



6 MAIN FINDINGS AND RECOMMENDATIONS

6.1 Main findings and observations

6.2 Recommendations

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This chapter summarises the main findings, observations and recommendations of the overall Safecoast project, based on results from studies in Safecoast and the wider orientation executed in the Safecoast synthesis process. Main findings and observations are considered within different themes, as follows:


- **“Today”**: Coastal risk management in the present situation
- **“Tomorrow”**: Developments driving future coastal risks
- **“Next steps”**: Strategies to adapt to future coastal risks
- **“How”**: Risk assessment to support decision making

Based on the Safecoast conclusions, further recommendations are provided to support and improve future coastal risk management practices and the continuation of the cooperation between North Sea countries.

6.1 Main findings and observations

“Today”: Coastal risk management in the present situation

- **The North Sea coastal flood plains show a large variety in both the probability of and vulnerability to flooding.** There is a large variation in types of coastal areas, land forms, land use and emphasis on certain risk management approaches in the North Sea countries. Shaped by the forces of nature and human presence, coasts are different everywhere. Also, there is strong disparity between well-developed coastal areas and peripheral rural coastal communities. Safecoast has studied and mapped this variation more closely.
- **Despite the variety in societal attitudes and approaches towards flood risk in the North Sea countries, there are large similarities in coastal risk management strategies.** A precautionary approach based on safety standards (embedded in law or not) for a certain design water level is dominant in Denmark, Germany, the Netherlands and Belgium. In England however, the strategic objective is not to solely minimise flood losses but to maximise the sustainability of the system. Of all North Sea countries, the risk-based approach is furthest embedded in England. Following initiatives taken on European level, all countries have adopted the principles of Integrated Coastal Zone Management (ICZM). In practice the consideration of precautionary, robust and risk-based management approaches in the various countries often leads to similar management choices: context, more than attitude, therefore appears to define strategy.
- **Historically, a large variety of coastal risk management measures has been implemented.** In the periods after the coastal flood disasters in the 20th century (in particular those in 1953 and 1962) measures have focused on the improvement of flood defence systems (e.g. shortening of coastlines, stronger dikes, sea walls and barriers). In the past decades, the scope of policy options is broadening to include various options related to ‘working with natural processes’ such as coastal nourishments, salt marsh / foreland



management (e.g. at the mainland coast of the Wadden Sea) and the upcoming use of managed retreat strategies where feasible and viable (such as in Essex, England). In Safecoast, a historical timeline and maps were produced to provide an overview of the various (inter)national policies and instruments applied.

- **In all North Sea countries and regions, annual government spending of coastal flood and erosion management is below 0.1% of their GDP (nominal Gross Domestic Product).** While some countries get close to this number, in other countries this expenditure may be reasonably lower than 0.1% of GDP. In the countries and regions funding is organised differently, given the specific administrative and geo-political situation. For instance, in Germany 70% of the costs for coastal defence investments are shared by the federal government, whereas in Southern Denmark dikes are funded by means of local and private ownership. In the Netherlands, all costs for strengthening flood defence measures are paid by the national government. Also in England, the majority of flood and coastal erosion expenditure comes from the central government.
- **At present, coastal flood risk management is influenced by societal concern for climate change in many North Sea countries.** As a result, in most of the North Sea countries a rise of government spending on coastal flood and erosion risk management can be observed. At the same time, due to the absence of recent coastal flood disasters there is a risk of decreasing societal awareness and support for protection measures in specific, flood prone areas. This stresses the need and importance of risk communication and awareness raising to ensure the continuity and support of required coastal risk management strategies.

