limitations of the global coastal model are not supportive enough to accurately predict the future potential of coastal protection. Yet the presented figures are a sound base to indicate the growth potential and compare this with the potential of other maritime functions.

3.4 Impacts, synergies and tensions

Table 3.1 Impact matrix of the medium-term and longer-term developments, relative to the current levels

Function	Indicators	Bal-tic	North Sea	Medi-terr.	Black Sea	Atlan-tic	Arc-tic	Outer most
1. Economic impacts	Budget for protection	0	0 (+)	++	+	0	0	0
	Export opportunities	0	+	0	0	0	0	0
2. Employment impacts	fte direct employment	0	0(+)	0	0	0	0	0
	fte value chain	0	0	0	0	0	0	0
3. Environmental impacts	CO2 emissions	0	-	-	-	0	0	0
	Geomorphology	0	0	-	-	0	0	0
	Fish	0	-	-	-	0	0	0
	Birds	0	0	0	0	0	0	0
	Mammals	0	0	0	0	0	0	0
	soil disturbance	0	-	-	-	0	0	0

++ = *Strong positive impact expected*

[19] Ciscar, J.C. (editor), 2009. Climate change impact in Europe. Final report of the PESETA research project.
Hinkel, J, Nicholls, R. J. , Vafeidis, A. T., Tol, R. S. J., Avagianou, T, 2010. Assessing risk of and adaptation to sea-level ris in the European Union: an application of DIVA

+ = Considerable positive impact expected

0 = Negligible impact expected

- = Considerable negative impact expected

-- = Strong negative impact expected

There is hardly a need for coastal protection in the Baltic, because of tectonic uplift of Scandinavian countries, sparse population etc. Growth is expected to be largest in Mediterranean basin, because of tourism concentration and relative high vulnerability to sea level rise.

Main synergies and tensions on other sub-functions:

- Coastal erosion and flooding threatens in particular **Leisure, working and living** in coastal areas. Coastal protection decreases the risk for erosion and flooding, but the protection work can also interfere with coastal tourism, shipping and offshore energy (wind and other renewables). As approaches to coastal protection design have been more and more integrated with other functions, solutions currently developed often benefit both protection and other functions as well as coastal eco-systems. This is considered an important synergy.Some of the interviewees of the sub-functional profile coastal tourism stress in particular the importance of looking for synergies with coastal protection, e.g. marina infrastructure contributing to coastal protection of land and property from erosion by the ocean.
- Performing coastal protection works requires the involvement of dredging fleet hosted by nearby ports, creating addition berth demand and associated services. Vice versa works in ports often also contain a protection component. In the case of oil and gas facilities in ports this is especially visible.
- As dredging and nourishment affects the seabed, it may impact certain segments of the fisheries sub-functions. On the other hand options for e.g. coastal aquaculture may be created through intelligent design of coastal protection works.
- Environmental monitoring developments provide useful insights into coastal developments that can be used for improving coastal protection approaches. Vice versa – the risk for erosion and flooding may result in increasing efforts in monitoring.
- Aquaculture and growing of algae can play a role in wave attenuation and erosion reduction. This is expected to increase with development of large-scale aquaculture installations in erosion-sensitive coastal areas, mostly in the Atlantic and the North Sea.
- Dredging an nourishments can facilitate coastal aquaculture, through intelligent design of coastal protection works.

- Horizontally, coastal protection can be a synergy as well as a threat to habitats:Habitats are as well threatened by erosion, flooding and submersion. Coastal protection against erosion and flooding can therefore contribute to the protection of habitats.
- However, protection measures itself can have (locally or regionally) a negative (temporarily) effect on habitats. In case the use of eco-system services and Building with Nature concept, the impact is minor (in best cases even a positive effect). In the past, hard constructions did have larger negative impacts on habitats.

4 Role of policy

4.1 Policy and political relevance

Public policy is very important in implementing sustainable coastal protection. Current practice regarding coastal protection in Europe shows that measures have generally been designed from a local perspective, often in a reactive way and with disregard to the larger time and space domains of sediment processes that are at the root of the problem.

