



QUICK SCAN CLIMATE CHANGE ADAPTATION

WITH A FOCUS ON COASTAL DEFENCE POLICIES IN FIVE NORTH SEA COUNTRIES

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Foreword

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1. Introduction

Why carry out a quick scan on climate adaptation?

Climate change will lead to a rise of sea level, more and more intense rainfall and presumably more extreme storms. This will probably have significant implications for the safety from coastal flooding. Every coastal country approaches these implications in its own way. This 'quick scan' study gives an overview of national debates about adaptation to the impacts of climate change on coastal safety in five North Sea countries. The aim is to inspire an international debate and learning process. The Dutch Ministry of Transport and Water Works, represented by the National Institute for Coastal and Marine Management, has coordinated this action in the framework of Interreg 3b Project Safecoast. This project aims to share knowledge between coastal authorities by trying to jointly answer the question: "How do we manage our coast in 2050?"

What does this study cover?

This study covers the national debates about the link between coastal safety and climate change in Belgium, Denmark, Germany, The Netherlands and the United Kingdom. It does not include contingency planning or international assistance for developing countries. It links to fluvial flooding where necessary. It looks into the debates among scientists, policy makers and politicians as reflected in official documents. DHV consultants have made the analysis with the assistance of national experts.

What is the status of this quick scan study?

This study represents only the professional opinion of DHV consultants, as we have interpreted information obtained through the Internet and through interviews by telephone and email (see section 9.1 for contact persons who provided data where no other source is mentioned in the text). It does not formally represent the views of national governments, nor of the Project Safecoast.

How is this report set up?

The setup is as follows:

- Chapter 2 describes the background of this study, as reflected in existing international documents, and its method.
- Chapter 3 compares the debates in the covered North Sea countries.
- Chapters 4 - 8 present details of each country in the quick scan.
- Chapter 9 presents references to our sources of information.

2. Background and method

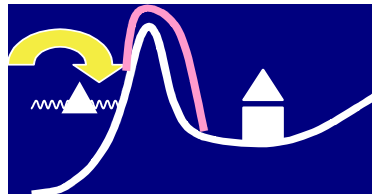
National debates about adaptation to climate change are often linked to the international (EU or global) debates. The current debates on global- and European level have been summarized in the next chapters. We can conclude that for decades the attention has mainly focused on mitigation of climate change instead of adaptation. Now it is acknowledged that significant changes are unavoidable and that we should adapt to these changes.

Furthermore, it has become apparent that the results of the general debates on climate change tend to focus on a series of adaptation measures for the short- and long-term, which in turn are related to climate change scenario's (sea level rise). Each country has a different combination of adaptation measures and scenario's depending on the coastline, the national policy and the social/cultural view on coastal flooding.

Adaptation measures

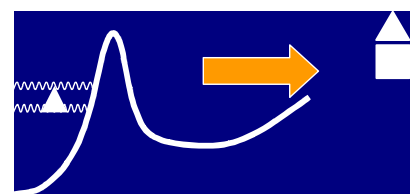
Generally, adaptation to climate change refers to policies, practices and measures which can moderate damage or realize opportunities associated with climate change. Throughout the different papers, policies, interviews etc. six main adaptation measures were identified:

Short term (0-50 years)

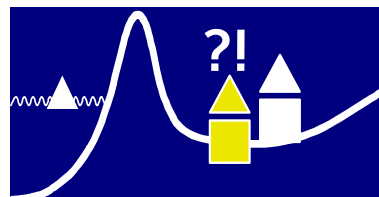


Strengthening defences
(dike reinforcements, nourishments etc)

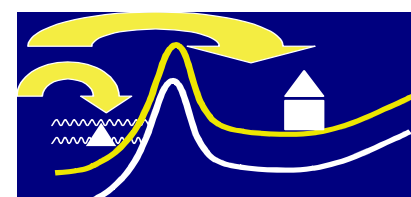
Long-term (50-200 years)



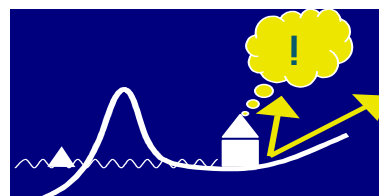
(Managed) retreat



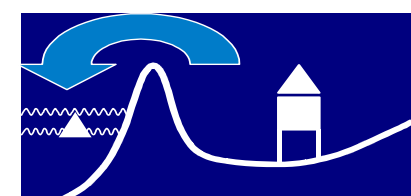
Spatial planning
(minimize risks, reserve space for future adaptation measures)



Strengthening and/or moving seaward
(sand, super dikes, planning, widening coastal defences, artificial reefs and islands)



Increasing risk awareness & being prepared
(support for proposed adaptation measures, early warning, evacuation plans, etc)



Stay put, increase capacity existing measures
(more pumping & adjusting, flood proofing)

Climate change scenario's (sea level rise)

The table below shows the sea level rise scenario's per country. A detailed description of these scenario's is given in a previously published report "Inventory of climate scenarios applied in the North Sea countries" (Alkyon, 2005). The numbers for the UK have recently been updated by DEFRA (2006) and have been incorporated in the table below.

Table 1: Policy scenario's for sea level rise in the five North Sea countries

	Minimum (mm/yr)	Mean (mm/yr)	Maximum (mm/yr)
Be1	-	5 Linear over period 2005-2055 Mean Sea Level	6 Linear over period 2005-2055 High Tide
DK2	Pragmatic No formal policy scenario on sea level rise, although a linear rise in water level of about 5 mm/yr was taken into account for the steps leading down to Metro stations during the planning of the new metropolitan district 'Orestad'.		
NL3	2 Semi-linear, short term design / nourishments (5 yrs)	6 Semi-linear, long- term design dikes, storm surge barriers (50-100yrs)	8,5 Semi-linear, spatial reservations (> 100/200 yrs)
Ge4	-	5 and 6 Linear, 5 mm/yr for Schleswig Holstein roughly based on IPCC (2001) and 6 mm/yr for Niedersachsen (excluding land subsidence - 0,6 - 1mm/yr)	-
UK5	2,5 Semi-linear. Recently updated figures of 2003 now reflect an almost exponential and regionalised curve, and replace the previous linear graph. See update report (2006) at http://www.defra.gov.uk/environ/fcd/pubs/pagn/climatechangeupdate.pdf		15

¹ Source: IMDC (2005)

² Source: EEA (2005)

³ Source: 3rd Coastal Policy Document (2002), NB: different (water) policy documents show slightly different scenarios (e.g. TAW, NW4)

⁴ Sources: Schleswig-Holstein Ministerium für ländliche Räume, Landesplanung, Landwirtschaft und Tourismus (2002), Bezirksregierung Weser-Ems (1997)

⁵ Source: DEFRA (2006)

2.1 International policies of climate adaptation

From 1972 to 1992: the scientific debate about climate change leads to political urgency

In 1972, the first international conference addressing climate change took place, the United Nations Conference on the Human Environment. Twenty years later, political urgency and mutual responsibility was underlined in Rio de Janeiro on the second international conference on the environment en development, de United Nations Conference on Environment and Development (UNCED, May 1992). At the UNCED conference, the importance of climate change as a global problem was acknowledged in the United Nations Framework Convention on Climate Change (UNFCCC). The 155 participating countries promised to take action against the causes of the greenhouse effect. The schedule for the reduce discharge of greenhouse gases was later decreed in the Kyoto Protocol (1997). The last international conference on the climate took place in November 2006 in Nairobi, with 189 participating countries.

2006: climate change is widely seen as unavoidable and adaptation emerges as second urgency

Although the UNFCCC gives hope that some of the climate change will be prevented through a reduction of greenhouse gas emissions, it is clear that its effects cannot be fully avoided. The UNFCCC obliges its parties to develop programmes for mitigation as well as adaptation. In the international debate, low-lying coastal countries had always recognized as major stakeholders of climate change. At the Climate Conference Nairobi (2006), coastal safety was again recognized as a major area of concern. This time scientists pleaded for evacuation plans for areas that are prone to flooding. Especially the poor countries are in danger of flooding because they do not have the means to protect themselves in contrast to rich countries. Rich countries agreed to establish a fund to help poor countries arm themselves against the effects of climate change (adaptation measures).

Where the UNFCCC and the Kyoto Protocol are major efforts of international cooperation on global issues by focusing on the mitigation of the climate change issue (by reduction of, mainly, CO₂ emissions), climate change adaptation has had only limited attention on a global scale and was mainly focused on developing countries and small island states. Recently, driven by the New Orleans flooding (linked with climate change) and other media attention, Climate change adaptation has been given more attention in Europe.

Milestones

In summary, milestones of this development are:

- 1972-1992: Scientific debate leading to urgency
- 1988: World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP): Intergovernmental Panel on Climate Change (IPCC) installed
- 1992: The UN Summit in Rio de Janeiro - "sustainable development"
- 1994: UN Framework Convention on Climate Change (UNFCCC) - "mitigation"
- 1997: Kyoto - "reduce CO₂ emission"
- 2000: European Climate Change Programme (ECCP) - "reduce CO₂ emission"
- 2001: Marrakesh accords: "adaptation fund" (for vulnerable countries)
- 2005: European Environment Agency - "Climate adaptation in EU is required"
- 2006: UN Nairobi summit - "Climate Change is unavoidable"
- 2006: Media attention (Katrina, Gore, Clinton, Stern)

2.2 European debates

At European level, most debates and policies have concerned the mitigation of climate change. A major document has been the 1993 Fifth Environmental Action Programme of the European Commission. The adaptation of coastal protection to climate change has entered the European agenda in coastal zone management and flood risk management. The European Commission is also exploring its role and the scope for a policy strategy to adapt to the impacts of unavoidable climate change and how best to assist local, regional and national efforts. (European Climate Change Programme Work group 2 'impacts and adaptation'⁶).

Coastal zone management

The European parliament and Council has introduced coastal zones on the agenda through the document 'European recommendation for the implementation of integrated management of coastal areas (2002)', but adaptation to climate change was not recognized as a major part of the challenge. In 2006 this strategy has been evaluated, and the evaluators have given the following new strategic recommendation: 'Address major long-term risks: Vulnerability to disasters and climate change Include the vulnerability of the coast to disasters as well as consequences of climate change, sea level rise and pollution on a Regional Sea level and in a long-term perspective, striving for the adoption of the precautionary principle'.⁷

The proposed EU Directive on flood risks

Another relevant European policy line is that of flood management. This process has started after a series of inland river floods, with hundreds of casualties. In November 2006, the European Council adopted a Common Position on a 'Directive on the assessment and management of flood risks' (COM(2006) 15 final 2006/0005(COD) in its first reading. The objective of this Directive is to reduce and manage flood-related risks to human health, the environment, infrastructure and property. It includes the flooding of coastal zones. The explanatory memorandum includes the following text: 'the scale and frequency of floods are likely to increase in the future as a result of climate change, inappropriate river management and construction in flood risk areas. Second, there has been a marked increase in vulnerability due to the number of people and economic assets located in flood risk zones.' According to the proposed Directive, all member states should undertake a preliminary flood risk Assessment. It should include, among other things:

- Maps of river basin districts including the borders of the river basins, sub-basins and where appropriate associated coastal zones.
- Descriptions of flooding processes and their sensitivity to change, including the role of flood plain areas as a natural retention/buffer of floods and flood conveyance routes now or in the future.
- Descriptions of development plans that would entail a change of land use or of allocation of the population and distribution of economic activities resulting in an increase of flood risks in the area itself or in upstream or downstream regions.

⁶ http://ec.europa.eu/environment/climat/eccp_impacts.htm)

⁷ Evaluation of Integrated Coastal Zone Management in Europe, August 2006. Rupprecht Consult - Forschung und Beratung GmbH, Cologne, and the International Ocean Institute in Gzira, Malta.

- Assessments of the likelihood of future floods based on hydrological data, types of floods and the projected impact of climate change and land use trends.
- Forecasts of the estimated consequences of future floods to human health, the environment and economic activity taking into account long-term developments including climate change.

According to the proposal, Member States must prepare and implement flood risk management plans and establish appropriate levels of protection, focusing on the reduction of the probability of flooding and of potential consequences of flooding to human health, the environment and economic activity, and taking into account relevant aspects: water management, soil management, spatial planning, land use and nature conservation. The flood risk management plans shall include measures that aim at achieving the established levels of protection. They must address all phases of the flood risk management cycle focusing on prevention, protection, preparedness, and taking into account the characteristics of the particular river basin or sub basin.

For coastal flooding, the following text in the Directive is important: ‘Flood risk management measures taken in one Member State must not increase flood risks in neighbouring countries.’ In The Netherlands, this is regarded to be an extremely important measure to reduce coastal flooding near estuaries (www.waternet.nl) as it decreases the high floodwaters from upstream member states as they take their measures to reduce the impacts of climate change.