“Tomorrow”: Developments driving future coastal risks

- **The most important drivers of future coastal risks are related to spatial (socio-economic) developments and climate change.** From the viewpoint of coastal risk assessment these are considered as (more or less) autonomous developments, which are subject to major variation and uncertainty. The assessment of such developments is not an exact science. Scenario analysis is considered the most important tool to make the effects of these uncertainties explicit in the assessment of future coastal risks. Another important aspect in risk assessment relates to future protection levels offered by the coastal defence system, following from decisions to be made by coastal risk management authorities, based on anticipated future risks.
- **For the North Sea region as a whole, further increase of spatial pressure due to socio-economic development in coastal flood prone areas is expected.** For example, based on existing development scenarios, the Hamburg (harbour) area, London and Thames Gateway and Central Holland are considered to be growing socio-economic hotspots. A Safecoast case study (part of Action 1) on Central Holland shows an increase of economic value by 30-40% by 2030. Large parts of these areas are situated in low-lying areas, historically reclaimed from the sea or from lakes. In other areas the demand for other functions, such as tourism and nature is also considerable and influences flood risk management decisions. A generally expected demographic trend is that population levels will slowly rise and stabilise by 2050. In some places the trend of an ageing population is stronger in coastal areas, such as in Flanders and in parts of the English coast.

- **General trends in spatial (socio-economic) developments may be appropriate for long-term, macro-level risk assessments but more detailed information is required in developing coastal management strategies for specific areas.** Safecoast has mapped a possibly plausible spatial development scenario for the North Sea region, based on existing national planning strategies. In addition, and as part of tiered flood risk assessment, there is a need to consider more detailed spatial development scenarios based on specific spatial plans. The translation to lower assessment levels should be done with utmost care as there may be profound implications for how scenarios are characterised at a regional and local scale, limiting their reproducibility and credibility. While the impacts of climate change would require the consideration of long time horizons, planning horizons of spatial plans commonly do not exceed 30 years. The matching of these different temporal scales represents a major challenge in spatial scenario development.
- **With respect to the development of climate change there is a reasonable consensus on the average order of magnitude of sea level rise (5 to 6 mm per year, following the IPCC).** However, a Safecoast study (Action 1) concluded that the translation from scientific based climate change scenarios in the various countries and the assumptions actually applied in coastal risk management lack consistency and transparency. Moreover, the actual scenario applications are generally limited to sea level rise and do not incorporate assumptions for future changes in storminess or tidal characteristics. The main reasons for that are the lack of scientific knowledge and the complexity of dealing with these different climate change aspects in a long term policy making context.
- **From analyses conducted within Safecoast it follows that overall vulnerability and flood risk could substantially increase in the coming 50-100 years.**
 - Safecoast Action 3A assessed the increase in flood risk for the North Sea region up to 2050, assuming the present coastal defence system would not change. The increase in risk follows from the combined effects of an increase in consequence (due to socio-economic developments) and an increase in flooding probability (due to climate change). Even without taking account of possible increases in urban areas and based on a fixed price level (2007), consequences would increase by a factor of 1.3 to 1.5. At locations where present flooding probability is relatively high, increases in flooding probability may be of the same order of magnitude. The increase in flood risk is most marked in the Thames and Humber estuaries, West Flanders/Antwerp, Central Holland, and coastal flood prone areas of Hamburg and Bremen.
 - The results of the more specific cases studies on flood risk assessment that were carried out in Actions 3B and 5B provide more detailed results on the potential increase in flooding vulnerability and flood risk of particular flood prone areas.
 - Coastal erosion is a primary driver for coastal flood risks in certain areas. Without countermeasures, gradual coastline retreat puts pressure on inflexible coastal defence structures such as revetments or sea walls. Climate change will exacerbate this trend. Coastal erosion is also an important process to be managed in dune areas that form natural protection of flood prone areas. The results of Safecoast Action 5A on Danish coastal erosion have emphasised the need to include the results of local erosion assessments in decision-making regarding long term adaptation measures.
 - Estuaries in Belgium, Germany, The Netherlands and England may be particularly vulnerable. Flood risks become increasingly high in estuaries when coastal storm surges coincide with high river discharges in winter (an example being the Thames flood in 1928). In addition, a rise of sea level influences sediment dynamics which may lead to 'drowning' of salt marshes, affecting hydraulic loads on flood defences (for instance in the Wadden Sea).