Often measures are taken without an explicit strategic objective, for instance because a national coastal zone policy is lacking or insufficiently elaborated. Coastal state indicators are often not monitored regularly and evaluations are seldom performed. This hampers an effective and sustainable solution to the problem. It also makes erosion control practices less transparent and thus difficult to engage stakeholders in the decision-making process. In many countries a national coastal policy is weak or even non-existent. Without a clear government policy, lack of sufficient funds and limited public understanding it is hardly surprising that the approach taken to erosion management is primarily through ad hoc arrangements.

Hence, there are at least four reasons why public policy regarding coastal protection is of high relevance:

1. Coastal erosion is dominated by long term and large scale processes, which should be studied and dealt with preferably at a regional, national or even international level. Local level interventions can have far reaching consequences elsewhere. Monitoring is a typical public task.
2. In most countries coastal erosion measures are paid by public funds. Coastal protection is often seen as a common good for which people are willing to collectively pay. There is no free market system and a government should operate as a active customer when it comes to innovations and applying new techniques.
3. Interventions are characterized by high capital costs (e.g. mobilization costs) as well as high maintenance costs. Although public private partnership structures can have good perspectives, this hardly exists in Europe until date. However even then the role of the government in setting goals (service level agreements) and providing public funds is highly important.
4. Coastal protection can have significant impacts on economic sectors and stakeholders and thus requires transparent and legitimate government regulations.

4.2 Domains for EU policy

Coastal protection operates in a much wider context than just the narrow coastal strip. It relates to key questions which have to be dealt with on a local and national level, such as policies regarding spatial planning, urbanization, tourism development, safety and environment. And these policies also relate to key political EU goals and policies, such as climate change, security and defence and environmental considerations.

Reasons for EU involvement in coastal protection:

- There are important **linkages** between local and national actions for coastal protection and several EU political domains, such as the EU climate policy, ICZM Recommendation, Flood Directive, Soil Directive, EU Marine Strategy Framework Directive, Natura 2000.

- Knowledge on erosion processes as well as on monitoring and intervention is highly specialized and unevenly distributed among countries and coastal practitioners. EU can play and through several projects is already playing an important role in **knowledge distribution.** EU promotes the integrated approach by showing examples of best practices. Knowledge sharing among Europe is an important driver for further development.
- Physical impacts and relations easily cross international borders. Therefore **international cooperation** is important for which EU policy can be a catalyst.
- More uniformity in coastal protection procedures (for instance in setting set-back lines, accountability etc.) could result in an **equal playing field** and more transparency for stakeholders.
- Coastal protection is a worldwide issue. Europe is relatively well advanced compared to for instance Southern America, Africa and Asia. EU can promote this as a **selling point** both with regard to innovative measures and techniques as well as an example of adaptive coastal management in view of climate change.
- A multitude of regulations applies to the sub-function. **Understanding of regulations** is not homogeneous across Europe facing many interpretation differences. This affects the sector and hampers implementation of projects or causes cost level rises.

The growing potential for sustainable coastal protection greatly depends on the implementation of an ICZM policy in all European countries. The Protocol on ICZM in the Mediterranean that recently came into force (24th March, 2011) is an example of an international mechanism promoting ICZM. It calls for a proactive, strategic and integrated approach to the management of the coast, with explicit reference to the problem of coastal erosion and protection. The EU can also play a decisive role in this respect, especially for Southern and Eastern EU countries.

Recommended policy actions:

There is difference in opinion regarding the future of the EU Recommendation on ICZM. Some are of the opinion that there is no need for a stronger EU role in legislation regarding coastal management. But there are many who would prefer a possibility on a Directive on ICZM. The ICZM Recommendation was positive and moved the ICZM agenda forward but it was insufficient to trigger a durable implementation of ICZM (EUCC, 2011). The main added-value of ICZM, as shown in the OURCOAST initiative, continues to be the focus on integration. This is not only integration of sectoral interests, but also integration at different governance levels and integration at EU policy level. For a fully integrated management process to work it is vital that EU policies and other instruments (e.g. economic mechanisms) which also drive coastal change are addressed coherently.