Views of the European Environment Agency

The European Environment Agency is an independent European think tank that gives advice to the European institutions and member states. In 2005 it has published the report ‘Vulnerability and adaptation to climate change in Europe’. It includes the following statements:

- ‘Climate change could have profound impacts on coastal zones due to sea level rise and changes in frequency and/or intensity of storms. This would result in threats to ecosystems, infrastructure and settlements, the tourism industry and human health.’
-
- ‘Coastal and low-lying areas constitute a substantial part of Europe. With changing rainfall pattern (including extremes) and global warming induced sea level rise, a number of countries will be facing increased risk of coastal and river flooding. Benefiting from the long tradition of dealing with extreme weather events, flood defence is among the areas with best developed adaptive measures. Policies, guidance documents, regulations, and even concrete technical adaptation actions have been developed at the EU, national, and sub-national levels. Some of these measures are not deliberately designed for adaptation to long-term climate change impacts, though. Instead, they are developed for addressing short-term extremes.’
-
- ‘At national level, strategies are currently under preparation in Denmark, Finland and the United Kingdom. In many EEA member countries adaptation measures are either planned or taking place in the context of natural hazard prevention, environment protection and sustainable resource management.’
-
- ‘Currently adaptation measures have been largely initiated and implemented by different actors in the public and private sectors. (...) they are mostly limited in scope (e.g. directed towards flood defence in a particular section of a

watershed). (...) there is little co-ordination between sectors and between countries in planning and implementing adaptation measures. But risk management may be more efficient through cross-sectoral and international efforts. Examples include: multinational monitoring and operational early warning systems for flood protection and weather forecasts; improving risk management by developing risk maps for natural hazards; and providing guidance, training for local and regional decision makers.'

In 2006, the EEA published a second important report about coastal zones, entitled 'The changing faces of Europe's coastal areas'. In this report the EEA indicates that sea level rise will reduce the tidal zones near hard coastal defences. This 'coastal squeeze' is regarded to be primarily a problem for biodiversity. The EEA identifies policies of 'managed realignment' to enlarge the tidal zone. It also identifies coastal urbanisation as a threat since it occurs at the expense of ecological and other functions. In particular it reduces the possibilities of future managed realignment. Both problems are most severe in the North Sea region, where 16 % of the coast is lined with hard structures, and 20% is lined with dense urban areas. In certain areas, the EEA sees an increased risk of coastal erosion. Coastal flooding is regarded as an important issue. Human spatial processes that threaten coastal qualities are not under control yet. The EEA thinks, summarizing the texts above, that climate change will cause significant coastal safety risks. It indicates that coastal safety has always been adaptive to extreme weather events, but the long-term impacts of climate change are still insufficiently addressed. It sees especially a risk for biodiversity, since tidal areas are increasingly squeezed between hard defences that are often difficult to retreat due to coastal urbanization, and a rising sea. It identifies cross-sectoral and international cooperation as a bottleneck for dealing with this problem.

2.3 Analysis method

This quick scan study gives an overview of national debates about adaptation to the impacts of climate change on coastal safety in five North Sea countries. We define adaptation of 'coastal defence systems' as any set of measures that would physically manage the safety of coastal flooding on the long term. 'Safety' is the reverse of 'risk', which is the likelihood that a flood occurs times the expected damage caused by that flood.

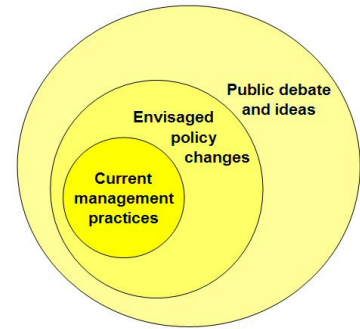
To address the question, we have answered the following questions in each country:

- What is the physical situation of coastal defence? (How safe is the coastal defence system, taking long-term effects of climate change into consideration?)
- What is done about it? (If the system of coastal defence is not safe in the long term, in which way does the government adapt that system to climate change?)
- What is the direction of thought in the government for the future? (If the government has made no decisions yet, how does it view coastal defence in relation to climate change?)
- Which more general debates about climate adaptation in relation to coastal flooding are going on? (Which debates about adapting coastal defence systems occur in the scientific community and wider policy communities?)

When confronted with changing circumstances, it is normal that a society needs some time to adapt. There is also the theoretical possibility of reacting prematurely - in panic. Through the questions above, we tried to observe how the countries react to the international debates and how national debates emerge. The answers to these questions are summarized in chapters 4 - 8 and compared in chapter 3, which is also

based on available international studies. In this chapter the following layers were distinguished:

- Coastal safety under current management practices as widely agreed upon by national experts.
- Coastal safety management practices and envisaged adaptations to it, as shown through official documents of the government.
- National debates about required adaptations, as shown in documents from several stakeholders and experts and as indicated by national experts.



3. Summary of findings

3.1 Key findings and suggestions

The problems and solutions are different everywhere:

- Key finding 1. **Key**Most of the North Sea flood prone areas can probably be kept safe at an acceptable cost⁸. Defences can be strengthened to compensate sea level rise, wave heights and -lengths and an increase of erosion. Existing defences can be widened and heightened. To increase the resilience of the defences along the coast itself, the inter-tidal area can be enlarged so that more wave energy is absorbed. This can be done seaward and landward depending on circumstances. Water depth at sea, ecological values and availability of sand are determining factors. Several countries have proceeded in making conscious, custom made decisions, at times sacrificing local (economical) assets for a greater benefit.
- Key finding 2. **The vulnerability of coastal flood plains is highly variable.** Some coastal flood plains are small and only have a value for agriculture. Others have built-up areas of various sizes and economic significance, for example along the western part of The Netherlands, which has a great socio-economic and natural value.
- Key finding 3. **It may be difficult to prevent an increase of risk for estuaries, where coastal defence and fluvial flood management coincide.** This is the case along estuaries in Belgium, Germany, The Netherlands and the United Kingdom. Risks become increasingly high in estuaries when coastal surges coincide with large fluvial floodwaters; both a prospective result of climate change. A linear strengthening of the current defence system may be insufficient to maintain the safety level that the public currently takes for granted. Solutions cannot be found solely along the coastline:
- a. Reduce fluvial peak runoff. A lot is already being done. Using selective realignment of rivers inland can alter flow and tidal patterns in estuaries, which in turn modify peak levels and reduce the risk of flooding. However, in The Netherlands and Belgium, there is some doubt whether at its present pace the ‘making space for the river program’ will create enough room for water to maintain its current acceptable risk level thus ensuring that the river dikes will not be overtopped in times of high fluvial runoff coinciding with high sea levels.
 - a. Functional inland flood plains. Inland damage may occur if flood plains cannot discharge their own fluvial water during high water levels in the estuary. Therefore, functional flood plains may be needed behind the

⁸ Wherever we refer to ‘cost’, we refer both to financial cost and amenities.

defences, to temporarily store water from rivers inland. This requires careful dedicated spatial choices.

There are two mutually reinforcing strategic options for coastal floodplains which are at risk so as to keep them at an acceptable level of safety:

Key finding 4. **Strategic option 1 is decreasing the probability of a flood by strengthening the defence system.** As sea level rises, so does the risk of flooding. Defences can be strengthened at their present location, landward or seaward. Dunes can be made 'fixed' or 'flexible'. Normal practices such as sand nourishments can be increased as the sea level rises to compensate for the ensuring erosion, or alternative measures can be used like sand nourishment on land to reduce inundation depth. The choice is often based on the economic and social value of the hinterland. In some cases it may be more cost-effective to remove buildings to make place for defences, at the same time increasing the inland storage capacity for drainage/overtopping water (functional flood plain). In cases where flood plains are dominated by urban sprawl, these measures will have too strong implications for spatial planning and seaward measures must be taken. Finally, along steep coasts coastal squeeze will result in a loss of (protected) habitats making a landward retreat more favourable.

Key finding 5. **Strategic option 2 is limiting the potential consequences of a flood by strategic planning of the (growth of) economic value of the vulnerable areas.** An increase in the risk of flooding can be compensated by lowering the potential damage the flooding can cause. By focusing on economic damage, the lives at stake are often automatically included. Urban and economic development can be shifted to areas that are less at risk. Alternatively, safety levels can be differentiated through compartmentalization of flood plains, an option that has been raised in The Netherlands. The choice for a 'full retreat' - giving land back to the sea - can be taken for outposts that are difficult and relatively very expensive to defend, at the same time creating valuable new (different) habitats. Although this is currently happening on a small scale in Denmark and in the UK, the relocation of existing built-up areas is a usually more of a theoretic option that is only sparsely cost-effective.

There are several management choices to be made:

Key finding 6. **We need more conscious decisions on acceptability of risks.** Procedures for making more conscious decisions about the risk of flooding are under way in the form of a new European Directive. In the UK such procedures have already been put in place. As yet, these decisions mostly still need to be made, or in the case of the UK: more widely adopted. Implementation of the Directive may therefore be a significant task. It is advisable that those bodies empowered to decide about acceptability of risks, also (partly) carry the risk of damage of flooding and the costs of protection in the same degree.

Key finding 7.

We need to agree more about responsibilities. Once the risk standards and the necessary measures needed to achieve these risk levels have been identified, the question is who is responsible for the protection and damage of flooding. There seem to be two ‘stereotypic’ ways of dealing with that:

- a. Local authorities are problem owners. In Denmark and in the UK the responsibility is decentralised and belongs primarily to the bodies “in the flood plain”; national level assists the local level to make responsible decisions. Low lying responsibility has the advantage that local development decisions are more likely to take risk of flooding into consideration. The flip side is that the outcome may be unfair for those who have acted and invested on the basis of decisions that were made before climate change was considered a risk. In the UK, local authorities make decisions on safety levels taking into account the desired function of the land. If the defences appear to be too expensive, they may choose to step aside leaving individual landowners to determine which protective works they want to use.
- a. A national authority is problem owner. In Belgium, Germany and The Netherlands risk of flooding is primarily regarded as a national (or state) interest. High lying responsibility has the advantage that there is less need for complex cooperation between several lower level jurisdictions. The higher levels can make superimposed master plans, which are then elaborated at local levels saving considerable and complex cooperation needed to make coherent spatial plans at lower levels. These plans incorporate required measures, based on a sharing of costs and benefits and solidarity. In this way individual local authorities do not have the perception that they are paying unevenly for the safety of a much larger or smaller areas. This debate on the relationship between responsibilities and formal powers is currently being held in The Netherlands. It is argued that the national government cannot be held responsible for problems at lower level it doesn’t have the competency / jurisdiction to solve. At the same time, the national government is held politically responsible for coastal safety.

Key finding 8.

In the short term, a process of joint fact-finding is required. A balance is needed between the two stereotypic approaches above. Involved groups should develop joint perceptions about realistic scenarios for climate change and actions. This is complex since it encompasses different governmental and local divisions responsible for development decisions in flood plain areas as well as upstream rivers, coastal protection and in the case of estuaries, for inland water protection. The debate is intensified by the involvement of private parties and non-governmental stakeholders. It will be difficult to develop consensus, in particular in large flood plain areas with many jurisdictions. Debates are needed about the following issues:

- a. How real is climate change and its possible effects? There is a need for an agreement on the certainties and uncertainties of available scientific scenarios offered by international think tanks. Dealing with risks is often determined by personal perceptions, but presently there seems to be a situation where many people and groups still do not accept that there is a risk at all. The debate should also relate to the options for action.
- a. Safety cannot be achieved by the national government or by local authorities on their own. More joint fact finding and (political) attention seems necessary to stipulate potential risk and action. Politicians still hardly use the risk of unavoidable climate change to raise the urgency of a more active role of regional and local governments in spatial climate adaptation. In the UK, the responsibility is already shared; powers of national agencies and local authorities are permissive. The national Environment Agency has prime responsibility for flood alleviation measures and local authorities can obtain financial assistance from the national government for worthwhile coastal erosion protection schemes.
- a. Insurance is a way of sharing risk. Insurance companies, in case of a non-mandatory system, can help developers and households to determine a risk level and decide which part of the risk they are prepared to carry by themselves. In the UK, insurances can be taken for household flood risk and the insuring companies prepare damage estimates of damage potential including how it is likely to change without adaptation to climate change (higher costs!!). The only other country in this quick scan with such insurance is Belgium, as of 2006. At the same time, there is an increasing awareness in the UK that the Environment Agency, as a national body, should have a stronger role to ensure that flood risk management options are integrated in regional and local planning.