Next steps”: Strategies to adapt to future coastal risks

- **Under presently assumed trends in climate change, most of the North Sea flood prone areas can probably be kept safe at acceptable levels and acceptable cost by continuing and upgrading current practices.** In principle, the probability of flooding could be reduced to any desired small number, assuming funding and capacity are without limits. A Safecoast quick scan (Action 6) concluded that most of the increasing risk in the foreseeable future could probably be counteracted by increasing and upgrading current practices, providing climate change developments would be within presently assumed trends. Such practices would include the strengthening, widening and heightening of existing defences or increasing sand nourishments to compensate for extra erosion, but would also have to consider a further broadening of possible protection and prevention measures. In addition, more conscious and transparent decisions are needed regarding the determination and allocation of ‘acceptable’ coastal risks. These can only emerge from public and political debate supported with the best possible knowledge provided by scientific communities.
- **The concept of integrated coastal zone management (ICZM) should provide the basis for developing specific integrated master plans for the various coastal regions subject to coastal risk.** The ICZM principles as adopted in the EU recommendation of 2002 are considered to be essential. Master plans should address the continuity of coastal risk management policies, provision of protection measures and the related operational procedures (i.e. in terms of balancing interests; financing; institutional arrangements; legal rights/obligations; and operational responsibilities). These aspects and possibilities have been further considered in Safecoast Action 4 on the development of a coastal protection master plan for Flanders. Moreover, the integrated planning approach should facilitate the necessary cooperation between coastal managers, land use planners and crisis managers and seek community participation at an early stage. Emerging climate adaptation policies should explicitly encourage this.
- **When considering possible alternative measures and options to manage coastal risks the risk management cycle or ‘safety chain’ must be considered in its full potential.** The safety chain should be addressed as a framework for categorisation and incentive for integration, rather than a principle for prioritisation. In spite of different terminology used in Europe, there is a lot of similarity in the meaning of the categories and types of measures considered. The EU Floods Directive is considered an important tool for the further harmonisation and integration of solutions and approaches regarding flood risk management. Within Safecoast, measure categories were defined by the following key expressions: (1) Prevention; (2) Protection; (3) Crisis management; and (4) Recovery. The focus in Safecoast has been primarily on the first two categories.
- **Within the measure categories ‘Protection’ and ‘Prevention’, many new ideas and concepts have emerged and are being developed in different North Sea countries.** Examples of observed trends related to such new ideas and innovative concepts include:
 - The development of various **sediment management principles** regarding the designation and maintenance of strategic sediment ‘reservoirs’ (‘sand motor’, passive drainage, salt marsh recharge). Such reservoirs would act as buffer zones directly protecting land from the sea, or aiming to secure sufficient sediment volumes within active coastal sediment cells to allow the shore to keep pace with sea level rise.
 - Ongoing **improvement of flood defences** by researching new techniques that reduce the probability of failure. Examples are given in EU projects like Comcoast and Erograss.

- A growing interest in creating more optimal **dike compartments** from the viewpoint of flood risk and/or the use or completion of secondary dike lines to enhance flood safety (for instance in the Netherlands and parts of Germany).
 - Emerging concepts towards the use of **wider flood defence zones** and the redesign and re-allocation of space surrounding existing flood defences, to seek additions to and alternatives for continuous dike strengthening and to better combine functions such as safety, nature and tourism (as illustrated by Comcoast).
 - Further implementation and discussion of seaward options to **reduce hydraulic loads** on flood defences (management of salt marshes as part of flood protection, wave energy reduction by artificial reefs and even islands, or increased coastal nourishments such as in Denmark, The Netherlands and Flanders).
 - An increase of various **forms of managed retreat**, especially in estuarine and salt marsh environments, however currently mainly used for purposes other than flood risk management (e.g. habitat restoration and nature compensation) and sometimes lacking local public support, such as in the Western Scheldt estuary.
 - Increasing incentives to better incorporate flood and erosion risks and vulnerability into the spatial planning process to **avoid or manage unsustainable developments**, e.g. discussions on revising coastal and flood risk planning policies in England, but also in other countries.
 - Selective use of **flood proofing** methods for local areas/structures/properties, especially in developed, but non-protected areas, such as in the Hamburg harbour area.
 - Increasing efforts and discussion in the North Sea region to **better allocate risks** (e.g. insurance) and to promote **risk awareness** and **preparedness** (communication campaigns (as covered in Safecoast Action 2), early warning, evacuation, self-help and flood risk mapping) and enhancing public support for proposed measures.
- **It is essential to consider the possible implementation of the various concepts that have emerged or are emerging in different North Sea countries in their specific context.** What can be worthwhile in one place could be inappropriate in another. Translation of coastal management concepts from one country to the other should therefore be treated with utmost care. However, in most North Sea countries there seem to be emerging trends relating to 'working with nature' and 'increasing resilience', following integrated policy goals and seeking to combine the various functions of the coastal zone.
 - **Flood risk communication and education is an important means to enhance coastal risk awareness and public support for measures.** Flood risk communication needs to be sincere, straightforward and aimed at all levels but with particular emphasis on the local level to target those at risk. In particular, awareness raising and communication should be aimed at reinforcing the potential for personal self-help before and during floods. In project Safecoast, a communication campaign in Schleswig-Holstein was performed and evaluated. The results obtained from an inventory of communication activities and experiences in North Sea countries and from a literature study, have emphasised the desire of people to be provided with guidelines on appropriate behaviour in crisis situations. Awareness of risks and believe in the effectiveness of possible measures is an important requirement to raise the interest and enhance the participation of people in this respect.