A Directive could put pressure on member states to take coastal protection and adaptation more seriously. Without the Directive, ICZM especially in Eastern Europe does not get enough clout due to the fragmented and sectoral approach in their country.

The ratification of the ICZM protocol of the Barcelona convention[20] will serve as an innovative tool, since it will allow joint collaboration between countries to tackle coastal protection more effectively.

A sound interaction between the different policy actors at EU level and a neat cooperation regarding coastal management at all levels will further the development of the coastal protection sector. Besides that, a considerate dovetailing of the marine and coastal policies, e.g. through a unified competency for both areas could help to further boost the development of the sector.

[20] Adopted on 13th September 2010 by the Council. More information on the ratification of the ICZM protocol of the Barcelona convention can be found here: http://ec.europa.eu/environment/iczm/barcelona.htm

Interaction should contribute to a widely accepted sustainable development objectives and implementation strategies to reach these objectives. This would clarify the attitude towards the public and the industry. A proper implementation of Directives is by some interviewees mentioned as an additional point of improvement: Implement correct standards, based on experts advice. At present, for safety's sake, standards appear to be sometimes set (too) high, or in fact not matching the ecological processes at stake in the location concerned, hampering the functioning of industry and the public benefits.

4.3 Recommendations for the study

It is recommended to focus on the following issues:

- How can durability and integration (sectoral, but also at difference governance levels and between public and private parties) be further improved in order to:
  - Increase the protection level of assets in the EU
  - Create an impulse in protection strategies / techniques that are more (or more general) efficient and multifunctional (for example by carrying out large scale experiments within the EU). Focus on the use of the eco-system service and in addition the extension of the Building with Nature concept.
  - Increase the export of such coastal protection strategies / techniques
- How can the different DG's of the EU contribute to such improvement (which role can they play).
- To further explore the synergy between environmental monitoring and coastal protection.

Taking these points into consideration it is recommended to invite interviewees with a good overview of policy structure and sufficient background in erosion and flooding principles and management options.

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Annex 2: Stakeholders interviewed

BLUE GROWTH - DG MARE - SUBFUNCTION PROFILES (WPII)
PROPOSAL FOR INTERVIEW LIST

Subfunction:

	Interviewee	*Organisation*	*City/country*	*Specific theme*
1	Luigi Cipriani	Regione Toscana	Italy	Governance (Southern part of Europe)
2	Dr Robin McInnes	Isle of wight	United Kingdom	Governance (UK)
3	Per Sørensen	Danish Coastal Authority	Danmark	Governance (Northern Europe)
4	Dr. Stefan Aarninkhof	Royal Boskalis and Ecoshape	The Netherlands	Research, technology and impact
	Dr. Anneke Hibma	Van Oord and Ecoshape	The Netherlands	Research, technology and impact
5	Soraya Van Donink	Policy Research Association	Europe	Economics
6	Rob Steijn	Arcadis	Europe	Governance
7	Prof. Vrijling	Technical University Delft	The Netherlands	Research and technology development
8	Ian Thomas	Pevensey Coastal Defence ltd	United Kingdom	Governance
9	Dr. Adrian Stanica	Director of Research in GeoEcoMar	Roemenia	Research and technology development

Annex 3: Case studies

Case study 1 Dutch pilots

Why this Case is important

Recently in the Netherlands several projects have been carried out combining coastal protection against erosion and flooding with other coastal functions. These projects are an example for:

- Innovation / pro-active erosion management
- Building with nature
- Cooperation between national and regional governance levels
- Multifunctional protection strategy
- Monitoring opportunities to increase knowledge
- Stakeholder participation
- Decisiveness (from planning to realization within a few years)