Key finding 9. **In the meantime, we should take no-regret measures.** Wherever possible, spatial decisions and decisions about coastal defence and water management should be made not to foreclose future measures to deal with climate change.

This all translates into the following suggestions:

Suggestion 1: Organize joint fact finding among stakeholders about scenarios, acceptable risk, spatial development options and water management. Such debates are already organized in the UK (see Figure 1).

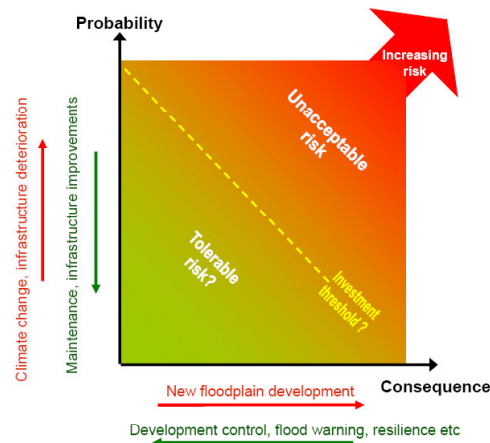


Figure 1. Components of flood and coastal erosion risk (from: Defra, 2006b)

- Suggestion 2: Governments should communicate more openly with the public about potential risk in (low-lying) areas near estuaries or the sea. This may increase the general sense of urgency for drastic measures if they are required. The implementation of the EU flood management directive will help to follow up this suggestion.
- Suggestion 3: **Discuss action scenarios and their fairness, including compensation for those who are confronted with higher damage expectations or with reduced development options.** This is a discussion about solidarity and about practicality of administrative procedures; complete fairness may not be achievable; those who have emitted greenhouse gases will not fully compensate the worldwide damage caused by climate change. By making this explicit may also increase acceptance by those who feel victimized by higher costs or unfavourable adaptation measures such as retreat.
- Suggestion 4: **Agree who has a moderating role.** The suggestions above require quite some resources, including transformative leadership. Each country should consider which body should take the lead in these discussions and subsequently moderate a national agenda.
- Suggestion 5: **Continue the international learning process.** As experience grows, it is likely that solutions will be found at acceptable cost. The North Sea countries should therefore try to learn from each other. They should also join in the research of the dynamics of the North Sea and its climate.

3.2 Coastal safety under current management practices

This section concerns the physical safety situation as it is expected to develop, taking current management practices as well as climate change into consideration.

Coastal flood risk and erosion will increase if no additional action is taken

Experts in all North Sea countries in this quick scan agree that the risk of flooding will increase. At sea, climate change will cause sea level rise, more extreme weather

events, higher and longer waves and stronger currents. The sea will flow father into the estuaries and rivers. This will cause a stagnation of fluvial runoff that may have to be stored on adjacent land. In addition, more rainfall will cause higher peaks in fluvial runoff (higher floodwaters). The combination of these two will cause higher risk of flooding on the landside of the estuaries. Under present management practices, it appears that the risks of inundation of larger areas of inhabited low-lying land are increasing (see table below). In addition to the climate changes, increasing urban development of these areas in Germany, Netherlands and UK ensures that the demand for proportional safety measures and thus compliance to higher risk levels is also increasing. Likelihood of a flood may be the same or even lower as a result of the upgraded defences, but the consequences and therefore risk are higher.

Table 1. Different physical context of North Sea countries

Country	Km Coastline	Km artificially protected coastline (2001) ⁹	Area potentially at risk of flood	Number of inhabitants of areas potentially at risk
Be	98	46	2,500 km ²	374,000
DK	4,605	201	<100 km	<5,000
NL	1,276	146	25,000 km ²	9,000,000
Ge (NS)	3,524	772	9,300 km ²	1,400,000
Ge (SH)			3,800 km ²	350,000
UK	17,381	2,373	5,000 km ²	2,500,000

Existing defence systems do not take climate change fully into consideration

Historically, local authorities have been responsible for the safety of most coastal zones along the North Sea. Densely populated areas were traditionally protected with 'hard' defence structures, whereas sparsely populated areas and natural reserves were usually protected with 'soft' measures like dunes, mud flats or cliffs. Generally speaking, the populations living along the coast felt and feel safe - also fed by the lack of recent serious coastal flooding.

But in anticipation of future developments, all countries have recently carried out or are carrying out routine inspections of their coastal defence system to determine if any changes are necessary. In Belgium, Germany and The Netherlands these routine inspections take into account climate change. In the other countries it may also be taken into account, albeit that the inspections do not always formally have the explicit aim to determine the effects of climate change. The results of the studies have already compelled The Netherlands to adapt its practices of sand nourishments in the sea near coastal dunes and to launch into studies searching for new innovative answers for the more complex hinterland areas needing protection in the long-term.

Results of these inspections show that routine adaptations are generally not thought to be sufficient to meet the enhanced effects of climate change. National responses and adaptation measures fulfilling public expectations for safety levels have not yet

⁹ SOURCE: [HTTP://WWW.EUROSION.ORG/REPORTS-ONLINE/PART2.PDF](http://www.eurosion.org/reports-online/part2.pdf)

been found or implemented. Exceptions are Denmark and the UK where levels of protection are generally not as high as in the other countries, largely due to the different nature of flood risk areas. The table below supports these findings.

An additional complication in the search for new responses and adaptation measures is the spatial complexity of these often densely populated areas of enormous economical, social and natural importance. It is difficult to draw one line for all coastal zones. Each local defence has to be customized and checked with regular intervals, turning the management of coastal safety into a practice of planning, decision-making and monitoring.

Table 2. Flexibility of existing defence systems

Country	Physical Measures	Flexible defence	Measures with view on climate change
Be	Sand nourishments, sea dikes	Annual monitoring and review every 5 year.	Additional sand nourishment
Dk	Sea dikes, sand nourishments at few locations	Routine inspections, maintenance when needed on managed coasts	Additional sand nourishment, dike reinforcements
NL	Sand nourishments, dikes, storm surge barriers	Routine raising of defence structures with 5 year review period, yearly coastline monitoring, 50m inland zone reserved (200yr sea level rise)	Additional sand nourishment, reinforcement 10 weak links, possible seaward extensions
Ge (NS)	Foreshore maintenance, Closing rivers, Sea dikes	50m inland zone reserved; Defences designed for raising 1 m max	None
Ge (SH)	Sea dikes Sand nourishment Foreland maintenance	Routine raising of defence structures with 10 year review period	Additional value for sea level rise in dike heights
UK	Sea walls, beach management, limited realignment, surge barrier	Routine programmes of cost-benefit and risk-based monitoring, beach management, shoreline management plans	Adaptive measures recommended for strategic planning of defences

Lack of space restricts the flexibility of potential solutions

Even when current practices take climate change into consideration to ensure the safety that citizens expect, problems emerge. There is often a lack of space to carry out potential large-scale coastal defence measures that are required in the long term. This is the case along narrow coastal zones that are already (naturally) eroding and/or which have real estate and industry close to shore. Only the German states of Schleswig-Holstein and Niedersachsen have compensated this by reserving sufficient space along the dikes with a view on climate change. The Netherlands, Belgium and Denmark have recently made provisions in legislation and policies empowering authorities to reserve extra land on a narrow strip along existing defence structures.

In the UK there are policies to encourage this for new developments. On a positive note, the lack of space also has instigated a search for innovative, economically attractive measures requiring less space.

3.3 Coastal safety management practices and future adaptations

In this section a description is given on how the different countries make decisions about coastal defence (safety levels), how they deal with the impact of climate change in their normal management practices and how they propose to adapt these practices to climate change.

Acceptable safety levels vary

Each country determines acceptable coastal safety levels in a different way. This means that similar hinterlands have different safety levels in each of the countries. The backgrounds of these differences have not been researched, but it is interesting to speculate about possible causes.

The Netherlands has safety levels reaching 1/ 2,000 to 10,000 chance per year depending on the value of the hinterland, as a flood would have many times more effect than in most other countries. For these other countries, it may be relatively attractive to accept more residual risk. For example, the Belgian coastal region of Flanders has adopted a safety level of 1/1,000 per year, whilst in Denmark local authorities determine their own safety levels case by case and adjust policies accordingly. In cases where there is no national interest such as outside towns and cities, the population and property owners have the responsibility to build defences, ensure their property and apply contingency plans. In the UK permissible land use depends on flood risk, and for new development vulnerable functions should only be allowed in areas where coastal flooding risks are less than one in 200 annual probability. In the other areas, landowners are responsible for the defences. In both Denmark and UK, the floodplains are generally smaller and of lower vulnerability compared to other the North Sea countries.

On the other hand, Germany puts an emphasis on solidarity at any cost. Authorities in Germany assume that the risk can be maintained at a negligible level for all citizens of the country; Niedersachsen applies standard design principles (State Dike Act) to guarantee a uniform security level.

Table 3: Safety standards

(water level with frequency x that a sea dike should withstand) (frequency in years)

Belgium	Denmark	Germany	The Netherlands	United Kingdom
1 / 1,000	Not determined nationally	Negligible (SH: 1 / 100)	1 / 2,000 - 10,000	1 / 200
Policy Flanders Region	Coastal Protection Act	Water Act	Flood Defence Act	Policy Planning Statement 25

Aware of the limitations of existing safety management systems, authorities seek new approaches

Alarm bells are already ringing in The Netherlands and the UK. Here, the national authorities have recently developed, or are developing, new frameworks for decision-making on coastal safety. Also in the other countries, the governments are actively starting up discussion.

Deliberations on which (combinations of) measures are advisable, such as managed retreat, strengthening the defences and/or expanding seawards, are taking place based on the social, historical, economic and natural value of the coastal land. In some cases strengthening or expanding can be so expensive and ineffective that authorities see retreat increasingly as a realistic and attractive option, including the relocation of existing property. In anticipation on the final measures, national authorities are already reserving this valuable land for future coastal defences. On the other hand the local populations and -authorities make choices in their spatial development plans blocking retreat. In practice, examples of managed retreat thus far seem to be limited to areas where the land has a low value such as an agricultural function.

Below is a short summary of which debates are currently taking place due to the limitations of existing safety management systems per country:

- In Belgium the government is starting with the preparation of a coastal management plan that takes retreat into consideration.
- In Denmark effects of climate change on sea level rise are considered a long-term process, implying no immediate danger to society and coastal areas. Because of this, public awareness is only rising slowly. However, the consequences of climate change are regarded as increasing important aspect needing to be dealt with in a sound way. In the mean time, existing structures are strengthened in order to maintain current safety levels.
- In Germany, the federal government has recently started a discussion about the safety of the estuaries. At the state level this debate has only been issued by the administration of Schleswig-Holstein.
- In the Netherlands, the government focuses on spatial plans that allow space for coastal defences, sometimes include a mild form of retreat.
- In the UK, the new PPS 25 (December 2006) for spatial planning stipulates that responsible local authorities must make flood risks assessments as part of the planning process. Managed retreat as an element of coastal management policy has thus far been applied only for ecological reasons and where the retreated area has relatively low value. PPS 25 will give local planning authorities the opportunity to set back proposed developments in coastal flood plains to improve flood risk management.

A raise in expenditure is often necessary

The observations made above seem to justify a raise of expenditure on coastal defence. Indeed, several governments have raised their budget for coastal defence as a result of climate change and ensuring maintenance of current safety levels. It has become apparent that responsible authorities have to strengthen existing structures and build new structures much more quickly than was done in the past. The available data, shown in Table 5, is difficult to compare. The cost probably primarily includes routine review and adjustment (raising) of existing structures. The cost of spatial measures (retreat and reserving space) is difficult to foresee, and probably has to be carried by local governments and property owners. The policies are not always clear about this. The actual cost of adaptation of coastal defence systems to climate change is therefore unknown.

Variations between the countries are caused by the amount of land that needs to be protected and the adaptation measures that are going to be taken. For example, in Denmark the raise is much lower than in the Netherlands or UK where much more property is threatened directly by climate change. Furthermore, there are differences in funding. Although in all countries the higher governments fund coastal defence structures, in Denmark and the UK landowners may have to co-fund.

