Climate adaptation in water management

- how are the Netherlands dealing with it?

Report of the 'Dutch Dialogue on Climate and Water'

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Climate adaption in water management
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FOREWORD

The Dialogue on Water and Climate (DWC) was launched in 2001 to bridge the information gap between water managers and the climate community. The specific objectives of the DWC are to initiate a political process on water and climate, collect and transfer knowledge and experiences, identify measures for the future and raise public awareness. Already, the DWC has initiated 18 local, multi-stakeholder dialogues at the national, regional and basin levels. The local dialogues deal with important questions of water managers such as how to address the consequences of climate change and what kinds of knowledge and actions are needed to resolve water problems. The locations of the dialogues are indicated in the map underneath. As the map shows, one of the partner dialogues has taken place in the Netherlands.

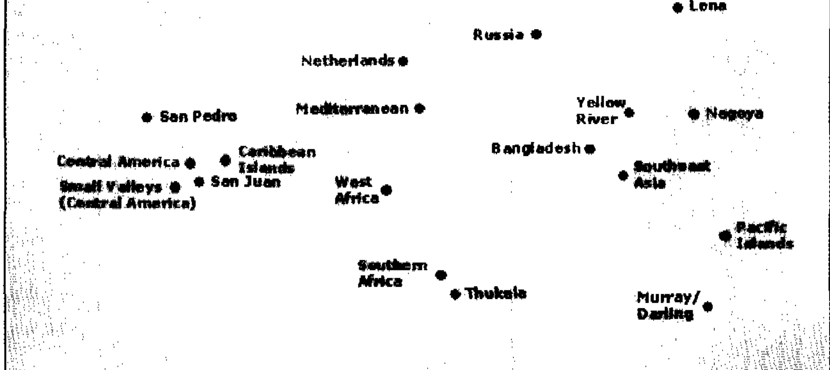
Indeed, the evidence is undeniable: during the Decade 1991-2000 more than 90 % of the people killed by natural hazards lost their lives as a consequence of extreme hydrological events. And, according to the Intergovernmental Panel on Climate Change (IPCC), the expected climatic change will further intensify the hydrological cycle. Heavy rains and floods are already occurring more frequently and becoming more intense. Increasing variability in precipitation (including longer periods of drought) could endanger species and crops, and lead to a decline in food production.

The relation between global warming and it's impact on the hydrological cycle has provoked scientific debate and political negotiations under the United Nations Framework Convention on Climate Change (UNFCCC). But, although climate change through its impact on the hydrological cycle has a profound effect on people's livelihoods, dialogue between water specialists and meteorologists is in its early stages.

The Dialogue Water and Climate is financially supported by the Government of The Netherlands till June 2003. The International Secretariat is located in Delft with a Science Support Office in Wageningen. The International Steering Committee of the Dialogue includes IUCN, UNESCO, WWF-3, GWP, WMO, NWP, Red Cross, WWC, UNISDR, UNEP, and UNDP.

The results of the partner dialogues and a policy makers report will be presented at the 3rd World Water Forum. Sessions on water and climate will highlight the challenges and discuss the actions to cope with the impacts. Other important water and climate issues for discussion at the WWF-3 include forecasting, the importance of storage, risk assessments and risk mitigation, health impacts, hot spots and vulnerability, communication and public awareness.

International Secretariat, Dialogue on Water and Climate
http://www.waterandclimate.org



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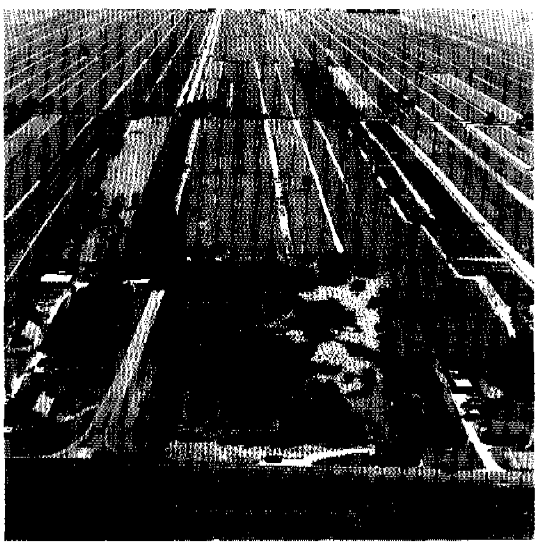
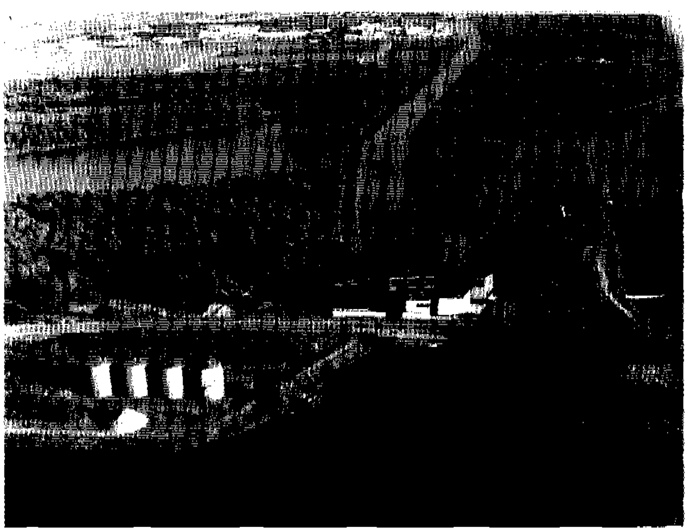
Without **dikes**, most of the Netherlands' land surface would be permanently flooded by sea water, or frequently flooded by the Rivers Rhine and Meuse rivers. After dike construction, a continuous effort is still needed to remove excess rainwater from the low-lying polder areas – for centuries this was done using thousands of **windmills.** The marine origin of the soils in some of the areas that were kept dry in this way makes them uniquely suited for large-scale growing of valuable crops like **tulips**. Despite sophisticated drainage systems, water levels in the Dutch **polders** are high and Dutch farmers used to wear **wooden shoes** that were suitable for such wet conditions. The fertile soils and plentiful water have produced the food needed for a **highly urbanised population** living largely in and near **trading ports** like Amsterdam and Rotterdam, that were the base for exploration of the world in past centuries, and still connect the oceans of the world to the European hinterland.

Top to bottom:
Intensive drainage in local water systems has been a matter of survival for centuries.
The Dutch coast is now fortified to reduce the chance of flooding to 1:10,000 years.
Huge pumping stations discharge excess water to the sea and the estuaries.





1. Summary Conclusions of the Dutch Dialogue on Climate and Water

Plans to make water management more resilient and sustainable are widely supported ...
It is widely recognised in the Netherlands that water management needs to change – this is translated in an ambitious national policy ('WB21') where 'room for water', 'resilience' and 'awareness' are key concepts. Support for these concepts is based on recent emergencies due to weather- and hydrological extremes and on increased awareness of the need for 'sustainable development' of the water system, i.e. in harmony with natural, cultural and landscape-values. Climate change is often perceived as the driving factor for these plans, although the recent extremes may well be caused by 'normal' climate variability. However, water management measures for climate variability or for climate change have many similarities. So if the Dutch water management system is improved to deal better with currently expected extreme events, it is also better prepared for climate change.

... however, implementation of plans is slow and uncertain ...
The new water management strategy is enthusiastically picked up by many scientific and planning organisations, resulting in an impressive number of studies. However, few projects have been implemented to date, and the fate of many others is uncertain. Some fear that 'WB21' may get stuck in studies, plans and discussions, and that such 'signs of goodwill' could be seen as sufficient progress at the political level. The reason for this slow progress in actual implementation is the fact that the new policies are a complete U-turn compared to traditional policies, and would in the short term negatively affect many stakeholders. Some stakeholders support 'room for water' measures mainly in theory: e.g. the Farmers' Union supports them only if they do not need valuable land, and municipalities and Provinces along the Rhine river tend to claim that measures should be taken upstream or downstream but not on their own land.

... as more transparency, more stakeholder participation and proper instruments are needed ...
Although 'public awareness' of water management issues is a priority of the 'WB21' policy, only scientific circles and national and provincial planning organisations are involved in the debate on how best to adapt to extremes in weather and hydrology. At the municipal level – where most measures must be implemented – and amongst the public there is little understanding of the issues and insufficient co-operation with measures. An important reason could be a lack of openness about the real long-term risks involved: authorities are not eager to point out that many Dutch are not completely safe from flood risks. This explains the reluctance to develop and use the proper instruments for damage reduction: flood insurance does still not exist, building restrictions and regulations are insufficiently applied. It could be said that authorities provide few incentives for a more pro-active attitude to climate adaptation.