Key description of the case

Sand motor (also known as Sand Engine)

(source: www.zandmotor.nl)

Along most of the Dutch coast every five years shoreface and beach nourishments are carried out to compensate the loss of sediment due to sea-level rise. The five yearly operations do the job, but can we protect the coast in more sustainable and natural ways? Between March 2011 and October 2011, Rijkswaterstaat (Dutch government) and the provincial authority of South Holland will create *The Sand Motor*, a hook-shaped peninsula, the first experiment of its kind (21.5 million cubic metres of sand – 100 ha). Nature will take the sand to the right place: if expectations are fullfilled, nourishments off the Delfland Coast will be unnecessary for the next 20 years. Scientists will be studying how the Sand Motor develops to see whether this innovative method for coastal protection does indeed work. The Sand Motor provides a new option for anybody looking for space, and peace and quiet, as a refuge.

Nourishment and surfing

Recently, a beach nourishment at Scheveningen was designed such that the surfing waves improve right behind the reef.

Foreshore protection with reef

In 2010 a foreshore protection with a large scale oyster reef experiment was started. The aim is reducing erosion of intertidal areas in the Eastern Scheldt (tidal basin).

In 2010 another (large) experiment was carried out in the Eastern Scheldt. A subsurface landscape was designed and constructed on a foreshore protection, expecting to result in a valuable ecosystem. Creating in particular a fabulous spot for divers.

Future developments

- Monitoring
- Research
- Explore export of strategy

Impacts on blue growth

Test (experiment) of concept. Positive results may lead to more locations in Europe and export of concept.

Policy implications

Combined effort of regional and national government and/or other partners.

Case study 2 Pevensey Bay UK

Why this Case is important

The concepts developed in the European research projects Eurosion and Conscience are applied in this case study. Furthermore coastal protection work is put on the market for a long period (not for a single intervention), based on results in stead of needed effort (fixed price).

Key description of the case

(sources: pilot site Conscience project www.conscience-eu.net and interview for *Blue Growth - Scenarios and Drivers for Sustainable Growth from the Oceans, Seas and Coasts*)

The UK has adopted a Flood and Coastal Erosion Risk Management Approach, whereby the coasts and benefits of each proposed scheme are assessed using a standard appraisal methodology. In the UK, four tactical objectives are considered at the level of a Shoreline Management Plan :

- Hold the line;
- Advance the line;
- Managed realignment;
- No active intervention.

At Pevensey Bay (a shingle (gravel) barrier beach between Eastbourne and Bexhill in East Susses on the English Channel Coast) the preferred tactical objective at SMP and Strategy Study level is to hold the line.

The intervention procedure consists of regularly measuring the gravel barrier, dividing it into sections and calculating the barrier profile in each. This is then compared to the threshold value of the cross-shore profile. If the measured profile is smaller than the target profile then the manager must choose an intervention procedure. In this case the available choices are nourishment, recycling and / or re-profiling.

The Pevensey Coastal Defence ltd has a contract with the Environmental Agency for the maintenance of Pevensey Bay (a set backline of 1/400 is required). The position is unique, as the contract is signed for 25 years for a fixed price. Therefore the company has a strong incentive to provide the tendered service at a lower cost.

Impacts on blue growth

Effects of this type of contract (result based instead of actual workload based); does it lead to innovations from industry?

Policy implications

Different type of construction contract with industry.

Case study 3 Managed Realignment Schemes

Why this Case is important

In stead of holding the line, in this case the option of setting back the line is chosen. Interesting aspects will be the results in terms of ecosystem value and defence costs.

Key description of the case

(Source: Ecoshape – Building with Nature – personal communication)

Managed realignment involves setting back the line of actively maintained defences to a new line inland of the original – or preferable to rising ground – and promoting the creation of inter-tidal habitat between the old and new defences. Managed realignment was studied under a.o. the Comcoast project (www.comcoast.org).