“How”: Risk assessment to support decision making

- **In the North Sea region, there is an increased use of risk assessment methods to support coastal policy and management decisions.** In England, risk assessments are embedded in the appraisal process of management options with guidance from the government. In the other North Sea countries, risk assessments currently have different purposes, such as creating support for existing precautionary approaches, increasing the knowledge base for risk management (e.g. failure of flood defences) and risk communication. For example in the Netherlands, a running national project (FLORIS 2) aims to provide the knowledge base for identifying critical weak spots in the flood protection system of flood prone areas based on an integrated flood risk assessment. Moreover, the knowledge base for flood risk assessment was also improved by EU project FLOODsite.
- **There is a need for risk assessments to be executed at different geographical and temporal scales.** The review of applications of risk assessment methodologies in Safecoast have emphasised the need to distinguish between different geographical and temporal scales in risk assessment in relation to specific planning objectives and phases. Different purposes require a different level of detail. In this respect, a distinction is to be made in a number of different, tiered assessment levels that could include:
 - The trans-national level, to identify the most vulnerable areas, e.g. in support of the implementation of the EU Floods Directive (as covered in Safecoast Action 3A).
 - The national/regional level or any level of competent administration, to substantiate or prioritise funding or planning decisions (as covered in Safecoast Action 4 on the development of the Flanders coastal protection master plan).
 - The local or regional level of specific flood prone areas to identify, design and evaluate possible measures (as covered in Safecoast Action 5B on the case studies in Lower Saxony).

In addition, it is observed that the planning for coastal risk management strongly interacts with other planning processes such as land use and spatial/infrastructural developments, involving many stakeholders and interests.

- **There is a large degree of commonality in flood risk assessment methods and approaches applied in the various North Sea countries.** Although the various countries in the North Sea Region all have developed their own approaches in dealing with flood risk assessment, the general method and approach is basically the same. Differences may pertain to specific methods and assumptions used, the emphasis put on various steps in the assessments, and the level of detail considered. The overall agreement and common aspects of the approach provide ample scope for joined methodological development and further exchange of knowledge and experiences.
- **Within Safecoast, part of the focus of the project was related to the application of risk assessment methods in specific case studies. The experiences from these applications have contributed to the international learning process by:**
 - Identifying shortcomings and problems related to data availability and accessibility.
 - Providing ideas for further methodological improvement.
 - Gaining new insights in the sensitivity of modelling parameters and assumptions.
 - Providing recommendations for the use and interpretation of modelling results, in particular in view of the major uncertainties involved in coastal risk assessment.