...better integration of water management sectors would help in achieving this.
Better integration in two is needed for implementation of climate adaptation measures:

- If climate scientists and water managers would work more closely together, the first group would become more aware of the type of information that is really relevant to society, and the latter group would learn how to deal with uncertainties in the predictions of extreme events.
- Flood risk management should be better integrated in spatial planning, because:
  - Reduction of potential damages in areas at risk is the most effective form of risk reduction. Therefore, spatial planning should not only aim to create more 'room for water', but also to limit investments in flood-prone areas, and to stimulate small-scale flood-adaptation measures such as modifications of buildings and infrastructure. Innovative measures could even include 'floating houses' and 'floating greenhouses'.
  - Many 'room for water' measures require space in areas necessary for other functions, and therefore compete with those functions. According to many, this integration of functions is the main challenge that water managers are now facing in the Netherlands.

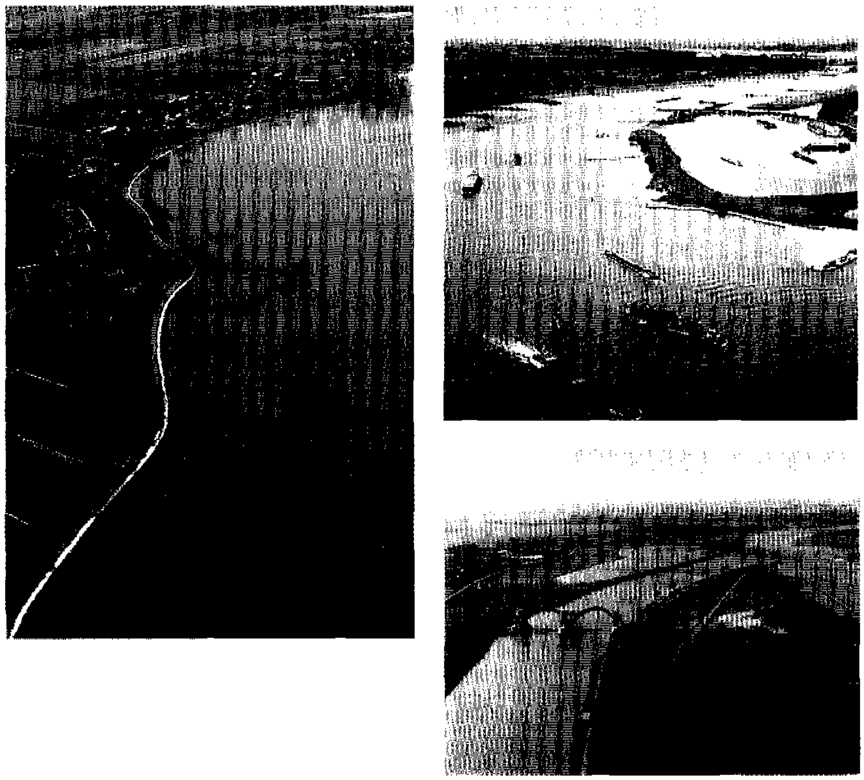


Figure 1 River regulation and flood management.

An extensive dike system along the Rhine river aims to reduce the chance of flooding to 1:1250 years. Apart from a potential source of flooding, the Rhine is also one of the busiest navigation routes in the world, and the river is entirely regulated for this purpose.

2. Introduction

2.1. The Dutch Dialogue: reflection and exchange

The range of 'water problems' (both floods and droughts) that has occurred in recent years, in all corners of the world, has given more urgency to the question whether current water management practices are sufficiently prepared for weather and hydrological extremes. Moreover, the question is raised whether climate change is a far-away prospect or something we are already experiencing. These issues, and possible adaptive actions, were discussed at the Development Conference in Johannesburg, and the discussion will be continued at the World Water Forum III conference in Kyoto. **This report is the Netherlands' input to the Dialogue on Water and Climate, which will be presented in Kyoto.** Apart from this report, a Summary is also prepared in order to present a quick overview of the Dutch Dialogue.

Can other countries learn from climate adaptation in the Netherlands?

Water management in the Netherlands has a long tradition. Many organisations are involved and the water management system is highly developed and adapted to very specific current hydrological conditions (see Text Box 1). However, the system is still vulnerable to current weather- and hydrological extremes, and water managers struggle to find out how to prepare for the impacts of forecasted climate changes in long-term policy plans. As in many countries, it is difficult to achieve political agreement on the balance between short-term economic growth and long-term sustainable development, and of course it is even more challenging to implement plans once they are agreed upon – the 'success rate' in climate adaptation in water management eventually depends not only on scientific knowledge and technical skills, but also on long-term public and political support. Developments in the Netherlands are unusual in one way: a series of extreme events in the 1990s, involving excessive rainfall and high water levels in the Rhine and Meuse rivers, has started a national debate on climate adaptation. Current water management practices have been reviewed and plans for what is seen as a drastic overhaul have been agreed upon following the advise on 'Water Management in the 21st Century' (see Text Box 9). Because of this special situation, an analysis of the strengths and weaknesses of the adaptive process in the Netherlands may provide valuable insights on the implications of climate change for water resources management in general. Therefore, the Dutch Dialogue may make a valuable contribution to the Dialogue on Water and Climate (DWC), to be presented at the 3rd World Water Forum (WWF3).

Set-up of the Dutch Dialogue

The Dutch Dialogue consists of the following components:

1. An assessment of the 'State of the Art' in water resources management in the Netherlands, focussing on its preparedness for weather- and hydrological extremes resulting from climate variability as well as climate change. Attention will be given to scientific, technical and institutional aspects.
2. An objective assessment, supported by stakeholders in the sector, of both the positive and negative sides of the 'climate adaptation' process in the Netherlands. The focus here is on institutional and technical aspects as well as on public awareness of the issues and on the existing dialogue between the water sector, politicians, decision-makers and the general public.
3. A stakeholder workshop where the above assessment is finalised, and where the Dutch situation is compared with that in several other (delta-) countries.
4. The above will be reported at the DWC 'Synthesis Workshop' (December 2002, Dhaka) and at the 3rd World Water Forum in (2003, Kyoto).

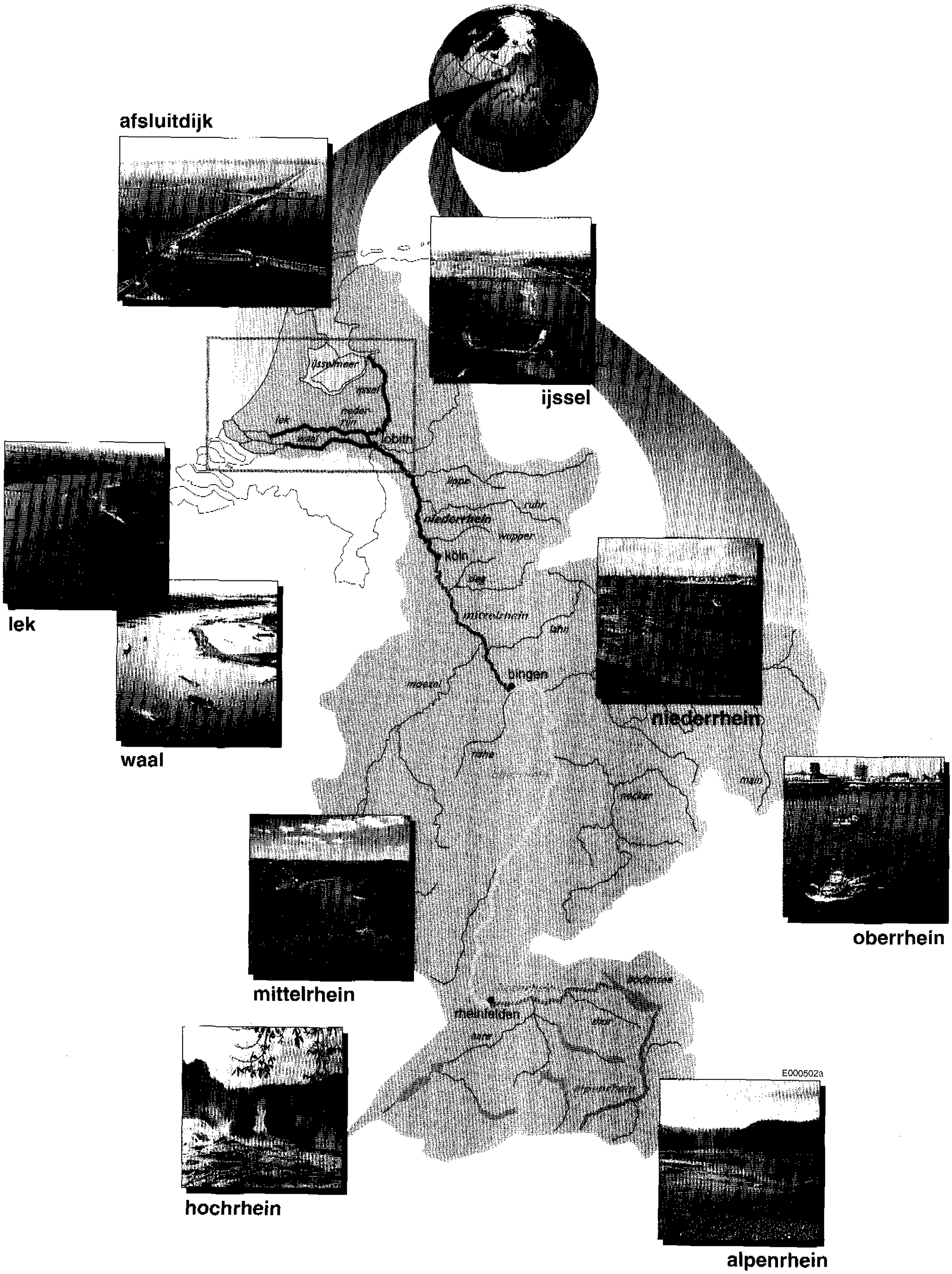


Figure 2 Map of the Netherlands, in the Rhine and the Meuse river basins. Photos show typical river landscapes throughout the basins.