Table 4. Envisaged measures and raise of national expenditure with a view on climate change

Country	Envisaged measures with view on climate change	Budget raise of national government with view on climate change	Total expenditure for coastal defence (million euro per year; data not fully comparable)
Be	Under study	None	€ 20 million (coastal management)
Dk	Studied and waiting for political backing; individual investments often take climate change into consideration	Unknown 'climate change component' of investments near the coast	€ 10 million (coastal management, but only government whilst most is private)
NL	Additional sand nourishments; spatial reservations behind flood defences for water storage, increase pumping capacity	Fifty percent raise of the budget for sand nourishment between 2000 and 2001 ¹⁰ . An extra 420,000,000 till 2010 is reserved for new investment and delayed maintenance of primary defences (river and coast), where 1.6 billion is necessary ¹¹	€ 500 (part national: reinforcements, part local: maintenance) ¹² € 44 (approx. sand nourishment per year)
Ge (NS)	Measures based on the measurement of sea level rise trends in the 7 last 100 years	Unchanged	€ 40 (excl nourishments?)
Ge (SH)	Development of flexible defence strategies (draft paper)	Unchanged	€ 45 (excl nourishments?)
UK	Portfolio of responses including adaptability and increased resilience	Almost doubling between 1997 and 2007 ¹³	1996/97 ca. € 475* 2006/07 ca. € 870*

* Conversion based on 1 euro = 0.65 pounds

¹⁰ Source: the annual national budget notes 1990 - 2005 as analyzed in "Beleidsevaluatie Dynamisch Handhaven" (Policy evaluation dynamic control), DHV in assignment for Ministry of Transport and Waterworks, 2005

¹¹ Advice Commission Water, Advice Safety against flooding (18 October 2006). These costs are needed because of climate change and delayed maintenance.

¹² Source: www.waterinbeeld.nl

¹³ Source: Defra (these are totals for river and coastal flood management and coastal erosion management in England)

3.4 National debates about required adaptations

In this section the debates in the countries that have not (yet) catered to a clear direction in the development of government policies are assessed. The issues are formulated as questions.

Will we be able to make enough space for water inland to prevent flooding near estuaries?

In The Netherlands, several programs are under way to reduce fluvial peak runoff; this is especially important as a high runoff can coincide with exceedingly high water at sea to increase a risk of flooding in estuaries. The question is if the Netherlands together with the upstream countries, will be able to make enough space for water, for example by creating functional flood plains? The London Climate Change Partnership (July 2006) acknowledges a similar issue for the Thames estuary, indicating 'London lies on a tidal river with an extensive floodplain and valuable parts of the city are at risk of tidal and fluvial flooding. Significant areas of London are at high flood risk and face restrictions in developing certain land uses within these areas.' (Part 1). For other estuaries, e.g. Schleswig-Holstein, no similar views were found. The Dutch situation may be different because safety levels are 10 times higher than in other countries.

Which degree of retreat is appropriate?

As mentioned before, coastal adaptation can take place as landward expansion, strengthening existing defences and in the form of retreat (a stop to, or adaptation of, development in flood prone areas). The first two options need constant upgrading whilst retreat can be considered a structural solution (if you move to high enough ground). Building higher defences on the developed flood prone locations become more and more expensive, reduce ecological values and in certain areas it may become impossible to ensure acceptable safety levels. Obviously, retreat is not always the best solution, and combinations should always be considered (see figure below).

In the case of retreat, three forms can be identified: accepting coastal erosion, moving primary defences landward and developing multifunctional areas where controlled flooding is allowed. Although in Germany adaptation through retreat goes against official policies, it is often seen as a major option for adaptation to climate change. It also extends to developed areas as proven in Belgium where this option is being studied, and in the UK where development in flood plains is only allowed if there are no alternatives.

In most cases, retreat has to be a 'managed retreat' to ensure a balance between costs and benefits and to control the area at risk as well as the level of safety in it. Areas with a lower safety level can remain in use by owners at their own responsibility, or may be left to nature. In the UK, a specific flooding insurance is possible that is differentiated according to the actual risk level. At the moment, there is a real risk of 'insurance blight': some property may become uninsurable due to changes in management or, in the longer term, due to climate change.



Figure 2: Debate about the principles for retreat

Some coastal retreat is envisaged in all five countries, primarily for ecological reasons (coastal squeeze), but also because the economic impacts are small compared with the cost of defence, as is the case in Denmark. In the Netherlands and in the UK (London) multifunctional flood plains in densely populated area are presently envisaged. In the UK, PPS 25 gives clear conditions for retreat (or a stop to development) in certain flood plains. In The Netherlands, the estuaries and upstream may require significantly more multifunctional flood plain than presently envisaged in binding decisions by the government.

How to deal with the lack of space?

Coastal retreat takes place at the expense of (valuable) land. It is an interesting question what an equivalent measure would mean in, for example, The Netherlands: by reserving land for retreat most development in the Western part of the country will be stopped as most of the land is equally unsafe. To develop land for multifunctional use (for temporary storage of water), many of the remaining less developed locations in the Western Netherlands are equal options. In the UK and Denmark, set back is often believed to be a preferable option for new development whilst in Germany restitution of developed area to the sea is not an issue in policy discussions. Germany adopts full solidarity among its whole population, and any cost seems justified to safeguard all developed land in the same degree. Decisions about retreat depend on (possibly implicit) choices about solidarity and acceptable cost. In Denmark property owners and local authorities are responsible to take action in accordance with the Danish Coastal Protection Act, if there is a need for coastal protection measures.

Spatial planning processes are often fragmented and have severe difficulties to reserve space for water required for the long-term approach to climate change. Burdens of coastal change and benefits of coastal management are not always spread evenly. However, in some countries like the UK, development in flood plains takes place where possible in low flood risk areas.

Do we need a shift of the prevailing paradigm dealing with risk and solidarity?

Different countries apply different water safety paradigms. In particular there is a difference in the power and responsibility of the national state compared with local authorities:

- In Belgium, this is under study.
- In Denmark, landowners determine technical measures. The Danish Coastal Authority has to approve according to the Danish Coastal Protection Act. In exceptional cases such as towns and valuable natural and historical areas, the national authorities can decide to assume responsibility and protect the land with national funds.

- In Germany, higher government has the responsibility to keep every German safe, and local implementation of the required defences seems not to be a problem.
- In The Netherlands, the problem lies with the higher governments, but they have little power to force local authorities to ‘make space for water’.
- In the UK, PPS 25 has recently been adopted to ensure that local planning authorities follow the national policies.

In The Netherlands, some experts indicate that maintaining the traditional approach of ‘dynamic preservation of the coastal line’ may become excessively costly creating an end to solidarity. The national government must intervene to make space for water where local government has difficulties in making the decisions. As the Dutch Advice Commission Water indicates, this is also a multi-level financial issue. Who will compensate the losses of the high market value of the land? It has become clear that the state can only solve the problems with the local authorities, possibly requiring a paradigm shift to implement the necessary policies.

Do the scale and complexity of the problem cause ‘paralysis’ in some countries?

Belgian, German and Dutch politicians seem to have relatively more difficulty than those in Denmark or the UK to openly communicate about risks in the long term and the associated paradigm shifts.

In the German state of Niedersachsen adaptation to climate change is not seen as an important issue in the first place, since sea level rise is taken into account already, based on past measurements of sea level rise (<http://www.nlwkn.niedersachsen.de>). In the German state of Schleswig-Holstein, the discussion is being led by the administration responsible for coastal defence. The general idea among politicians at the state level is, ‘our dikes are safe’ implying that safety, also in the long term, needs no urgent attention. However, at the federal level in Germany, the responsible minister recently stated that adaptation to climate change is needed. He founded an organisation that has the responsibility to increase awareness about climate change adaptation.

The scale of the potential problem can be very large, the solution complex requiring the cooperation of all levels of government, as well as several private sectors and NGOs. This has led to some policy discussions about long-term costs for defences, lack of space for defences, etc. Managed retreat options, such as in Denmark and the UK, appear to meet resistance from the local authorities and stakeholders who are responsible.

Should we take the international policies more thoroughly into consideration?

The IPCC recommendations to develop national programmes for adaptation, next to mitigation, are followed up by several programmes at EU and national level. The question is, should this be done with more intensity or in a different way? Coastal flooding in relation to climate change is coming up as a national issue in most countries in the quick scan, headed by the UK and possibly The Netherlands. However, with the possible exception of the UK these programmes do not seem to create the urgency to find and implement solutions. The question is, how can national programmes help to create that urgency?

The proposed EU Directive on flood risks is not mentioned in the data retrieved in the quick scan, but the UK’s approach in PPS 25 seems to be ahead of that proposal. If the Directive were adopted and implemented in the other countries, the necessary

choices would have to be made. However, the complexity of that task would depend on the size and intensity of use of the flood plains.

4. Belgium

What is the physical situation of coastal defence?

The Belgian coastline lies in the Province of West Flanders, which is part of the Flemish Region (Vlaamse Gewest) (roughly the Flemish speaking part of Belgium). It is 65 km long consisting mostly of a sandy coast, locally strengthened by sea dikes. Some 2,500 km² of rural and urban areas (inhabited by 374,000 people) are at risk to be flooded. The Western Scheldt - i.e. the Scheldt Estuary up to Antwerp - lies in the province of Antwerp. It is directly under influence of the storm surges from the North Sea and therefore influenced by sea level rise and climate change. However, in Belgium this area is not considered as part of the coast but as part of the river and river dikes protect it. Different governmental departments and projects exist for the river dikes (e.g. Sigma plan).

Erosion occurs in about 60% of the coastline. The authorities compensate erosion, which occurs along most of its coastline, with sand nourishments of which the size is based on annual aerial surveys together with shoreface surveys. This policy is termed 'restoration of dynamic behaviour'. Nourishments are the main technical measures to strengthen the coast against flooding, Theoretically, sea level rise (according to IPCC scenarios) is included in the design for the protection works.

What is done about it?

The federal government is responsible for national contingency planning. The Flemish government (Flanders region) is responsible for maintaining the coastal defence.. The (regional) Flanders government has defined the minimum safety level of the coastal defence at 1/1,000. However, this safety standard is not included in any law or decree. In Belgium there exists no legislation on the level of coastal protection.

To achieve this safety level, the Flemish Region (Gewest) executes the required works, which depend on the available budget. The costs of these works are completely carried by the regional government. A risk-based approach is considered to prioritise the needed protection measures. To obtain the required safety level along the entire coast, the safety level is increased step by step every year. A complete review of the safety level of the entire coastal protection is done every 5 years. Sea level rise is included in the design of protection works, according to IPCC scenarios.

The total annual budget for coastal management is some € 20 million, of which almost half for nourishment.

For the realization of coastal defence works a building permit is required and often an environmental impact assessment is needed since large parts of the coastal area are special protection areas. Building activities on beaches are mostly prohibited, except in designated areas or if it concerns temporary buildings. The Flemish Region (Gewest) has the ownership of approximately 60% of the dunes and is trying to get more control on the coastal zone by slowly increasing the ownership of dunes. According to the so-called "Dune decree (duinendecreet)" of 1993, the Flanders region can purchase dune area. Construction activities in the dunes are forbidden.

In this way it controls construction activities in and around the dunes it owns and it defines safety zones where no building activity is allowed. These defences and safety zones only take effect after they have been included in local plans, for which the Region (Gewest) Flanders needs the cooperation of municipalities.

The federal government is responsible for the coordination of contingency plans in case of national calamities. If a disaster only effects one or more local communities, the Governor of West Flanders or the mayor will coordinate the necessary operations. For several years no new dykes have been built, because these hard safety measures intervene with the natural dynamic of the coastline whereas soft measures, like nourishments, work together with the accretion and erosion processes of wind, waves and currents.

Since 2006, Belgium has a compulsory insurance for flood and earthquake damage (http://www.pap.be/newsletter/lire_detail_nl.asp?id=108).

What is the direction of thought in the government for the future?

The environment department of the Flemish Region (Gewest), Agentschap voor Natuur en Bos (agency for nature and forests), has identified adaptation of coastal defence to climate change as a possible priority, and it is now under study. The federal and regional government acknowledges the risks involved in climate change and the resulting impacts to their coastal defence system. However, as the magnitude of the sea level change and increased wave action is unclear the present policy of carrying out nourishments is continued in order to see what will happen in future. The present defence policy of nourishing the coastline when required is thought to be the most adequate strategy for climate adaptation.

The Flemish Region (Gewest) has coastal department in its ministry of mobility and public works. The Flanders region is currently formulating a new integrated masterplan for the future coastal safety of Flanders (Geïntegreerd kustveiligheidsplan). A 4 year project has been set up, in which the coastal protection strategy for short and long term measures will be defined. A risk based approach, which could lead to differential safety levels, environmental impact assessments and costs-benefit analysis approaches for coastal defence will be evaluated. Defence strategies as retreat, holding the line and seaward extension are regarded as an option for mid-term and long-term strategy. Whereas the current policy is based on a holding-the-line approach, retreat is a reasonable option in broad dune areas and to increase the biodiversity.

The Safecoast project is made part of this study, focussing on the long-term strategy.