6.2 Recommendations

By continuing, intensifying and expanding current management practices it is expected that most of the North Sea flood prone areas could be kept safe at acceptable risk levels and at acceptable costs, under presently assumed trends in climate change. In achieving this, the findings of Safecoast effectively point towards the need for a more *integrated* approach to coastal risk management, where the main aspects of integration would include: different types of problems, developments, stakeholders, solutions, and types and scales of planning. The adoption of integrated planning procedures for managing coastal risk should not be underestimated and will require considerable effort and cooperation from all parties involved, as well as the necessary financial resources.

Recommendations following these main findings are categorised for different target groups related to coastal policy makers and managers and the various research communities.

Policy and management

- **Make use of the full potential of measures considered within the risk management cycle or 'safety chain'.** In addition to present management practices, a wide scope of potential measures should be considered to reduce coastal risks, building on experiences obtained in the various North Sea countries. This broad orientation on potential measures should stimulate innovation and help manage future coastal risks, taking into account the specific circumstances in coastal regions.
- **Clearly define national and regional coastal risk management goals in a broad and long-term perspective.** Coastal risk management and other planning objectives and existing trade-offs (e.g. related to economic development, flood risk and nature conservation) should be made explicit and discussed with the affected public. A clear understanding and communication of the trade-offs involved should warrant the development of sustainable solutions, balancing the interests of all stakeholders including the public at large. This requires an honest and open communication and participation process with affected communities.
- **Increase the focus of coastal planning procedures at the participation of local communities and authorities.** The purpose of this local participation is twofold. On the one hand, optimal use is made of the know-how and skills of local communities, taking into account their wishes and needs. On the other hand, the involvement and shared responsibility of local parties in the coastal risk management planning process will guarantee a sound social basis for the management plans to be developed. In Safecoast, this was put into practice in Action 5B, where the Lower Saxony flood risk assessment and simulation was discussed with a local contact group.
- **Continue the international cooperation and learning process.** Safecoast findings have confirmed the similarities in coastal problems and possible solutions, and the commonality in methodological approaches, among the various North Sea countries. As experience grows in coastal risk management there will be emerging options relating to policy and implementation to reduce risk and promote sustainable solutions. The North Sea countries should therefore continue to learn from each other by cooperation and knowledge sharing. They should also join in the research and monitoring of the dynamics of the North Sea and its climate and improve the knowledge base for all steps involved in



flood and erosion risk assessments. Moreover, they should improve conditions and arrangements for international data availability, data accessibility, and knowledge / information exchange.

Research communities

- **Further develop the integrated planning approach to manage coastal risks.** Important common aspects for further research include the integrated development of: scenario specification procedures; coastal risk assessment methodology; and the hierarchical planning approach for coastal risk management, linking short and long term time horizons and different geographical scales. A multidisciplinary approach is therefore important.
- **Improve the knowledge base on the aspects and impacts of climate change.** In addition to sea level rise, further developments should also be involved with other aspects of climate change such as wind speed and direction, storm surges and altered wave behaviour. The focus should be on the need and possibilities to explicitly include these aspects in policy and management scenarios to provide reliable estimates of the impacts to be expected under projected climate change scenarios. This may lead to a joint development of methodological procedures to include other climate change impacts in coastal risk assessment.
- **Continue the exchange of knowledge for development and further improvement of risk assessment methodologies.** The preparation and execution of case studies on risk assessment in Safecoast have yielded a variety of detailed suggestions for the improvement and further application of risk assessment methods. In chapter 4 of this synthesis report, specific recommendations with respect to these improvements and applications are provided in the context of the various case studies.
- **Reduce and better manage uncertainty in coastal flood and erosion risk assessments.** Further research should aim to understand and identify methods to explicitly include uncertainty in all decisions relating to coastal management. Major uncertainties are related to 1) natural and human induced variability and 2) knowledge uncertainty. Scenario analysis should be applied to manage uncertainty by making the effects of uncertainties explicit and transparent. This does not take away the uncertainties but provides a basis to 'minimise' the risk of making wrong decisions.

Among the most important uncertainties found in Safecoast case studies are:

- The magnitude and direction of economic and spatial developments (driving the possible extent of flooding consequences in terms of damages and casualties);
- The occurrence and development of hydraulic loads (in relation to climate change);
- The location and nature of possible failure of flood defences;
- The extent, duration and gravity of flooding events.