2.2. The function and set-up of this report

This report presents the outcomes of all steps in the process described above: (1) state of the art assessment, (2) stakeholder reflection, (3) international workshop. It aims to provide a basis for discussion between representatives of the Dutch water management sector and counterparts from countries that face comparable challenges.

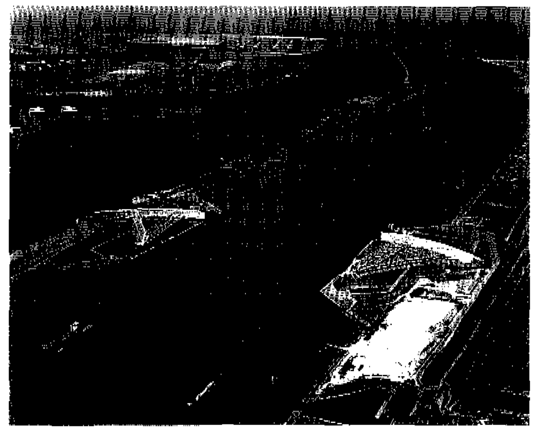
In **Chapter 2** of this report, a brief description of the hydrological characteristics, water management system and infrastructure of the Netherlands is given. **Chapter 3** starts with the climate scenarios that were accepted as the starting point for the Dutch Dialogue, and then introduces the expected climate change impacts on flooding & drainage, water availability & shortage and water quality & salinisation. The actual and planned responses to each of these impacts is described in **Chapter 4**, which starts with an introduction to the processes through which water management policies are developed and implemented in the Netherlands. **Chapter 5** contains the 'Lessons Learnt', including a critical evaluation of the Dutch Dialogue process itself.

In addition to these Chapters, much information is presented in **Text Boxes**: each tells a 'stand alone' story on one single issue. Other components of the report are **Annexes** with an 'inventory of available information ('literature list') and a comparison of the situation in the Netherlands with that in several other countries.

2.3. Contributors to this report

The 'Dutch Dialogue' process was carried out under the umbrella of the Netherlands Water Partnership (NWP) and supported by 'Partners for Water' (the Program for the Netherlands' involvement in the foreign water sector), and by the Secretariat for Water and Climate. For the collection and analysis of information, and the writing of the 'Dutch Dialogue' report, a core group was formed among the members of the NWP consisting of representatives from the Ministry of Public Works, Transport and Water Management, the Royal Meteorological Institute of the Netherlands (KNMI), the Ministry of Housing, Spatial Planning and Environment, the International Institute for Hydraulic Engineering (IHE-Delft), and WL | Delft Hydraulics (Project Management partner).

In a Co-ordination Group, other organisations with a specific expertise and/or interest in the subject are represented. These are sector organisations and other stakeholders: e.g. NGOs, regional Government bodies and Water Boards. Several participants in the Co-ordination Group have submitted text inputs to this final report, others have commented on the draft version and have supplied suggestions for improvement and completion of the report.



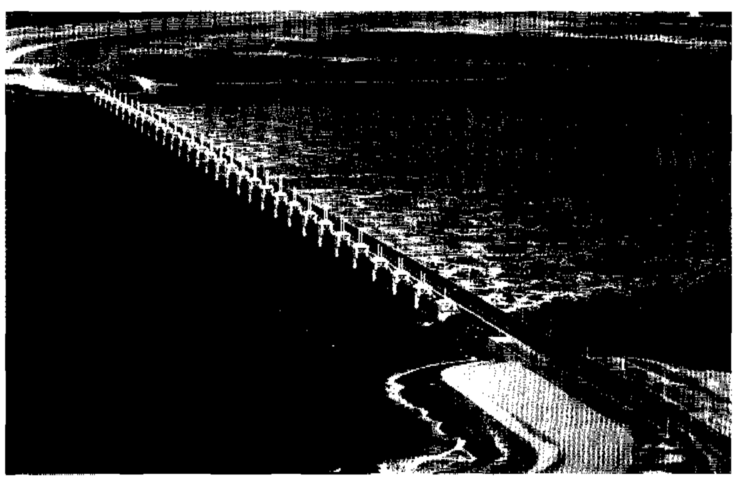


Figure 3 Large-scale 'traditional' water management measures in the Netherlands

From top to bottom:

- **River flood protection: dike raising and strengthening along the Rhine and Meuse rivers.**
- **Coastal protection Oos Protection of navigation routes: the flood barrier in Rotterdam Waterway.**
- **The gates in the Westerschelde Sea Barrier (Zeeland) close when the sea water rises dangerously high.**

3. Water management in the Netherlands

Many images the country is associated with are related to water management: just think of dikes and windmills. Those who have visited the country will be familiar with its canals, with the very high population density that is concentrated near the coast and rivers, and with the position of many polders below sea level. The fact that these may be the best-known aspects of the Dutch culture and landscape illustrates how the country has been shaped by water and by water management: the position of the country in the low-lying Delta of the Rhine and Meuse rivers, near the sea is, a fundamental factor in the Dutch history, economy and culture (see Text Box 1).

3.1. Water management regions

The fact that most of the Netherlands is covered with flat grasslands on fluvial and marine soils, and rainfall varies only between 700 and 900 mm annually, may suggest hydrological uniformity. However, several regions with very distinct hydrological conditions and associated water management can be distinguished. The main 'water management regions' are:

- The sandy Dutch coastal zone is part of a larger system ranging from the north coast of France to Denmark. Currents, wind, waves, deposits from rivers and man-made structures have formed the present coastline which is still changing in a continuous process of accretion and erosion. The dominating process is erosion and in the last few centuries several Dutch coastal towns have been lost to the sea and had to be rebuilt further inland. Approximately 300 km of natural beach flats and sand dunes protect the coastal zone from flooding. In addition, 60 km of dikes and dams, with a safety level of 1:10,000 years, protect those areas where the natural dunes are absent or insufficiently strong.
- Behind the coastal 'protection zone', a patchwork of areas separated by older dikes exists; these **polders** are the result of step-by-step reclamation of land, where there once was sea, over many centuries. The land surface within the polders is below sea level, necessitating continuous drainage through an intricate system of ditches. This has resulted in further lowering of the surface level of most polders (where there are peaty or clayey soils), sometimes to as much as 7 metres below sea level. This drainage is a defining characteristic of the water management in the 'polder' water management system. Almost 9 million people live in this part of the Netherlands; many in urban areas, and approximately 60% of the Dutch national product is produced here. Economic and population growth in the 21st century are likely to occur particularly in these areas.
- In the east and south of the country, extensive **sand plateaux** exist at elevations up to a few tens of metres above sea level. These plateaux are drained by local brooks and small rivers. Water management aims at stabilising water levels for the benefit of agriculture.
- Along the rivers Rhine and Meuse, and their branches, extensive floodplains are inundated most winters. Within the **river corridor**, floodplains are separated from polders by an extensive system of dikes, designed to allow flooding once in every 1250 years at the most. Water management between the dikes focuses on facilitating river discharge and navigation.
- A unique feature of the Dutch water management system is the existence of several **enclosed estuaries**, the largest of which is the IJsselmeer lake, formerly the Zuiderzee, in which the saline water has been replaced by fresh water in the 20th century. While the reason for closing these estuaries was mainly flood protection, they are also important for water supply, nature management, recreation and freshwater fisheries.