Public awareness in Belgium on safety against flooding has to be increased. With several communication strategies the Flemish government is informing the public and private stakeholders on aspects related to coastal management. The strategies involve among others a National communication campaign 'De Kust, kwestie van evenwicht', an Annual week of the coast, a Periodic information bulletin 'de Grote Rede', and example projects to show benefits of sustainable management. Climate change and required measures for climate adaptation are included incidentally in this campaign, but are not a priority.

Lessons from the past, e.g. within the European project COMRISK, learn that the awareness of coastal inhabitants has to be increased concerning their vulnerability during flooding. In the framework of the "integrated master plan for Flanders future coastal safety" more efforts in informing the public will be taken.

Which more general debates about climate adaptation are going on?

In view of the predicted climate change it is clear that the budget should increase as the sea level continues to increase. In line with this discussion, proposal for public

private partnership for coastal maintenance is discussed. The requirement of works to maintain safety is not always felt by local stakeholders. Independent experts are used to increase the public awareness and to support the required works.

An example is the sea dike at Oostende:



Figure 3. Illustration independent experts use to create a sense of urgency (Source: <http://www.lin.vlaanderen.be/>)

5. Denmark

What is the physical situation of coastal defence?

The west coast of Denmark, the North Sea coast, is by far the most exposed coast in Denmark. It consists of three types of coast: in the South there is a tidal coast along the Wadden Sea. Sea dikes made of sand and clay (approximately 115 km in length) protect an area of about 600 km². In the Centre and the North, the coast consists respectively of sandy beaches and sandy dune coasts, alternated with clay cliff coasts. In the central part of the coastline, this natural sandy protection of the coast is being eroded. Especially the sand spit coasts with dunes separating coastal lagoons from the sea are prone to severe erosion. Mean erosion rates reach values up to 2 m/year and littoral drift (net sediment transport) is in the order of 100.000 - 1.000.000 m³/year. In the central part, most towns are situated on higher ground. There are a few exceptions like the towns Højer, Tønder and Ribe, which are subject to significant flood risks.

The problem in the Wadden Sea Area is the risk of flooding due to relatively high tidal ranges. On the central part of the Danish North Sea coast the problem is erosion and primarily the risk of flooding. On the Northern part of the Danish North Sea coast the problem is minor erosion. The problem of the inner coast may be erosion and in some areas risk of flooding. The low-lying areas are primarily farmland and land with few inhabitants.

Currently the safety level of the sea defences is being evaluated in a social-economic and environmental context. In particular, in the light of the rising sea level, the two Wadden Sea Counties and the Danish Coastal Authority are conducting a technical reassessment of the safety of the dikes. It is expected that the outcome of this reassessment will result in the reinforcement of existing dikes and an increase in nourishments. Local water boards under supervision of the responsible county and the Danish Coastal Authority maintain dikes in Denmark. The technical measures used to protect the Danish Coast against flooding and erosion are 'dike enforcement' and 'nourishments'. Beach nourishment is the main technique used for coast protection along the West Coast of Denmark.

What is done about it?

The Wadden Sea area the central part of the North Sea Coast and two localities on the northern part of the North Sea Coast is managed by the authorities. There is no legislation on safety levels. The practice in the Wadden Sea Area is a safety level 1:50-200 year depending of the risk of the hinterland. On the central coast it is minimum 1:100 year. The different inner coasts might be managed locally by a board of landowners, elsewhere it is up to the individual landowner.

Adaptation of coastal defence to climate change is in the present situation not an important motive for coastal defence in Denmark. In fact, compared to other North Sea countries, risk of flooding is a minor issue in Denmark. Most of the coastal areas prone to flooding are not or hardly inhabited. Apart from specific areas, the main motive for coastal protection in Denmark has been the control of coastal erosion. Adaptation of coastal defence to climate change is an important issue. Not all coasts are low inhabited - along the Baltic coasts major towns such as Aarhus or Copenhagen are located. The storm surge of 1 November 2006 showed again, that the risk of flooding is a major problem along many coastlines in Denmark.

The Dike Protection and Coast Protection laws from 1874 state that landowners are responsible for the coastal protection of their land. However, they do not have an immediate right to protect property. As a result of the disasters of flooding in 1953 and 1962 in Europe, a Storm Flood Committee was appointed in Denmark to evaluate flood safety conditions. The Storm Flood Committee was only appointed for the dike protection in the Danish part of the Wadden Sea. They only evaluated the safety levels of the dikes in the Wadden Sea region. Safety standards for the dikes were assigned based on a safety assessment level. In practice safety levels in the Wadden Sea Area range from 50 to 200 years (dikes at towns Højer and Ribe). On the Central part of the North Sea Coast the minimum accepted safety level is 100 years.

Recently, a number of new acts and management instruments have been drafted to promote integration in management of the coastal zone. Coastal protection in this new legislation is included in among others the Coast Protection Act (1994, revised 2006), The Nature conservation Act (1994) and the Planning Act (1994).

Regional and local authorities are empowered by the Coast Protection Act to decide whether project drafts for coastal defence structures are suitable for further consideration to protect the land against flooding and erosion. Furthermore, appraisal by the Danish Coastal Authority is needed to proceed with project preparation. The Nature Conservation Act and the Planning Act also protect the coastal zone. The first act defines a 300-meter inland setback zone (summer cottage areas excepted). The second act defines a 3 km wide belt in which planning for new activities is restricted. In both cases permission is required from the Danish Coastal Authority (Minister of Transport and Energy) to establish the coastal protection works and other technical changes. Development of the area is possible when the function of the development is directly related to the coastal zone. These acts and the preceding legislation, which had been in power for a long time, secured a reasonable state of sustainable development of the coastal zone in Denmark.

Although there is no public obligation to undertake coastal defence, political bodies consider it a public duty to enforce or erect dikes in inhabited areas or areas with high socio-economic and natural value that are under threat. The government typically pays 50-70 % of costs and in some cases even 100% of the costs. There is no insurance coverage against flooding in Denmark. A specially appointed Storm Fund Board determines compensation for damages due to flooding. This board decides which areas - depending on maximum registered water levels - can claim to be a storm flood area. To be eligible to coverage from this fund, landowners must have constructed a minimum of protection works.

No national rules for safety assessment for dunes and the remaining dikes have been set up. Safety assessment policies in relation to flooding and erosion control policies may be established in cooperation between local authorities and the Danish Coastal Authority. The Danish Coastal Authority elaborates recommendations since it is the technical institution with respect to coastal protection.

There is also no active long-term plan to enforce the existing dikes in Denmark. In the case of the major dikes, they are tackled when it becomes apparent that they need to be repaired. In the future it could be an option that dikes will only be strengthened or maintained if it is socio-economically proven that the dike is justified.

What is the direction of thought in the government for the future?

The Danish government has studied the impacts of climate change for coastal defence. In 1992 it was estimated that it would cost about 60 million Dkk. per cm sea-level rise to protect the 120 km of the west coast of Jutland from Lodbjerg to Nymindegab. This corresponds to about 24 million Dkk. per year assuming a sea level rise of 20 cm over 50 years (present annual prices for nourishment to compensate the natural erosion is 75 million Dkr.) (Fenger, 2000). Research of the impacts of sea level rise on the Danish Wadden Sea has shown that the sedimentation in the Wadden Sea is in balance with the existing sea level and that the yearly sedimentation is readily keeping pace with the sea level rise. It is concluded that the level in the Wadden Sea will follow the rise of the sea, which means that the Wadden Sea is expected to exist under a changing climate with respect to sea level rise.

To aid the discussion on the implications of climate change, the Danish Coastal Authority has just finished writing a report on the implications of climate adaptation along the Danish coast. This report is based on IPCC predictions (so-called A2 Scenario), isostatic land subsidence (during the last 100 years) and meteorological and hydraulic predictions from the Danish Meteorological Institute. It presents an overview of the situation that will arise if climate change occurs and can be seen as a reference-level for the discussions. The report gives a qualitative overview of the envisioned consequences and an estimate of the budget needed in the long-term to maintain the existing coastal protection and sea defence. It was concluded that in order to counter the effects of climate change:

- There is a need to enlarge and reinforce existing dikes, increasing costs for coastal protection;
- There is a possible need for new dikes to secure new, flood exposed areas;
- Higher costs to drain farmland in exposed areas;
- Existing farmland can be changed into new wetlands naturally following the sea level rise.

The general view in the government is that climate change is a rising problem that needs to be addressed. On the political scene, Denmark is working to raise political awareness. The general opinion is that action now, using the latest technologies, may prevent grave disasters in the future (at a lower cost).

Which more general debates about climate adaptation are going on?

Within the local and the regional authorities the planning and the initiatives that make allowance for the rise of the sea level hardly exist despite the extent of its consequences. The Danish Board of Technology has written an advice to the Danish Parliament (TEKNO, 2005). In this advice it is stated that because of sea level rise, more water means less land, and Denmark ought to begin the discussion about the allocation of the land, which will be left. Today already, local authorities with a coastline in their area ought to include a rise of the sea level in their planning, and they would benefit from involving the local interests of the existing associations of house owners, farmers, fishermen, and nature organisations.

Only few authorities have indeed initiated plans to make allowance for the future sea level rise etc., among these are the Danish Coastal Authority, port authorities, some insurance companies and some local authorities. But many local authorities and officers, mortgage-credit institutions, farmers' unions, house owners' associations, summer cottage owners, business companies and tourist industries have not yet initiated a change in their planning for the reduced and altered territories. The

Danish board of technology states that it is essential to map exposed areas along the Danish coasts and assess their socioeconomic value to make a qualified basis on which we can decide if it will be worth it to maintain them in the long run.

The Danish Board of Technology also carried out a project designed to draw attention to the consequences of climate changes, in order to make sure that these consequences can be considered in long-term planning. The main topic of the project is that it is time for Denmark to prepare itself for the rise of the sea level - on local and national basis. Both the local and the regional authorities need to start planning and take initiatives that make allowance for the rise of the sea level.

As a part of the project, two scenario workshops were arranged in 2003 (see box below), where local actors gathered to discuss the future planning in the two local areas considering the sea level rise of half a meter. When the workshops were carried out, there was hardly any alertness on this issue in the society despite the extent of its consequences. Today, alertness is starting to increase in response to the various inputs and the debate in the national medias: local authorities with a coastline responsibility ought to include the sea level rise in their planning, and they would benefit from involving the local interests of the existing associations of house owners, farmers, fishermen, and nature organisations. National research has been addressed towards effects of climate change more than actually adaptation strategies.

Text box: Project 'New Climate- New Life' of the Danish Board of Technology

In February 2004 the Danish Board of Technology carried out two scenario workshops on the rise of the sea level in Skallingen and Ho Bugt/Varde Ådal near Esbjerg and Karrebæk Fjord and Dybsø Fjord near Næstved. About twenty local politicians and technicians, farmers, people from house owners' associations, and nature organisations took part in each of the scenarios. The facilitators were experts and researchers representing universities and other research institutions. During the day they worked out their vision of the local area in the future and its consequences for how to decide priority and how to plan with a sea level, which will rise faster and faster. The general conclusion was, that the citizens wish to protect built-up areas and other substantial facilities against the rise of the sea level, for instance by dikes, but apart from that they wish to let the sea spread freely over existing farmland and nature resorts (TEKNO, 2005)

The participants in the workshops expressed no interest in 'large-scale dike' solutions or the possible control of the water level in large water areas and at river mouths by dikes, floodgates, and sluices. The most important message from the participants in the scenario workshops seems to be their recommendation that the citizens must be involved in the planning of the future of their own area, and that the results of the sea level rise must be incorporated in the plans for the local, the municipal, and the regional plans as soon as possible. There is a need for the relevant, national institutions to compile information for the local authorities on the sea level rise and how to cope with it. In a lot of places there is only a modest public awareness about the fact that it is time for planning the changes that will arise with the slowly rising sea.

6. Germany

Coastal protection in Germany is regulated in state acts. This chapter therefore makes a distinction between the two States Schleswig-Holstein and Niedersachsen. Both North Sea coastal states have their own laws and their own way of organizing coastal protection. The federal level is still relevant to this quick scan in two ways:

- As coastal defence has national consequences, capital measures are co-financed by the federal government with 70% of total eligible costs (the other 30% are matched by the states). The States finances maintenance measures to 100%.
- The federal level is interfering the State policies (Umweltbundesamt (2006)). In a recent interview the federal minister for environmental matters announced a national action plan for climate adaptation. In the interview he states: 'Wir brauchen Konzepte gegen Sturmfluten' (we need concepts against storm floods). To deal with this issue, in October 2006, the centre for climate change and adaptation (KomPass - Kompetenzzentrum Klimafolgen und Anpassung) has been opened by the federal minister for environmental matters. The aim of this centre is to increase the public awareness about this issue, and for the short term, to calculate the risks, to investigate the possibilities for the reduction of risks and to investigate measures to reduce global warming.