Traditionally design options are: Do nothing – Do minimum – Advance the line – Hold the line. In contrast with this traditionally designs the new ecodynamic design is: Retreat the line (Managed Realignment). It can be applied to many different situations that fall within the scope of coastal and flood management. There is still considerable uncertainty regarding benefits and costs of Managed Realignment. It is worth noting that with climate change and sea level rise, holding the line options are likely to become increasingly costly.

Impacts on blue growth

In case of added ecosystem value and a decrease in defence cost, the investment in coastal protection may possible increase (holding the line is more expensive and investment in the option holding the line may be not taken, but investment in managed realignments schemes might be chosen due to lower costs?) At present the succesfactors (ecosystem and financial) of managed realignments are studied.

Policy implications

Different approach, change in the mind-set

Annex 4 Table of cross-links and synergies

Function affected	Sub-function Affected	General	Baltic	North Sea	Mediterr.	Black Sea	Atlantic	Arctic	Outer most
1. Maritime transport and shipbuilding	1.1 Deepsea shipping	0/+	0	0/+	0/+	0/+	0	0	0
	1.2 Shortsea shipping (incl. RoRo)	0/+	0	0/+	0/+	0/+	0	0	0
	1.3 Passenger ferry services	0	0	0	0	0	0	0	0
	1.4 Inland waterway transport.	0	0	0	0	0	0	0	0
2. Food, nutrition, health and eco-system services	2.1 Catching fish for human consumption	0/-	0	0/-	0/-	0/-	0	0	0
	2.2 Catching fish for animal feeding	0/-	0	0/-	0/-	0/-	0	0	0
	2.3 Growing aquatic products	0	0	0	0	0	0	0	0
	2.4 High value use of marine resources (health, cosmetics, well-being, etc.)	0	0	0	0	0	0	0	0
	2.5 Agriculture on saline soils	0	0	0	0	0	0	0	0
3. Energy and raw materials	3.1 Oil, gas and methane hydrates	0	0	0	0	0	0	0	0
	3.2 Offshore wind energy	0	0	0	0	0	0	0	0
	3.3 Marine renewables (wave, tidal, OTEC, thermal, biofuels, etc.)	0	0	0	0	0	0	0	0
	3.4 Carbon capture and storage	0	0	0	0	0	0	0	0
	3.5 Aggregates mining (sand, gravel, etc.)	0	0	0	0	0	0	0	0
	3.6 Mineral raw materials	0	0	0	0	0	0	0	0
	3.7 Securing fresh water supply (desalination)	0	0	0	0	0	0	0	0
4. Leisure, working and living	4.1 Coastline tourism	+	0	+	+	+	0/+	0/+	0/+
	4.2 Yachting and marinas	+	0	+	+	+	0/+	0/+	0/+
	4.3 Cruise including port cities	+	0	+	+	+	0/+	0/+	0/+
	4.4 Working	+	0	+	+	+	0/+	0/+	0/+

Function affected	Sub-function Affected	General	Baltic	North Sea	Mediterr.	Black Sea	Atlantic	Arctic	Outer most
	4.5 Living	+	0	+	0	+	0/+	0/+	0/+
5. Coastal protection	5.1 Protection against flooding and erosion								
	5.2 Preventing salt water intrusion and water quality protection	0/+	0/+	+	0/+	0/+	0/+	0/+	0/+
	5.3 Protection of habitats	+	0/+	+	0/+	0/+	0/+	0/+	0/+
6. Maritime monitoring and surveillance	6.1 Traceability and security of goods supply chains	0	0	0	0	0	0	0	0
	6.2 Prevent and protect against illegal movement of people and goods	0	0	0	0	0	0	0	0
	6.3 Environmental monitoring	0/+	0	+	0	0	0	0	0

Explanation:

++ = Strong positive impact on other subfunctions/sea basins expected

+ = Considerable positive impact on other subfunctions expected

0 = Negligible impact on other subfunctions/sea basins expected

- = Considerable negative impact on other subfunctions expected

-- = Strong negative impact on other subfunctions expected

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