Text Box 2 Example of institutional co-operation in planning and implementation of measures: the coastal zone

Many authorities are involved in the management of different aspects of the coastal zone such as flood protection, spatial planning, nature conservation, recreation or economic development. Increasingly, Dutch authorities are aware that they can only reach their own objectives by close co-operation with the authorities at a different level or responsible for a different aspect. To obtain a good balance between only coastal flood protection and spatial planning, co-operation between no less than five different authorities at three levels is already required:

	FLOOD PROTECTION	SPATIAL PLANNING
NATIONAL	Ministry of Transport, Public Works & Water Management	Min. of Spatial Planning and Environmental Protection
REGIONAL	Coastal Provinces	Coastal Provinces
LOCAL	Water Boards	Municipal Authority

3.2. Water management organisations

Because water management is such an important and complex issue in the Netherlands, a large number of organisations have over time assumed responsibilities for different aspects at different scales. The responsibilities and interactions are too numerous to detail here, but it is possible to list the main organisations:

- A department of the **Ministry** of Transport, Public Works & **Water Management** ('Rijkswaterstaat') is responsible for most national aspects of water management such as coastal protection and the river regulation system including primary dikes.
- Each polder region belongs to a specific water management organisation: the **Water Board** ('waterschap'), responsible for maintaining water levels and water quality in the polder. The management of the Water Boards is directly elected by the local population. There are now some 50 Water Boards.
- Rijkswaterstaat and the Water Boards are responsible for much of the water management system, but several other government organisations are also dealing with aspects of water management. E.g. the **Ministries** of 'Housing, Spatial Planning and the Environment' and of 'Agriculture and Nature Conservation' are often involved, as these issues are closely linked to water management.
- **Provincial** and **municipal** authorities also have important responsibilities in water management, both at the planning and the implementation (especially municipalities) level.
- A number of **NGOs** have a strong influence on water resources management issues. Prominent among these are nature management organisations (such as WWF and Natuurmonumenten), farmers unions (e.g. LTO), environmental pressure groups (e.g. Natuur and Milieu, Milieudefensie), and platforms representing industrial interests (e.g. water supply companies or the energy sector).
- Finally, water management in the Netherlands is increasingly controlled **by international agreements**. Some of these are bi- or multi-lateral and non-binding, such as the plans made in the context of the International Commission for Protection of the Rhine (ICPR, see Text Box 3), but EU Directives (such as the Water Framework Directive) now have a status almost equal to national laws.

3.3. Current water management strategy and main instruments

Water management in the Netherlands, in recent decades, relies almost entirely on water control measures. A strong belief in technical solutions has created a system where water levels, water flows and water quality are controlled using technical means. An extensive and very complex water management infrastructure has been developed (see Text Box 1, Figure 3):

- Coastal flood protection is ensured by dikes in places where the natural defence line is weak.
- Floods by river water are prevented by a combination of river regulation (straightening, deepening) and dikes. Often, two dike systems run parallel: low 'summer dikes' along the channel aim to prevent floods during summer, while high 'winter dikes' further from the channel are designed to prevent any flooding.
- Inundation in polders and other low-lying areas is prevented, apart from the flood protection tools listed above, by rapid discharge of rainwater through a dense network of drains and pumps.
- Availability of fresh water for use in dry periods has been achieved by closing off several estuaries, the largest of which is the IJsselmeer lake, from the sea. The newly formed lakes are huge reservoirs where river water and excess rainwater is stored.
- Improvement of water quality already has a high priority in the Netherlands, where pollution has caused great problems in the past. Surface water quality is managed, apart from using a system of water treatment plants, by following two strategies: (A) Source-oriented approach: this aims to limit the outputs of pollutants by individual companies, municipalities, farmers etc. (B) Emission-oriented approach: this aims to bring water quality within the target range by taking additional measures in and along water bodies: dredging, improving riparian zones and wetlands, restoring the natural (meandering) morphology of stream channels.
- Drinking water production in most areas requires extensive treatment. Both surface water and groundwater are used. In some places (especially the coastal dune belt), surface water is injected into the underground for purification and to replenish groundwater resources.

Text Box 3 The international context of Rhine River Basin Management: the ICPR

Transboundary river basin management needed

Most of the Netherlands is formed by the deltas of the Rhine and Meuse rivers. From a water management point of view, the country therefore is only a small part of two river basins that also include other countries: Germany, Belgium, France, Luxembourg and Switzerland. Co-operation with these countries is a priority in water management and significant progress in this area has been made, especially for the Rhine, a river of 1.320 km long and a basin area of 185.000 km^2 with some 50 million inhabitants. In 1950, the International Commission for Protection of the Rhine (ICPR) was formed on the initiative of the Dutch.

Success in pollution reduction

During the first decade, the focus of the ICPR was mainly on pollution reduction. A series of regulations was drafted and adopted by the governments of the separate Rhine countries. Especially after the 'Sandoz' pollution disaster in 1986, pollution emissions became strictly regulated and the target was raised to full ecological restoration, 'symbolised' by the aim to allow the return of migratory fish to the river in the year 2000. These initiatives has undoubtedly contributed to a drastic reduction in loads of some types of pollutants such as industrial emissions, pesticides and heavy metals, and the Rhine is now a lot cleaner than it was a few decades ago. However, the loads of some types of pollutants, including nutrients, are still too high to claim complete success. The partial success is illustrated by a shift in targets: salmon have only returned in low numbers so far, so the earlier slogan 'Salmon 2000' has become 'Salmon 2020'. Nevertheless, the ICPR role in the cleanup of the Rhine is generally considered a success.

New focus on flood risk management

After the Rhine floods of 1993 and 1995, which not only occurred in the Netherlands but also upstream in Germany, the focus of the ICPR shifted towards flood risk management. The 'Action Plan High Water' was drafted, and approved in 1998 by the governments of the Rhine countries. The basis of the Action Plan is the idea that '*high waters will always be a danger, we have to learn to cope with them better than we do now*'. The change in the thinking about flood risk management in the Rhine countries is similar to the change in thinking about water management in general in the Dutch 'Water Management 21st Century' plan, and could be summarised as 'room for water'. Specific measures that are promoted, are:

1) Reduction of potential flood damage by 25% by the year 2020.
2) Reduction of high water levels, mainly by creating more detention space along the channel.
3) Increase awareness of high water by creating flood risk maps for the entire river corridor.
4) Improve the flood warning system by increasing warning times by 100% in 2005.

Will political agreement lead to flood risk management solutions?

The fact that a basin-wide flood action plan was created is in itself a success that forms a strong basis for action. However, some critical notes should also be mentioned: 1) it is already clear that the potential damage reduction goal is unlikely to be met, in fact potential damages keep rising because investments in risk areas continue unchecked; 2) the high-water reduction goals set are also optimistic, especially as some of the proposed measures (e.g. increasing infiltration- and retention capacity upstream in the basin) are less effective than assumed in the Action Plan; 3) the flood risk map, at least for the Netherlands, is of limited value to decision makers as it does not differentiate risks, and it appears to generate little awareness. Clearly, translating political targets into the practice of water management and spatial planning is a difficult process even if there is so much agreement on the goals!

Does the Action Plan promote climate adaptation measures?

Similar to water management plans in the Netherlands, the Action Plan mentions climate change as a reason for action. When it comes to the proposed actions, however, the focus is on the ability to deal with extremes as they are expected *on the basis of the historical record*. As discussed elsewhere in this report, this focus is perhaps unavoidable and should also be seen as 'climate adaptation'. The concern about climate change is expressed in the emphasis on a 'no regret strategy' which will allow maximum flexibility in taking measures in the future. An important condition for such a strategy is that many measures must allow 'multifunctionality': development of different functions, including nature restoration, in one area.

Many aspects of the present 'control-oriented' water management approach are currently under discussion, and some measures that are now considered are less 'technical' in nature. Examples are measures to further reduce pollutant emissions at the source, a trend to allow a greater area to be flooded by rivers in order to reduce the need to build increasingly higher dikes, and an increased interest in optimising spatial planning as a tool in water management. Some of these current developments, many of them linked to the Government policy 'Water Management 21st Century' (see Text Box 9), will be discussed in greater detail later in this report.

3.4. Specific vulnerability of the Dutch water system

The effects of extreme weather conditions, due to climate change or climate variability, depend on hydrological, geographical, economic and demographic conditions. The Netherlands are a small country in a special position: much of the country is in a delta, a large area is below sea level, the population density and the level of economic investments are very high, and a sophisticated water management system has been developed. Moreover, much of the country is subsiding slowly. In this situation, the weather- and hydrological extremes most feared are those that increase the risk of flooding: from the sea (due to high sea levels), from rivers (due to peak discharges) and from extreme local rainfall leading to inundation of polders. Because of this specific vulnerability, studies have focused on effects on flood risk, but other expected effects – water availability and water quality – are increasingly considered.