6.1 State of Schleswig-Holstein

What is the physical situation of coastal defence?

Schleswig-Holstein is at risk of flooding from as well the North Sea as the Baltic Sea. The length of the North Sea coastline is in total 553 km. In total 3722 km² (24% of the total area of Schleswig-Holstein) is at risk of flooding at extreme high tides. Only 135 km² (mainly at the river Elbe) is located below mean sea level. Almost the whole mainland coastline at the North Sea side is protected with a system of sea dikes. In case of flooding, evacuation is a problem, because of the distance to the higher areas. At the moment, there are no immediate threats of flooding.

Table 5: Coastal defence key data Schleswig-Holstein

	North Sea (beneath NN +5)	Baltic Sea (beneath NN +3)
Area (km ²)	3.404	318
Coast line (km)	553	637
Sea dikes	408	119
Population	252.618	91.606

What is done about it?

Coastal protection in the state of Schleswig-Holstein is regulated in the State Water Act. The Division Flood Defence, Coastal Protection and Harbours of the Schleswig-Holstein Ministry for Agriculture, Environment and Rural Areas is responsible for the state dikes. The water boards are responsible for the other dikes (second ring). In general, a 100 meter zone inland of the coast line is reserved for future reinforcements of the coastal defence structures. Legislation concerning the

obtaining of building permits protect these areas. The responsibilities for maintenance and reinforcement of the dikes are prescribed in the master plan for coastal defence. This plan holds the technical aspects and dimensions (www.kuestenschutz.schleswig-holstein.de). To prevent flooding, the following main technical measures are taken:

- Maintenance and reinforcement of the dikes;
- Maintaining the foreland;
- Sand nourishment (only at the island Sylt).

What is the direction of thought in the government for the future?

The master plan for coastal defence of Schleswig-Holstein (2001) addresses the possible consequences of climate change. It also prescribes adaptation of the dikes to rising sea levels. Furthermore, the height of the dikes is evaluated every 10 years, regarding the rising sea level. If the evaluation results in a deficient dike height for a certain stretch, this stretch needs to be reinforced. An extra value of 50 cm is then included in the dike dimension to consider sea level rise until 2100. The measures to adapt to climate change until now are limited to technical measures. However, in contrast to Niedersachsen, climate change is an issue and strengthening of the dikes is envisaged.

The state of Schleswig-Holstein does not differentiate in safety levels. All State dikes should withstand a 'once in a century' storm surge. However, in taking measures, priorities have been set by defining the weakest links that would cause the highest damage in case of flooding. The investments in coastal defence (45 millions a year) have decreased in recent years and are now set at a level of 10 years ago. However, this is a trend in all parts of the public sector in Schleswig-Holstein and compared to other sectors, coastal defence still has high priority.

Within the Division Flood Defence, Coastal Protection and Harbours, the concept of integrated coastal defence management has been launched (Hofstede and Probst, 2002). In contrast to integrated coastal zone management, this concept is specifically aimed at coastal risk management and does not aim at comprehensive planning. The idea is that this will be too complex to be effective. Therefore, to ensure a sustainable planning process that protects human life and assets from coastal hazards, the State Ministry has established an integrated coastal defence management programme for its coastal zone. The management programme consists of the following tasks:

- Defining a coastal defence planning area (instead of concentrating on the defence line),
- Definition of general principles for coastal defence, thereby taking into account other interests in the coastal zone,
- Development of public participation instruments for coastal defence planning,
- Development of flexible strategies to cope with possible changes in environmental conditions, e.g. climate change and sea level rise.

This programme will provide planning authorities with experience in integrated management with more advisory boards and regional councils (*Beirate*). Furthermore, pilot studies are under way using new methods in which there is an active role for the local population in the process of planning coastal defence measures. It is hoped to serve as a precedent for further integration.

New insights in climate change have not fundamentally changed the governmental view on coastal defence. Only technical measures were taken to defend the land of flooding. In spatial planning documents of the state of Schleswig-Holstein, climate change has not been mentioned explicitly, although coastal defence management has come up in the texts.

The Division Flood Defence, Coastal Protection and Harbours of the Schleswig-Holstein Ministry for Agriculture, Environment and Rural Areas has tried to widen the governmental view on coastal defence management (see discussions and papers about climate change and integrated coastal defence management). The view of this administration is that to adapt to climate change and to be less dependent on the dikes (if the dikes fail, there is no alternative defence), a multi-sectoral approach is needed.

Recently, this resulted in a text in the draft of the forthcoming new spatial planning document of the state of Schleswig-Holstein. In this draft, the ministry of spatial planning states that climate change and its coastal consequences (rising water temperatures, sea level rise and increasing wind storms) have to be taken into account. For inland flooding (rivers) this has to be achieved by assigning areas in regional plans in which high water protection has priority. Furthermore, inland high water protection gets a special priority in other protected areas in order to face the competition with other spatial claims. For coastal flooding, there are no special arrangements in the plan so far. The planned EU-directive on flood risk management may change this. According to the ministry of planning of the state of Schleswig-Holstein - 'the land amidst seas' - the climatologic changes will make coastal defence an important social and economical challenge.

In the state of Schleswig-Holstein, the discussions in the administration recently resulted in the first texts about climate change and adaptation in the draft of a forthcoming new spatial planning document for the state of Schleswig-Holstein.

Which more general debates about climate adaptation are going on?

The main message of politicians in Schleswig-Holstein is that people are safe, because the dikes will protect them ('Unsere Deiche sind sicher'). Politicians do not openly admit that safety can't be guaranteed. There are two important dilemmas. The first one is that politicians rather don't speak about uncertainties and hazards. The second one is about the financial consequences. To adapt to climate change brings about high costs. In this respect, communication is essential to open the debate about coastal defence and climate change. It has been suggested that the Stern review and the forthcoming IPCC reports could function as eye-opener.

6.2 State of Niedersachsen

What is the physical situation of coastal defence?

The coastline of Niedersachsen counts seven barrier sand islands that protect the coastline. The whole coastline is protected with a system of sea dikes (1143 km total) and flood defences in river arms and estuaries (Ems/Dollard, Weser and Elbe). The highest dikes have a height of about 9 meters. The height line of the protected areas in Niedersachsen is up to 5 meters above sea level. Apart from the harbour facilities, there are no settlements or buildings located outside the dikes. Figures about the number of people living in the area and the size of the area will be presented in the new master plan for coastal defence. At the moment, there are no immediate

threats of flooding. Moreover, the elevation of the flood prone areas makes the problem of flooding less extreme than for example in the Netherlands.

What is done about it?

Coastal defence is seen as an important issue, that has traditionally high priority. Coastal protection in Niedersachsen is regulated in the Dike Act. Niedersachsen is the only German State with an act specifically for coastal protection. The policy for coastal defence and the measures to be taken are based on this Dike Act and an additional 10 rules that have been formulated for the technical measures to be taken (for example rules that guide decisions about on which side to strengthen the dikes) (Niedersächsisches Umweltministerium, 2006). In the Dike Act, 50 meters inland of the dikes is reserved for coastal defence. Building permits protect these areas.

The state of Niedersachsen does not differentiate in safety levels. The bottom-line in the Dike Act is that everyone should have the same chances, the same safety level. The water boards are responsible for the sea dikes of the mainland. The NLWKN (state agency for water management, nature conservation and coastal protection) is a more strategic organisation, which has the role of adviser to the state. Furthermore, the NLWKN is responsible for the dikes on the islands. 70 % of the finances for coastal defence comes from the federal state. 30% is financed by the state of Niedersachsen, a part of this budget comes from taxes that landowners have to pay for coastal defence.

To prevent flooding, the following technical measures are taken:

- Maintaining the foreland to keep a higher beach (stopping erosion)
- Shortening the dike line by building storm surge barriers and 'closing' rivers
- New dikes and barriers are developed and constructed in such a way that they can be heightened with max. 1 meter.

The measure to enable heightening of the dikes with a meter can be seen an adaptive measure. It is not only taken with regard to climate change. The idea is that in this way money is saved, while at the same time the structures can be adapted to changing circumstances. It is seen as a no regret measure.

All measures are guided by a master plan for coastal defence. The last one (for Weser-Ems) dates from 1997. A new master plan is prepared and will be published at the end of 2006. The new master plan is an in-house production - the NLWKN does not communicate about it before it is published. The investments in coastal defence amount to 40 million a year.

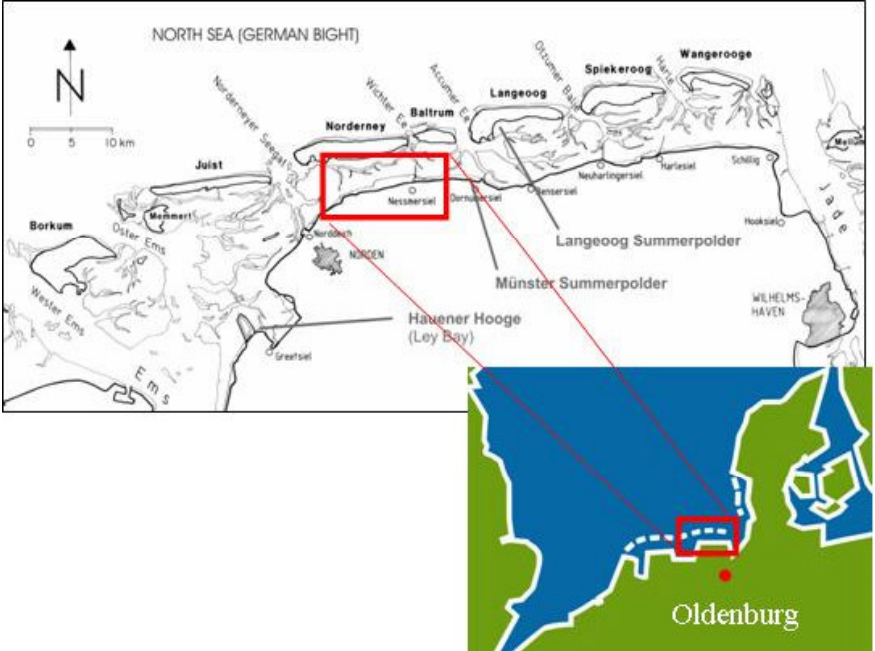
There are contingency plans for flood prone areas. The NLWKN informs the authorities that are responsible for contingency management.

What is the direction of thought in the government for the future?

In the state of Niedersachsen, there is no discussion about climate change and the need for adaptation. In the design rules for dikes and other flood defences, climate change is taken into account, as well as historic sea level rising rates, IPCC figures and worst-case scenarios. At the end of 2006 a new master plan for coastal defence will be published. Probably the impact of climate change will not be part of the plan. Climate change is seen as one of several aspects to take into account in determining the parameters of the existing approach, not as a development that demands a new approach (Schröder, 2005).

The priorities in Niedersachsen have not changed due to the notions of climate change. Climate change is also not a big issue in politics at the moment. Furthermore, it is not an issue in the negotiations with the Minister of Finance about coastal protection. The feeling in broad public is that people are protected well.

Text box: Germany, Pilot Neßmersiel



The pilot Neßmersiel is in scope of the ComCoast project which explores the spatial potentials for coastal defence strategies for current and future sites in the North Sea Interreg IIIb region. The pilot is located in the north-western part of the federal state Lower Saxony, Ost-Friesland in Germany west of the village of Neßmersiel. The coastal area consists mainly of lowlands, protected by coastal defences against flooding due to storm surges. Neßmersiel exists of a broad coastal defence system: land reclamation fields (groyne systems) and salt marshes, summer dike, summer polder, main dike, polder and second dike line. The consequences of sea level rise scenarios for safety against flooding and the interrelation with socio-economical and spatial planning aspects are the main focus. Different alternatives for coastal defence systems to guarantee safety in case of selected sea level rise scenarios will be investigated.

<http://www.comcoast.org/content.asp?L=1&id=85>

There is no ongoing discussion in the government, on changing situations due to climate change. In spatial planning documents and in economic policy documents the word ‘climate change’ is not being mentioned in relation to coastal protection. In a strategic spatial policy document (Raumordnungskonzept für das niedersächsische Küstenmeer - Stand 2005), the responsible ministry of the State of Niedersachsen states with respect to coastal protection that the main stretch of dikes needs to be strengthened due to the rising sea level. The role of spatial planning in coastal protection is limited to the dikes. There is not something like a spatial view on the coast.

Which more general debates about climate adaptation are going on?

The public debates in Niedersachsen do not focus on climate change. An important debate in Niedersachsen concerns the tensions between coastal protection and nature conservation (the coastal zone is a national park). Coastal defence measures have their impact on nature. Discussions about at which side to strengthen the dikes and where to get clay dominate the debates about coastal defence.

The legal basis of decision-making is that all areas should have the same flood risk, notwithstanding differences in expectable damage and casualties. In practice, priorities have to be set and the authorities have to deal pragmatically with this rule. The consequence is that you are talking about different levels of safety. This discussion might become interesting in the future.

7. the Netherlands

What is the physical situation of coastal defence?

Two-thirds of the Netherlands, some 22,500 km² has a potential risk, of which 9,000 km² lies below sea level. This area comprises large, densely populated area (some 9 million people) and accommodates most of the Dutch economic production (60% of BNP). The vulnerable area is protected with 260 km of coastal dunes and 430 km of hard flood defences in river arms (related to the sea) and parts of the seashore. There is considerable structural erosion along several locations of the sandy coast, which is compensated through active sand nourishment (a policy termed 'dynamic preservation'). The coastline is allowed to move freely within certain boundaries. Within these boundaries, nourishments, either on the beach or in deeper water in this strip, maintain the total volume of sand. The costs of these nourishments amount to ca. 44 million Euro in 2005 (source: rijksbegrotingen in: evaluatie kustnota's 2005).

A recent inspection of the coastal defences has shown that a few coastal defences and many river defences do not meet the safety levels of the Flood Protection Act. In the mid 1990s, it became increasingly clear that in the long term these practices would become insufficient. The Third Coastal Policy Document (2000) identified increasing pressures from sea, including among other things climate change, with associated sea level rise and increased storm intensity. Besides increasing pressure from sea, an increasing pressure from land use (tourism, new housing, nature development) can be noted. The authorities expected certain coastal towns to be gradually more at risk, and identified 'weak links' in the coastal defence.

Recently, government published the results of the latest review of the safety check of the dikes. It turned out that a considerable percentage of the dikes are not up to the predefined safety standards, or their safety cannot be calculated due to lack of data. Coastal surges may go far inland after sea level rise, and cause problems with the river dikes. Although this publication is on all primary dikes in the Netherlands, also some sea dikes were not in order. This initiated complaints from scientists and water board directors in the media. The proposed technical solutions are expensive, and they require space. They are not taken for granted anymore.

What is done about it?

The Flood Protection Act, last revised in 1996 but in force for decades, stipulates that the state must provide appropriate defences. Local water boards and provinces must inspect the safety of their flood defence on a five-yearly basis. Responsible authorities must take hydraulic conditions into consideration. The responsible minister defines the inspections, which must include failure modes of overtopping, storm erosion, geotechnical instability and piping. National authorities must take appropriate measures where inspectors rate defence sections as unsafe.

More recently, the national authorities responded to climate change in the Third Coastal Policy paper (2000) by:

- Raising the budget for sand nourishment to replenish sand eroded in deeper water (up to NAP -20 m). This was assumed to keep the entire coastal foundation strong enough to support resilient coastal dunes.
- Starting studies to find acceptable solutions for 'weak links'. The solutions should be reflected in local development plans (see box). These solutions would be combinations of making existing defences higher and a landward or seaward

relocation. Higher defences would have to be wider, and therefore these would require more space on the landside. Farther landward retreat of the defences would increase the resilience of the dunes against sea waves at relatively low cost. The spatial plans should also reserve more area with the aim of accommodating larger defences that can withstand future changes in hydraulic boundary conditions with a time-horizon of 200 years (based on IPCC climate scenarios).

River flooding resides under a different policy area, called ‘making space for the river’, and inland flood management. In that policy stream, studies are done to create more space for storage of fluvial runoff. The national authorities intend to develop a binding spatial plan for the Rhine river and its main branches, mandating appropriate solutions to cope with situations of high runoff from Germany. This might include a managed retreat (moving defences landward, and creating ‘functional flood plains’). The website (www.ruimtevoorderivier.nl) does not relate this to protection from flooding from the sea, although for areas in estuaries this policy of making space for rivers can be implemented.

Text box: The Netherlands ‘Weak Links’



The Dutch provinces Noord-Holland, Zuid-Holland and Zeeland have evaluated long-term coastal safety. They have identified 10 points at which our coastal defences would no longer meet legal requirements within a couple of decades due to sea level rise and expected increased wave action. These places are so-called ‘weak links’, as a chain is only as strong as its weakest link. To deal with these weak links, integrated planning studies are being developed taking into account the goals for the mid-term safety (2050). Also (spatial) measures are incorporated to make sure that additional improvement of the sea defense is possible in the future. In the integrated planning studies, the issue is not only how to strengthen the coastal flood defenses, but also how to improve the spatial quality of the areas in question, and in a sustainable way. These planning studies are being

developed by the relevant provincial authorities. Each province has set up a project group which includes representatives of national government and the water boards. For each planning study, there is also a local project group in which the municipality is represented. The planning studies are expected to reach completion in 2007. For most of the weak links, a solution has now been chosen which will guarantee safety and the spatial quality of the coastal region for the next fifty years. All ten weak links will be strengthened within the next five years. For most weak links is chosen for protection with nourishments on the foreshore and seaward solutions. About € 743 million is reserved for the reinforcement of all weak links by the Ministry of Transport, Public Works and Water Management.

What is the direction of thought in the government for the future?

The policies above should be sufficient to meet the safety requirements laid down in Flood Protection Act for decades. The safety levels are based on a risk analysis and

are expressed in return periods that indicate the probability of exceedance of a certain design water level (the probability of a flood are much lower). These safety standards range from 1/2.000 to 1/10.000 years, This means that in any year, there is a probability of occurrence between 1/2,000 and 1/10,000 that, in that specific year, hydraulic conditions will occur which the flood protection structures cannot withstand. These safety standards have been based some decades ago, among other things, on the economic value of the protected ring dike area and the potential loss of life, and they are specific for each dike ring area.

Nonetheless, documents of the government bring up several issues that may need attention:

- Government officials have also raised the question whether the safety levels in the Flood Protection Act should be adjusted to account for the increase of the population and economic value of the coastal area, which has occurred in the past decades (e.g. VNK (2005) and WV21 (2006)). They think about changing the current approach (single sections and probability of exceedance of water level) into a fully risk based approach. Hereby, actual probability of flooding is considered taking into account all failure mechanisms and all elements in a protection system. It is risk based, so potential consequences are explicitly taken into account.
- Whilst Holland may be safe for some decades, it is believed that measures are required earlier to prevent that in the farther future we will not be able to remain safe. A sandy coast resilient to higher sea level rise, and higher waves due to increased storm intensity, is believed to depend on increasing natural coastal dynamics. In this view wider zone should be considered as one, dynamic soft defence structure. This structure should extend from the deeper parts of the nearby coastal area to an area that is to be reserved inland from the existing defences. In this view, this whole coastal defence zone is seen as a sandy river with natural dynamic behaviour. This sandy river should be allowed to move more freely on top of a solid fundament of sand, which should be maintained through nourishment in deeper water. This would create a more robust coastal dynamic equilibrium. In some stretches of the coast this would require a retreat of the existing functions.
- With view of the coastal defence as ‘sandy river’ in mind, government papers have expressed doubts about sufficiency of the weak links approach to allow flexible land use in the long term. Stronger national directions may be necessary to ensure safeguarding of space for future managed retreat. This has been formalized in the “Nota Ruimte” - the National Policy document on use of Space in The Netherlands. Technical Working Groups and Commissions are being formed to translate internationally accepted climate scenario’s to hydraulic boundary conditions specifically for the Dutch coast (KNMI-study) and subsequently to translate these conditions to fixed criteria for 5-year verification and maintenance of the flood structures (HR2006/HR2011).
- On a national level the government has launched the ARK (Adaptation of Space to Climate) programme. The aim is to define the necessary adaptation measures needed to counter to climate change on the whole. This programme addresses the total scope of climate change, including flooding from the sea, rivers, drainage/storage of intensified rainfall etc.
- The responsible ministry studies on insurance and the acceptance of a certain amount of risk, combined with contingency planning, as instrument for steering spatial planning.

Which more general debates about climate adaptation are going on?

Dutch experts indicate that a sea level rise rate of over 1 to 2 meter per century could make coastal safety unaffordable, but that this is not yet realistic. Estuaries and the Waddensea will be impacted most seriously when sea-level rise rates go beyond 1 m/century, leading to a loss of their physical integrity (pers. comm. Stive). An issue on the shorter term is that policies may insufficiently take into consideration the possibility of a coinciding high tidal flood and high fluvial runoff. This would increase the risk that water from the main rivers cannot flow into the sea, and rainwater has to be kept inland, causing floods. The present programme 'making space for the river' may be insufficiently successful to create room, especially if large amounts of rain water from the Dutch land surface also cannot be stored inland. In this situation there may be higher than expected a risk that water in the estuaries will overtop the dikes, or that major inland floods occur.

The government has installed the independent Advice Commission Water, chaired by the Prince of the Netherlands. It has published an advice on 18 October 2006, with the following passages: 'The commission (...) suggests that (the state secretary) soon develop a coherent vision on water safety, and place it higher on the agenda. It believes that financing of safety against flooding should be better-safeguarded and less dependent on the short term agenda. The commission also believes that the next Cabinet should reserve more budget for the primary defences to catch up with maintenance delays and to meet the required safety levels. (...) The commission also emphasises the importance of a sound availability of information and communications of risk and a better embedding of water safety in the spatial processes of the country'. 'The commission observes that the legal safety levels are outdated and are inconsistent with the actual (...) value of the dike ring areas.' 'The layers of government are fragmented', 'Citizens should carry their own responsibility', 'it is important that there be an understandable communication about risk without creating a larger sense of unsafety'. 'A turn around in thinking is required (...) to anticipate long term problems (...) considering climate change and lowering of the land surface.' 'A possible rupture of dike ring 14 (South Holland) would create a damage of up to 37 billion euro, about a million inhabitants would have damage, and in the worst case there would be thousands of casualties.' 'The building in hazardous locations continues.' 'If nothing happens soon, space users (...) will ensure that later we will have no space left for water.' 'The approach of the weak links (...) is not well developed and supports inevitably on simultaneous availability of funding by the concerned layers of government.' 'The commission advises to include potential measures to increase water safety, like other uses of land and retention ponds, in local plans, and to make an overall vision for the coast.' 'The commission recommends to take long term needs into consideration in spatial planning as early as possible.' The general debate in the Netherlands therefore concerns the evaluation of the level of flood risk and the question whether the standards still offer sufficient protection to the values protected. Proposals have been made that significant areas for storing water are required (functional flood plains). The present spatial policies do not provide for this. Alternative strategies to deal with the flood risk are investigated. Economic centres and residential areas in these areas should be constructed on knolls (heightened ground). The population should accept more risk than the present allows, and should ensure itself against damage. Local governments should be held more responsible for their own safety, so that they will not force the national state to develop solutions at its own cost.

A number of environmental organizations have proposed the idea of natural climate buffers, a kind of huge 'multifunctional flood plains', which should be able to take the first blow in case of catastrophic climatic events. They should serve different uses, which have to be designed in a way that is robust to climatic events like flooding, and may be combined with nature reserves (Bureau Strooming 2006).

On the other hand, politicians hardly participate in these debates about the future safety of the Netherlands. They also have not reacted to publications in the media that a few of the existing sea dikes presently do not comply with the safety levels required in the Flood Protection Act. The government has recently launched a publicity campaign on the dangers of climate change on the Dutch coastline and what they intend to do about it. The campaign is intended to warn the public on the situation and the coming adaptations in government spending and policymaking.

8. United Kingdom

What is the physical situation of coastal defence?

The coast of the UK has a varied topography, including cliffs, estuarine marshes and mudflats, coastal lowlands and sand dune systems. Latest figures show a total floodplain area for England (incl rivers) as 15,000 km² of which approx 1/3rd is coastal/estuarial (Source: Environment Agency). Thousands of square kilometres that are partly in use for housing and industry are at risk. Throughout England and Wales there are tens of thousands of kilometres flood defences. Insurance claims for storm and flood damages in the UK, including river flooding, totalled more than £6 billion over 1998-2003, which was twice the amount for the previous six-year period. Certain high-valued urbanized coastal areas are increasingly at risk. Risk may increase four to tenfold in the next 100 years.

Building flood defences may increase the value of land directly behind these defences, increasing the value of assets and lives at stake in case of emergency. In several locations hazardous areas are still further developed. Natural tidal habitats are at risk from coastal squeeze, trapped between a higher sea and hard defences. In some locations saline intrusion and increased flooding hinder agriculture.