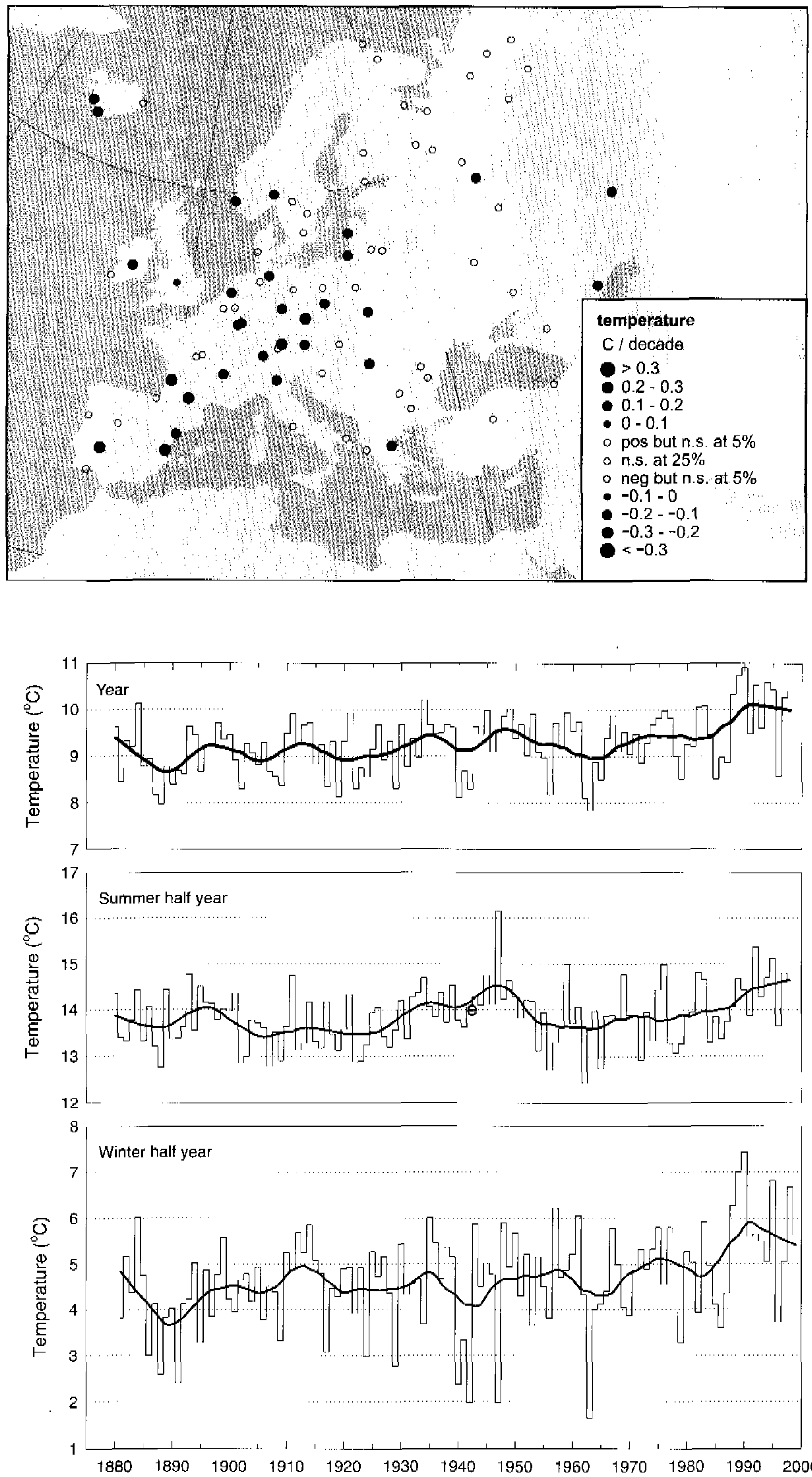


Figure 4 Observed temperature trends in Europe and the Netherlands

Top: **Changes in annual mean temperature in Europe, over the 1946-1999 period. (Source: KNMI).**
Bottom: **Historical temperatures in the Netherlands, averaged over the calendar year, the summer- and the winter half year. (Source: KNMI).**

4. The impact of climate change on the water system

A working definition of 'climate adaptation' (as used in the Dutch Dialogue discussions) could be "to prepare the water management for extremes in the weather -- not only as we know them to occur in present climate conditions, but also as we expect them to occur when the climate changes". This definition tells us that water managers must deal both with climate variability and with climate change. However, it is also clear that practical adaptation policies are generally based on developing insights in climate variability, causing extremes in the weather and in hydrological conditions, not on projections of climate change. To avoid getting caught in discussions on the actual climate change projections, and their impact on the water cycle – discussions that would obscure the real debate on climate adaptation in water management – the 'state of the art' on climate change impacts as described below was accepted by participants, early on during the Dialogue.

4.1. Expected Climate Change in the Netherlands

In short:

- ***It is deemed 'likely' (probability more than 90%) that the future developments fall within the range of three defined scenarios for the coming decades: 'low', 'middle' and 'high'; at present it is not possible to predict which one is most likely to become reality, but the scenarios predict the same trends.***
- ***Winters in the Netherlands are expected to become wetter and warmer. In the summer, rainfall will also increase and often be more intense. Nevertheless, water shortage problems during summers may also occur more often as evaporation is likely to increase more than rainfall, and the main rivers will bring less water in summer.***
- ***Current projections of climate change are 'conservative' in that they assume certain basic processes to be unchanged. Should these assumptions be wrong, the result could be 'unpleasant surprises': climate change could be worse than the currently accepted scenarios predict.***

It is necessary to define what climate change is expected before describing the response of Dutch water managers. What might happen with the climate in the Netherlands, and how probable are these changes? Climate scientists in the Netherlands have studied this intensively, especially after the UN Framework Convention on Climate Change (UN-FCCC) put the issue on the world's political agendas.

The present climate

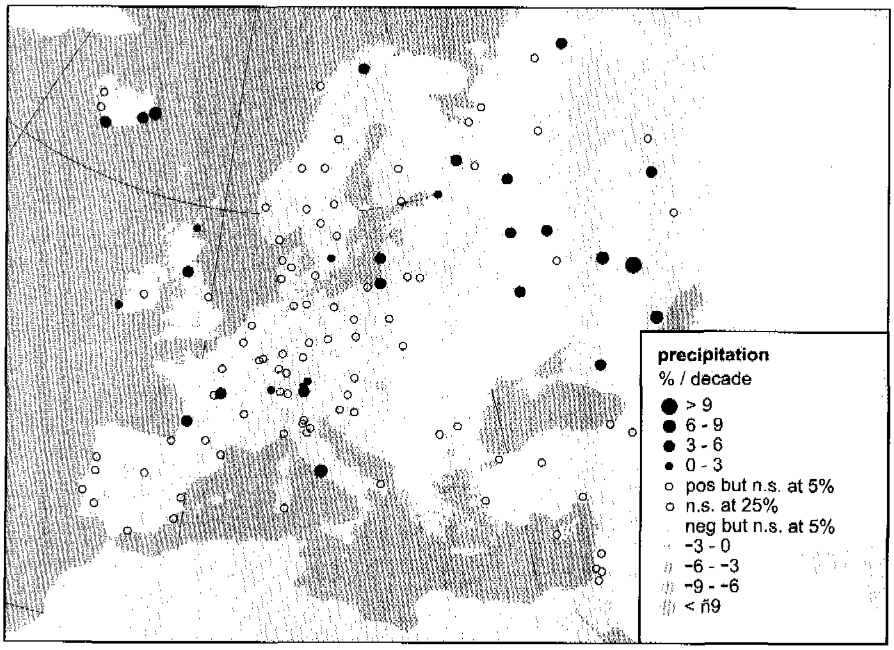
Before a fruitful discussion on the expected impacts of climate change is possible, the following must be known:

- The ***current climate*** must be quantified precisely.
- The range of current ***climate variability*** around the 'normal' climatic conditions must be defined in order not to confuse the occurrence of extreme events with long-term change.

The ***climate of Western Europe*** is characterised by prevailing mid-latitude westerly winds that bring relatively warm and moist air from the adjacent (northern) North Atlantic Ocean. The catchment areas of the major rivers that enter the Netherlands experience the North-South contrast of the climate in Western Europe, with sub-tropical influences in the Mediterranean and a maritime mid-latitude climate more northerly.

Observed climate changes

Taking into account these current 'normal' conditions and variability, recent ***observed climate trends*** can be determined from meteorological records (see Figure 4, Figure 5). The average temperature in the Netherlands in the last twenty years of the 20^{th} century was 0.7C higher than it was in the first twenty years of this century. This ***increase in temperature*** has been particularly pronounced since 1988. There was also ***more precipitation*** in the second half of the century, which may be partially related to the warmer weather.



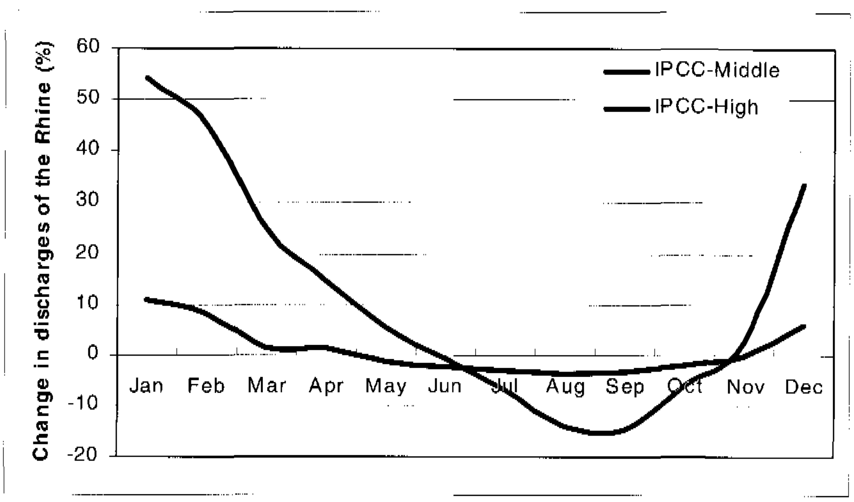


Figure 5 Observed precipitation trend in Europe, and predicted trends in Rhine discharges.