It is believed that there are around 1 million residential properties and some 100,000 commercial and industrial properties in coastal and tidal flood risk areas (comm. Department of Environment, Food and Rural Affairs, DEFRA). According to the Office of Science and Technology (OST) the risk from fluvial and coastal flooding is likely to increase in future due to climate change and economic development (http://www.foresight.gov.uk/Previous_Projects/Flood_and_Coastal_Defence/index.html). The Department for Communities and Local Government (DCLG) accepts the OST recommendation that sensible planning and appropriate flood defences should enable the risks to be managed while allowing necessary development to continue (www.communities.gov.uk). At the same time the urgency of retreat is increasing in the Thames estuary, according to www.thamesweb.com: 'Sea level rise, changing fluvial flows and tidal surge patterns have traditionally resulted in flood defence walls and other structures being constructed infinitely higher. Alternative approaches to dealing with flooding, which are sustainable in the long term, must be found. Flood risk must be managed in such a way that it is possible to make space for water during flood events, whilst retaining the normal use of the land, or even enhancing and diversifying its use and quality. Innovative processes are required to deliver sustainable solutions'.

Climate change is regarded to be a problem near the coast, according to Policy Planning Statement 25 (December 2006): 'Flooding to low-lying land from the sea and tidal estuaries is caused by storm surges and high tides. Where tidal defences exist, they can be overtopped or breached during a severe storm, which may be more likely with climate change. The onset of flooding from the sea can be extremely rapid. Deep, fast-flowing water can create an extreme hazard. The severity of such flooding will depend on a number of factors, often in combination: the height of tides; weather systems; wind and wave conditions; topography; the effectiveness of drainage systems; and the condition of flood defences. The consequences and impacts of flooding from the sea and tidal waters are more severe than flooding from rivers.'

What is done about it?

The UK defends its coasts, where these are vulnerable, against flood risk and erosion. It does so mostly on a basis of assessment of costs and benefits. Although there is no law, safety levels that should be applied for new development are described in the Planning Policy Guidance Note 25 about Development and Flood risk, original release 2001 (PPG25), which has been replaced by Planning Policy Statement 25 in December 2006. The increased risk of flooding due to climate change for coasts and estuaries is incorporated in general guidance on flood risk management decision making (<http://www.defra.gov.uk/enviro/fcd/pubs/pagn/climatechange-update.pdf>).

Although the mentioned PPG-25 makes strengthened provisions for enforcement, planning authorities have to balance all risks and opportunities when making development-planning decisions. In February 2006, 8% of decisions made by local planning authorities were not in line with Environment Agency advice (www.communities.gov.uk). In December 2006, Planning Policy Statement 25 (PPS 25) replaced PPG 25. It is stronger, and intends to ensure flood risk is taken into account at all stages in the planning process, avoid inappropriate development in areas at risk of flooding and direct development away from high risk areas. PPS25 amongst other things clarifies procedural steps in the local planning process and provides for a 'Flooding Direction', providing greater scrutiny for major developments proposed in flood risk areas. It should amongst other things ensure that development takes better account of future increases in flood risk due to the expected impact of climate change and provide opportunities to reduce existing flood risk to communities, for instance by *re-creating and safeguarding functional flood plain* and wash lands and designing-in green space and sustainable drainage systems. PPS25 does not ban all development in flood risk areas. This would be unsustainable and result in economic stagnation, depriving existing communities of much-needed homes and services. The proposed Direction would result in call-in only in extreme cases where local authorities persistently ignore advice from the Environment Agency (www.communities.gov.uk).

PPS 25 introduces the 'functional floodplain': This zone comprises land where water has to flow or be stored in times of flood. Flood risk assessments should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the local planning authority and the Environment Agency, including water conveyance routes. Under many circumstances development should not be permitted in these functional floodplains according to PPS 25: 'relocate existing development to land with a lower probability of flooding.'

Finally PPS 25 indicates that the consequences and impacts of flooding from the sea and tidal waters are more severe than flooding from rivers. 'It is for this reason that Flood Zone 3a (..) has a 0.5 per cent annual probability boundary for flooding from the sea and tidal waters while from rivers it has a 1.0 per cent annual probability boundary.' This means that development restrictions should be applied to coastal zones that are expected to flood with a one in 200 annual probability or more.

The process of determining acceptable risk on a case-by-case basis is well elaborated and participative, and the Environment Agency has considerable capacity as a specialised advisory body. It advises planning authorities as well as providing flood risk information to the public (e.g. via its web site). Most coastal defence schemes are publicly funded from central taxation where decision-makers can show that the benefit of defence measures clearly exceeds their cost. The cost-benefit based approach has led to mixture of physical measures, in particular fewer hard

engineering solutions and more widespread environmentally friendly solutions like beach management. In some areas managed realignment (managed retreat) has been promoted, largely as a response to mitigation of loss of internationally designated inter-tidal habitats.

The UK has done a Regulatory Impact Assessment for PPS 25 (December 2006). It includes the following text: ‘Where there is no SFRA¹⁴, uncertainty is likely to result in large numbers of Environment Agency objections to development proposals. For example, Boston Borough Council, which is entirely within flood zone 3, highlights the benefits of undertaking a SFRA. The Environment Agency objected to a large number of its planning applications on the basis of flood risk prior to a SFRA being undertaken. Because of this, the LPA¹⁵’s local planning performance was poor (...). By undertaking a SFRA in close co-operation with the Environment Agency, there is now a much better understanding of flood risk and much more certainty about appropriate locations for development. By producing clear policies taking flood risk into account developers are in turn clear on what requirements they need to meet in order to gain planning permission.’ Apparently it is difficult for some local planning authorities to adjust their plans to flood risks, and they need the external force of PPS 25 to compel them to do that. It is possible that this is not merely a question of less professional governance; it may also be the case that taking flood risk into consideration is against their short-term economic interest. It is possible that this is in particular the case where local planning authorities have little alternative area for development available. However, these issues are not clarified in the Regulatory Impact Assessment, because at a higher geographic scale the benefits of PPS 25 are clear, since development can move to areas farther away.

Text box: The United Kingdom “Managed retreat for ecological purposes”

Managed retreat or ‘managed realignment’ of land use as it has come to be known, has been pioneered in the UK by local authorities situation along the Eastern England coastline, including Norfolk, Essex and Lincolnshire. Managed retreat is a collective term for the application of coastal zone management and mitigation tools designed to move existing and planned development out of the path of eroding coastlines and coastal hazards. It involves relocating the embankments further inland, or retreating to higher ground, and recreating inter-tidal habitat in front of them. Managed retreat is often a response to sea level rise, so in the UK has been most common in the south-east of England where the impact of global sea level rise is exacerbated by local subsidence of the land surface isostatic rebound. Much of the low-lying farmland around the coastline of south-east England was once inter-tidal salt marsh, which was subsequently reclaimed from the sea and converted to farmland. One of the first examples of managed retreat in the UK is taking place at Freeston near to Boston on the Wash, where land was reclaimed for agriculture in the 1970s. It is becoming increasingly uneconomic to maintain the embankments, which protect this land from the sea. The privately owned primary sea wall is being abandoned, whilst the secondary sea wall is being adopted by the Environment Agency as the new primary defence. 80 hectares of saltmarsh will be created along with 14 ha of brackish marsh and a visitor centre and hides will be constructed. Salt marsh not only provides a protective buffer for these sea walls by dissipating wave energy, but it is also important as a habitat for birds and as a source of organic matter for fish and inter-tidal fauna. It is anticipated that the project will promote tourism in Boston and birds such as waders, widgeon, twite, turns and Brent Geese should be attracted

¹⁴ Strategic Flood Risk Assessment

¹⁵ Local Planning Authority

to the site. It must be noted, however, that managed retreat has been evaluated on several schemes on the Lincolnshire coast in the past and in every case rejected on economic grounds (Steve Vernon, pers.com., June 2000).
<http://www.ingentaconnect.com>

There is an active national policy to discourage inappropriate development in areas at risk, since 1992's Planning Policy Guidance note 20 (Coastal Planning). In most places owners have the option to insure their assets against flood risks as part of general property insurance, but there is increasing concern over the continuing availability of affordable insurance policies in some higher risk locations where alleviation measures are unlikely to be justified. No public compensation is payable for loss due to flooding or erosion, but in cases where coastal realignment is managed for environmental mitigation the land has generally been purchased.

Although most community defence measures are nationally funded, some supplementary funding is raised through local taxation and contributions from developers or major industrial or commercial beneficiaries. Defences that primarily protect major infrastructure such as roads, rail lines and power stations are maintained by these utilities.

To manage the coastal defence, the Environment Agency and maritime local authorities prepare Shoreline Management Plans (SMPs). These plans make a significant contribution to the strategic planning of coastal management measures and are intended to feed into regional and local development planning processes. The whole coast is now covered by first round SMPs from which considerable lessons have been learnt and these have been incorporated in to guidance now being used for second round plans that should be completed between now and 2010.

What is the direction of thought in the government for the future?

Recognising the difficulties of delivering sustainable coastal change in a situation where some individuals lose and others gain, there is currently an emphasis on the development of adaptation tools that may be developed to deliver more just and equitable solutions whilst recognizing the advantages of solutions that work with, rather than against natural coastal evolution.

There are ongoing developments to provide better public information on both flood and erosion risks, new flood warning systems, new and improved approaches to risk management, and strengthened policies to avoid inappropriate development. The government has increased funding on all flood and coastal erosion risk management in England (including river flood risk management) from an outturn of around 310 million pounds in 1996/7 to provision of over 600 million pounds in 2006/2007. The government invests in new defences such as physical structures or management regimes where none were in place before and at the same time improves defences by replacing or upgrading areas where an existing protection already exists.

The government remains committed to managing and, where appropriate, reducing flood risk, although it has no statutory duty to do so. The primary responsibility remains with landowners who are at risk. However, the government acknowledges that more should be done to ensure social justice and fair outcomes. The Department of Environment, Food and Rural Affairs (DEFRA), responsible at national level, is aiming to promote more holistic and sustainable approaches through 'Making space for Water', 2006 (see hereafter).

Which more general debates about climate adaptation are going on?

Many debates are going on at regional level, where decisions must be made about the level of protection, the sustainability of some coastal management measures and the appropriateness, in some areas of managed retreat. At the national level, Defra is leading the development of 'Making Space for Water', a cross-governmental Strategy for Flood and Coastal Erosion Risk Management for the next 20 years (<http://www.defra.gov.uk/enviro/fcd/policy/strategy.htm>). This has included a recent consultation on the potential for more strategic governance arrangements for coastal management. A study by the Tyndall Centre (scaling adaptation, 2004) questioned the capability of local communities to deal with long-term issues. Also consultations indicate that there is some debate about the need of a more statutory system of regulation. Coastal management institutions receive little formal empowerment from central government, in particular to support resettlement or retreat processes. Local planners are said to be on weak ground in rejecting applications for new development, even if they might privately agree with the Environment Agency's opposition. Stricter regulations could help developing more coherent responses from local and regional government bodies, the private sector and the wider public but the preferred approach is more likely to revolve around greater consensus building.

Text box: UK "Discussions in London" Source: Climate Change. The UK Programme. Defra 2006

The London Climate Change Partnership: Adaptation decision-making in London

The London scoping study was published in 2002 by the London Climate Change Partnership (LCCP). Information from the study was incorporated into London's key land use planning document, 'The London Plan' (Greater London Authority, 2004), which also refers to the role of the partnership in developing adaptation policies:

"The Mayor will and boroughs should assess and develop policies for the likely impacts of climate change on London identified in the work of the London Climate Change Partnership. Policies will be developed in conjunction with the Partnership and addressed in the first review of the London Plan."

"London is already feeling the effects of climate change. Sea-level rise relative to the land is now widely accepted as occurring at 6mm/year at high tide in the London area. A significant proportion of future development will be in east London, which could be increasingly at risk from tidal flooding. Preventative and adaptive measures will therefore be needed, including the construction of appropriate flood defences in new developments."

Following on from the scoping study, the LCCP's work has focused on transport and 'growth areas' such as developments in the Thames Gateway. LCCP has commissioned research to evaluate climatic risks and costs to London's transport systems, including the underground and overground railways systems and road network. This information will be used by London's transport decision-makers. In 2005, together with the South East and East of England climate change partnerships, the LCCP launched a consultation draft of 'Adapting to Climate Change: A Checklist for Development' (TRCCG, 2005). This provides developers and their design teams with information and a checklist so that a new development can be designed to be comfortable and secure in the face of climate change throughout its lifetime.

In early 2005, the GLA announced that it was developing the first climate adaptation strategy for a world city. This strategy will include policy directions on flooding, overheating, water resources management, emergency planning and other issues which will be affected by London's changing climate. Public consultation on the draft strategy is due to take place in summer 2006.

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