Top: **Changes in annual mean precipitation in Europe, over the 1946-1999 period. (Source: KNMI).**
Bottom: **Changes in Rhine discharges (compared to the present situation) by 2050 (IPCC 'Middle Scenario') and 2100 (IPCC-'High scernario'). Predicted is that accelerated climate change will result in an an increase of discharge in winter, and a decrease in summer. Although the changes predicted for the Middle Scenario are far less extreme than the High Scenario, the change it predicts for 2050 is already significant. (Source: the 'National Drought Study').**

All the winters in which more than 500 mm of precipitation were recorded in De Bilt (the Netherlands) came after 1960. A study of ***wind activity*** in the 20th century reveals no trend: the chance of storms and above-average tidal levels has ***remained unchanged***.

The risk of unusually high tides has increased due to an average ***rise in the sea level*** by 18 cm per century along the Dutch coastline. One quarter of this sea level rise can be attributed to land subsidence in the Netherlands. The remainder is mainly due to the increase in the volume of seawater resulting from the rise in temperatures world-wide since the end of the nineteenth century.

Projections of future climate

Though different climate models show fairly consistent results on a global scale, their simulations differ in 'details' on continental scales and smaller. This is no surprise: it is well known that the ability of climate models to represent the properties and dynamics of atmospheric circulation and weather is less at the continental scale than at the global scale.

Several model simulations by KNMI indicate that the Sea Surface ***Temperature*** in the Northern North Atlantic Ocean may not increase as strongly and as rapidly as the globally averaged surface temperature. With prevailing westerly winds, this may influence the land surface temperatures in ***North Western Europe*** in a similar manner, thereby moderating temperature increase due to climate change. In ***South and Central Europe***, however, dryer continental conditions may give rise to faster and greater ***increases in land surface temperature*** than the global average. Increased (winter) ***precipitation*** in middle- and high latitudes, also in Europe, and increased (summer) ***drying*** in the Mediterranean and continental interior are projected by most models.

The expected increase in winter precipitation, an increasing ratio of rain versus snow, due to higher temperatures, together with an only marginally increasing evaporation will lead to an ***increased water flow in the river Rhine in winter months***. In summer the balance is different: the decreasing snow cover implies less melt water in the summer. Together with increased evaporation that will not be fully compensated by increased rainfall in the summer, this will lead to a ***decrease in the average water flow in the summertime***.

While regional climate simulations are, especially on the (rather small) scale of the Netherlands, not very reliable and consistent, water managers (and others) need climate scenarios to think about response strategies. KNMI therefore developed a method to derive ***temperature and precipitation scenarios for the Netherlands***, using observed statistical relations between precipitation and temperature (which are assumed to also hold in a warmer climate). In consultation with users such as water managers, three climate change scenarios for the Netherlands, based on the third IPCC assessment report (IPCC 2001, TAR) were developed by the KNMI (see Table 1).

It is deemed ***'likely'*** (probability more than 90%) that the future developments fall ***within the range of the three scenarios*** for the coming decades. Sea level scenarios are slightly more certain, because most of the projected rise in the coming decades is related to past climate change, about which climate scientists are certain.

Text Box 4 Climate adaptation: should the Dutch adapt to climate variability or to climate change?

Definition of climate variability and climate change

Climate is defined as the *long term* (over a period of 30 year) *statistics* of the weather. Not only the (yearly) average temperature, rainfall, wind etc., but *also the variations* around those values (which contain both periodic (seasonal, daily), systematic (slow trend) and chaotic (weather) excursions, *are aspects of the climate*. Extreme weather events, which occur maybe only once in several tens, hundreds or thousands of years, are important because of their potential impact. Due to their very nature, however (they are rare!), their statistics is hard to define, determine and predict. The terms climate *change* and climate *variability* are not always clearly defined. Because climate is defined over a period of 30 years, all changes in (average) weather parameters on a shorter timescale are part of the variability of the local *weather*. Changes in the weather statistics on longer timescales comprise climate variability. The term climate *change* is often reserved for a particular type of climate variability, e.g. the component that is associated with human influences (definition used by FCCC/IPCC) or a long term shift of weather parameters in one direction (e.g. warming).

Should a distinction really be made, when it comes to a management response?

In discussions on climate adaptation in water management, the question whether Dutch society should prepare for climate change or 'just' deal with climate extremes often comes up. Adaptation plans (including 'WB21' in the Netherlands) usually are a response to observed extreme events (in the Netherlands: the near-floods of 1993 and 1995), that are part of climate variability according to the definition above. It is not impossible that such events will in the future – with hindsight – be seen as part of climate change pattern, but we can't tell now. One thing is certain: water management problems are usually caused by extremes, not by 'average' weather, and a change in weather extremes is even harder to predict or observe than a change in average conditions. Clearly, there is little hope for a clear, unambiguous, answer on this subject in the near future...

The question is: does it matter to society, water managers in particular? In the Dutch discussions on the practical implications of climate adaptation, including the 'Dutch Dialogue on Weather and Climate', the issue does not play an important role. A pragmatic working definition of 'climate adaptation' as "*adapting the water management system to extreme weather as we now expect it, on the basis of recent insights*", appears to be sufficient. These insights may change when extreme events happen, simply because the calculated frequency distribution may also change.

Table 1 Expected climate change by 2001.

Predicted changes by 2050 are more or less half those by 2100. (Source: KNMI)

	'Low' Scenario	'Middle' Scenario	'High' Scenario	Present
Average Temperature (C)	+ 1	+ 2	+ 4 to 6	
Average winter precipitation (%)	+ 6	+ 12	+ 25	350 - 425 mm
Average summer precipitation (%)	+ 1	+ 2	+ 4	350 - 475 mm
Average summer evaporation (%)	+ 2	+ 4	+ 8	540 - 600 mm
Max. 10-day precipitation sum in winter (%)	+ 10	+ 20	+ 40	
Return time of 10-day sum now occurring 1/100 years	47 years	25 years	9 years	
Average sea water level (cm)	+ 20	+ 60	+ 110	+ 18 (20th cent. rise)

Climate changes now expected by water managers

Based on the information presented above, the following prognosis is now generally accepted in the Netherlands, and serves as the basis for many studies into future water management options (See Table 1). It is deemed likely that the current trends will at least continue and probably accelerate – in this case, it could be said that the Dutch society should prepare for ***'more of everything'***:

- ***Rainfall*** rates will continue to ***increase*** both in the Netherlands and in the upstream catchments, especially in winter.
- ***Temperatures*** will also continue to ***increase*** in the Netherlands and in the upstream catchments, both in summer and in winter.
- (Summer-) ***rainfall intensity*** and the frequency of extreme rainfall events are likely to ***increase*** as well.
- ***Evaporation*** will also ***increase***, especially in summer.
- ***Sea levels*** will continue to ***rise***, by at least as much as they have done in the 20th century, probably considerably more.

The possibility of 'unpleasant surprises' due to climate change

The current climate change scenarios present the latest knowledge, but are inevitably also based on assumptions. IPCC warns, in its third assessment report, explicitly for possible 'surprises' in the climate system. One example is the possibility of a complete ***failure of the*** so-called ***thermohaline*** ocean ***circulation***. This north-south flow in the Atlantic Ocean brings large amounts of warm surface water towards the North Atlantic, which warms the current West European Climate on the average by a few degrees Celsius at least. Another surprise in the climate system might be the ***rapid disintegration of*** parts of the west Antarctic or Greenland ***Ice Sheets***, which could cause a much more rapid and drastic (several meters in a few hundred years?) sea level change than in the scenarios. The unknown probabilities of such events are considered very small and they do not play a prominent role in the Dutch Dialogue (KNMI did, however, develop a scenario for a cooler North Atlantic ocean and one for a drier European continent that the IPCC projections.). However, it would be irrational to ignore these possible surprises altogether, especially when considering that in some water management sectors, e.g. in flood-protection, events that occur maybe once every few hundred or few thousand years *are* considered!

4.2. Climate change and Floods

In short:

Climate change could cause flood problems in several ways and at several scales:

- ***The probability of sea floods could increase due to both sea level rise and increased storm activity.***
- ***River peak discharges are likely to increase due to a number of factors: increased precipitation upstream, a higher proportion of rainfall vs. snowfall in the Alps, earlier snowmelt due to higher temperatures, and sea level rise.***
- ***Local water systems can expect a higher frequency of inundation as intense rainstorms occur more frequently.***

Text Box 5 How can the 'weather forecast' deal with climate uncertainties?

A contribution from the Royal Netherlands Meteorological Institute, KNMI

Careful communication is needed on climate change issues

The 'public awareness' of climate issues is largely shaped by the attention such issues get from the media. The way in which the media report, in turn, partly depends on the way weather services and climate research institutes deal with climate change - especially in relation with extreme events. When communicating about possible climate change, a balance must be found between too extreme caution ("climate science is so uncertain that nothing can be said") and oversimplification ("this is what was predicted and now you see it happening!"). The first approach could remove the incentive for climate adaptation, the second could distract from the real problem at hand; we all know examples of river floods that are followed by discussions on climate change, rather than on the measures needed for that river. The fact is, that the weather/climate system is extremely complex and 'chaotic', especially on the smaller scales of continents and countries, and that our knowledge and understanding is incomplete (to say the least). Observations of climate are – by definition – of a statistical nature and any 'predictions' (more properly called 'projections') must always have a probabilistic character: at best, it is possible to tell how much chance there is of a certain scenario becoming reality. Such statistics are not easily communicated without causing confusion.

An active media policy helps in educating the public and the media

It is therefore important that climate scientists take the lead in educating not only the public, but also the media. The KNMI, is responsible for the weather forecast on the national news as well as for scientific climate studies. It has an active policy in supplying the press and representatives of TV and radio with (background) information on climate issues. News releases, fact sheets and assessment reports are sent to them, especially when actual weather events need to be explained. The press is also invited to symposia and on the occasion of important publications or climate news, press presentations are organized. Meteorologists that appear on radio or TV are invited to special educational days on climate change. KNMI's most important general channel of communication concerning climate and climate change is the Internet, where information is presented at various levels of sophistication: www.knmi.nl/voorl/klimaat/index.htm. KNMI is also responsible for a daily 'teletext' page on national television, which features climate change background information regularly. Finally, KNMI participates in various books, articles and even television courses on climate change and has prepared a traveling exposition on climate, climate change and climate research, which is used all year round in varying locations in the country.

The expected impact of rising sea water levels and changing wind patterns
Impacts on floods along the coast : The need for protection against sea floods is, and has always been, the greatest water management concern in the Netherlands, and the prospect that sea level rise would increase flood risk is strongly on the political agenda. The possible effect of sea level rise is not just that of higher water levels: changes in wind patterns and sea-currents may influence sedimentation and erosion processes near the coast.

While the assessment reports of the IPCC (Intergovernmental Panel on Climate Change) and KNMI give projections of the global mean sea level rise for the 21st century, such information is not yet available for the expected changes in storminess. Nevertheless, a possible rise in storm activity along the North Western European area is of increasing concern to scientists. The large impact of such an increase could make this the most important manifestation of climate change for this region. The information from and the confidence in climate models is still insufficient to make solid statements about future changes in numbers and intensity of storms in northwest Europe.

While sea level rise alone is worrisome, the combination of sea level rise and increased storm activity would be far more dangerous and could well necessitate additional strengthening of parts of the sea defences in order to continue to meet current flood safety standards. To maintain these standards, additional strengthening of parts of the sea defences would be necessary.

Effects on large lakes: Sea level rise would cause water level rise in the coastal large lakes, like the IJsselmeer and Markermeer, unless actions are taken to increase drainage capacity from these lakes. This would, of course, also lead to an increase in flood risk along these lakes, where the flood protection system is designed to deal with current levels and dikes are not as high as along the coast. The effect of increased wind activity is as yet unpredictable but potentially very significant. In these large shallow lakes, sustained strong winds can 'push' the water levels up by nearly a metre and a half, and thereby also decrease drainage capacity of the large sluices at the Afsluitdijk and in IJmuiden. In the canals around the lake, substantial fluctuations in the water level can result. In areas where the water level is normally regulated to an accuracy of centimetres, this may result in the partial flooding of polders and urban areas bordering the lakes.

Effects on inland floods: large rivers: Though flooding from the Rhine and Meuse rivers is mainly caused by extreme discharges from the upstream catchments, sea level rise may play a role as it increases water levels in the lower stretches of these rivers, through backwater effects.

Effects on inland floods: local water systems: Regional hydrological systems in the coastal zone are more sensitive to climate change than regional water systems in the upper part of the Netherlands because they are exposed to both sea level rise and changed precipitation patterns, as well as soil subsidence.

The expected impacts of changing precipitation and temperatures
Effects on floods by large rivers: There are two climate changes that can have a significant impact on the peak discharges in the rivers Rhine and Meuse. These are (see Table 1):

1 Amounts of precipitation have increased in the 20th century and are likely to further increase in the 21st century, especially in winter. Winter precipitation for the Netherlands is expected to increase by 6 to 25%, by 2100 (see Table 1); increases in the upstream catchments are expected to be in the same order of magnitude. Furthermore, this precipitation is likely to be concentrated into intense events more often: annual winter maximum precipitation in the Netherlands is expected to increase by 10 to 40% by 2100. This would almost certainly result in an increase in peak discharges in both the Meuse and the Rhine rivers.

2 Average temperatures are also increasing and may be 1 to 6 degrees Celcius higher in 2100. Furthermore, within total precipitation amounts, the ratio rainfall/snow is increasing. Both factors will affect the timing of river flow peaks that are caused by melt-water, and are expected to further increase the frequency of peak flows in the Rhine River.

Text Box 6 Recent events defining developments in water resources management in the Netherlands

It is often said that changes in water resources management are mostly the result of catastrophic, or potentially catastrophic, events which convinced the public and decision makers that action was inevitable. For the Netherlands, this can be illustrated with a few examples:

Coastal protection: the Delta Plan and the flood of 1953
In 1953 a devastating Sea flood killed more than 1800 people in Zeeland, the south western province of the Netherlands. As a result a national master plan (Delta Plan) was developed. Flood protection standards were set and implemented between 1955 and 1985 and regulated by national law (Act on Flood Defences). The most densely populated western part, including cities such as Amsterdam, Rotterdam and The Hague, enjoy a safety level of 1/10,000 per year (considering only the risk of floods from the sea). For less populated areas this is 1/4,000 or 1/2,000. Lower safety levels are accepted for flooding from the rivers. To meet the new standards, dikes had to be strengthened along the coast and rivers. Most estuaries have been closed off by dams and storm surge barriers to shorten the length of the coast-line.

Ironically, the success of the 'Delta Plan' is best illustrated by the fact that sea level rise did not enter the political and public debate in the Netherlands in the 1990's because of its impact on flood risks, but because of the possible ecological effects on the estuarine Wadden Sea. Only after near flood-disasters along the Rhine did coastal safety become an issue again.

'Room for rivers' plans and the high waters of 1993 and 1995
The public and political awareness of flood risks was drastically increased by the occurrence of two near-flood situations along the river Rhine in the 1990's, one requiring the precautionary evacuation of over 100,000 people. The extreme discharges were attributed by many to the effect of climate change, which provoked heated political discussions and much media attention: the images of near-collapsing dikes and evacuations had a profound effect on public perception. Flood risk management is now an important aspect in national and regional policy plans for spatial planning, public safety and nature development. The basis of the new policy is the recognition of the fact that it is safer to 'give room to water' than to try to control the water system under all circumstances: the Dutch don't always need a 'finger in the dike'. However, the practical implementation of the policy is only just starting.

The Rhine Action Programme on Water Quality and the 'Sandoz' disaster
The Rhine has long been one of the most polluted rivers in the world. Although plans to improve this situation date back decades, it took the 1986 fire in the Sandoz chemical factory, which caused huge pollution and massive fish kills all along the river, to take serious action. The Rhine Action Programme, drafted in 1987 by the International Commission for the Protection of the Rhine, set ambitious goals for water quality improvement, many of which have indeed been met (see Text Box 3).

The Elbe flood in 2002: international events and national action
Sometimes, dramatic events in other countries will also affect water management in the Netherlands. As recent as 2002, the massive floods along the river Elbe in Germany have provoked discussions in the Netherlands on how to avoid such events. The Ministry of Transport and Water ordered a rapid study of the likelihood of such an event in the Netherlands: the meteorological conditions that caused the flooding in Central Europe were 'translated' into similar conditions in the Rhine basin, and the resulting flood was modelled. The resulting report concludes that an extreme flood of 11.600 m^3/s (at the Dutch border) would result: unheard of in summer but below the peak discharge of the 1995 flood (12.700 m^3/s), and well below the safety level of 16.000 m^3/s for which the Dutch river management system should be prepared. Though events like those in the Elbe basin would therefore not have led to floods in the Rhine basin, they have shown again that water management should be prepared for the unthinkable, and have stimulated discussions on whether we are seeing increased flood risk due to climate change - even though **the report explicitly states that it is far too early to attribute the floods to such a change.**

While there is broad agreement that climate change may increase the probability of peak discharges and therefore of floods, there is less agreement on the precise degree of increase. Even if the precise change in climate could be predicted more accurately, there would still be uncertainty in the way in which this is translated into floods. One factor is the fact that flood peaks from river tributaries could or could not combine 'in phase' in the main channel, another one is that uncertainty already exists in the current probabilities of the extreme events (with a 1:1250 year return time) that is used as a design condition. In the case of the Rhine, further uncertainty exists in the probability of floods upstream in Germany, that would reduce downstream discharges and hence flood risk. In a way, flood risk from the rivers in the Netherlands is as dependent on the German response to climate change (in terms of safety management: dike raising etc.) as it is on the climate change itself. Because flooding is such an important issue in the Netherlands, there is considerable debate in scientific and political circles (see Text Box 12, Text Box 3) and even in the media (see Figure 7) on these issues, and several studies are ongoing. The prospect of increased flood probability is already often explicitly mentioned in management plans, but flood risk management is still based on historical records of high waters instead of projections. In the case of the Rhine, this means that safety levels are calculated with a 1:1250 year discharge of 16,000 m^3/s, though it is increasingly recognised that this could increase to 18,000 m^3/s in the future.

Effects on inundation of local water systems: polders and free-draining catchments: Changes in local weather patterns are likely to cause pronounced changes in local precipitation patterns. Rainfall intensities in showers may increase by 10 to 40% by 2100 (5 to 20% by 2050). By that time, the return period of an extreme 10-day rainfall event with a current return time of 100 years may be reduced to between 47 and 9 years (75 to 25 years by 2050).

Whether an extreme rainfall event will lead to inundation in a local water system depends on management factors like storage space, discharge capacity, and the water level that defines the initial conditions. As storage space and discharge capacity are often limited, inundation events have occurred regularly in recent decades. The expected increase in both extreme events and groundwater levels (in 20% of the Dutch area, according to recent studies) is therefore likely to result in more frequent and more serious inundation events unless measures are taken.

4.3. Climate change and water availability

In short:

Although serious droughts (by international standards) are not expected in the Netherlands, an increase in the frequency of water shortages is expected. While this is not likely to be nearly as problematic as an increase in flood events, there would be economic costs.

The Netherlands as a whole can be considered a 'wet' country: not only does it have an excess in precipitation most years, but it also has a reliable supply of water from the upstream catchments of the Rhine and Meuse rivers and smaller streams. In fact, no less than 73% of the available water budget originates from across the border; 62% from the Rhine river basin alone. A sophisticated water transfer network has been developed to distribute this water: for water supply, irrigation and cooling water. In an average year, the water requirement for evaporation is only about 20% of the incoming water, and as much as 80% ends up in the sea. Considering these numbers, it is no surprise that the country very rarely experiences drought as it would be defined by water managers in most of the world. The last time that water shortage had a serious economic and environmental impact on the country was in the summer of 1976; the estimated damage to agriculture was in the order of 1 or 2 billion Euro, while the price of vegetables more than doubled. Damage to inland navigation was in the order of hundreds of millions Euro. A drought of this magnitude is estimated to occur less than once in a hundred years; however, less extreme and local water shortages occur regularly. Serious local or regional shortages occur every 10 to 20 years, lack of cooling water causes shutdowns of some industries and power stations every 2 to 5 years, and action by the National Co-ordination Team Water Distribution was required 4 times in the last 10 years.

Text Box 7 Examples of publicity by NGOs and the government on Climate Change and 'WB21'

An analysis of how 3 stakeholders with very different interests (the Farmer's Union, environmental groups and the 'Ministry of Spatial Planning and the Environment') deal with climate adaptation in water management in publications, gives an indication of the status of the issue.

The Farmers' Union (LTO) has produced a Discussion Paper ('Value of Water') on its views on the recommendations of the Commission Water management 21^{st} Century (WB21). The Union states its support for the recommendations and recognises that a higher risk of droughts (in summer) and floods (in winter), due to climate change, could become a real problem for farmers and society as a whole. It is agreed that agricultural practices can be adapted to better suit natural hydrological conditions ('water as controlling factor'), thereby leaving more space for sustainable water management and nature. On this basis, it is recognised that groundwater levels need to be raised in those areas where over-drainage has created potential water-shortage problems, that creation of flood water detention areas on agricultural lands along rivers may be an option, and that new ways of sustainable farming (e.g. 'aquafarming') should be investigated.

However, the LTO also clearly indicates the limits to this support: regional water systems should not be made 'autonomous' (i.e. storage space for excess water should be found elsewhere), 'room for rivers' needs to be found along rivers and not behind the current dikes (i.e. major changes in land use are not acceptable) and water should remain a 'public property' (and therefore as cheap as possible). In other words: **some of the basic 'room for water' principles are rejected** and only minor adaptations to the current 'water control' strategy are accepted. LTO also warns that the agricultural sector should not be made solely responsible for certain adaptations, that the Government needs to financially support changes, and that a system of insurance against flood- and draught-damage should be developed.

The websites of several ***environmental and nature conservation NGOs*** (Greenpeace, Environmental Defence (Milieudefensie), World Wildlife Fund) give similar information on climate change:

- A very radical change is presented; scenarios that are not found in 'official' publications, such as the effect of a disappearing Gulf Stream, are considered serious possibilities.
- It is stated that the effects of climate change can already be seen, with reference to IPCC conclusions
- The emphasis is on damage to natural systems, which are seen as more vulnerable than societal systems.
- It is emphasised that the vulnerability of developing countries in the tropics is even greater than in areas that are considered to have a higher adaptive capacity, such as Europe.
- Adaptive measures in water management (including 'room for rivers measures') are mentioned, but receive relatively little attention. The **emphasis is strongly on mitigation**: both through reduction of CO_2 emissions and through adaptations in nature management and agriculture to enhance carbon storage.

The ***Ministry of Spatial Planning and the Environment*** (VROM) presents a summary of the 'official' Climate Policy of the Netherlands on its website (www.vrom.nl). The site deals with the following issues:

- *On climate change and its consequences:* most scientists agree that the climate is changing due to greenhouse gas emissions. Temperature is expected to rise by 1.5 to 6 degrees in the 21^{st} century, the sea level by 9 to 90 centimetres. This will have significant consequences everywhere, but problems will be greatest in developing countries; both floods and drought problems are cited.
- *On government actions to combat climate change:* under the Kyoto Protocol, the Netherlands have promised to reduce greenhouse gas emissions by 6 percent in 2010. Actions named include promotion of fuel-efficient cars and industries, stimulation of use of renewable energy sources and stimulation of public awareness of climate change.

Significantly, a **mitigation strategy is promoted**. Adaptation actions that will be needed to deal with the consequences of climate change are not mentioned. This illustrates how climate adaptation may be an increasing concern of water management organisations, but has not achieved 'official' status yet (see Text Box 8).

Though water shortages may not be the most pressing water management problem, they are expected to become more problematic in the future: not only because water availability in summer will decrease, but also because climate change and economic growth increases the demand for fresh water of high quality. The foreseen decrease in availability has several causes:

- According to the 'National Drought Study', Rhine discharges are likely to decrease throughout summer (see Figure 5). This decrease could be a high as 15% in August and September (by 2100).
- Though average summer rainfall is actually expected to increase by 1 to 4 %, an increase in the frequency of very dry years is also foreseen.

The expected increase in demand is caused by:

- Salt-water intrusion, through estuarine systems and through ground water seepage, is expected to increase due to sea level rise. More fresh water may be needed for 'flushing' freshwater systems,
- If temperatures increase (by 1 to 6 degrees Celcius in 2100), so will evaporation (by up to 16 %).

Of course, water availability is not only dependent on the water balance and the occurrence of dry summers. Water quality issues and reservoir management are also a factor. The first of these is discussed separately in this section, information on the latter can be found in a Text Box presenting the WIN project (see Text Box 11).

4.4. Climate change and water quality

In short:

Predicting the effects of climate change on water quality appears to be even more difficult than predicting the water quantity impacts. This is not only because of the greater number of processes and interactions involved, but also because climate adaptations in water quantity management are likely to have side-effects on water quality.

It is expected that the Netherlands will have to deal with several water quality effects of climate change, through changes in rainfall, evaporation, sea level and temperature. However, a lot of uncertainty exists on how severe these effects will be, especially as they are partly interdependent and also depend on changes in water management. The National Environment Plan states: "in the Netherlands, winters will become wetter and warmer and summers will be drier *[note that summer rainfall is actually expected to increase (see Table 1), but that this effect is expected to be offset by an even stronger increase in summer evaporation]* while summer rainfall will be increasingly associated with storms". In general it is expected that, in the Netherlands, the impacts of changes in precipitation will be more severe than the impacts of sea level rise. The following effects on water quality are possible.

Surface water pollution

- Flushing of nutrients from agricultural lands will be enhanced if the *frequency of extreme rainfall events increases*. At present, flushing is already four times as high in the 10% driest years than in the 10% wettest years. As this increase in nutrient loads would be accompanied by increased water flows, the effect on concentrations is not clear.
- Climate change may have a direct impact on water quality through agriculture, if more pesticides and herbicides would be needed in a 'wetter' climate. The need for different (climate-adapted) crops may also have a direct effect.
- In urban areas, *changes in rainfall intensity and timing* can have an effect on A) the capacity of sewage systems to deal with wastewater, and B) the quality of wastewater.
- Temperature changes will have an effect on biological processes like mineralisation and (de-) nitrification, and also on growth of algae and plants. For example increased summer temperatures may also have an effect, which can be positive with regards to the 'self-cleaning' ability of freshwater systems but may also lead to an increase in algae growth.
- In rivers and other surface water systems, an increase in winter river peak flows can result in greater pollutant mobility. On the other hand, higher discharges also mean greater dilution of pollutants, so the net-effect on concentrations may be unpredictable.

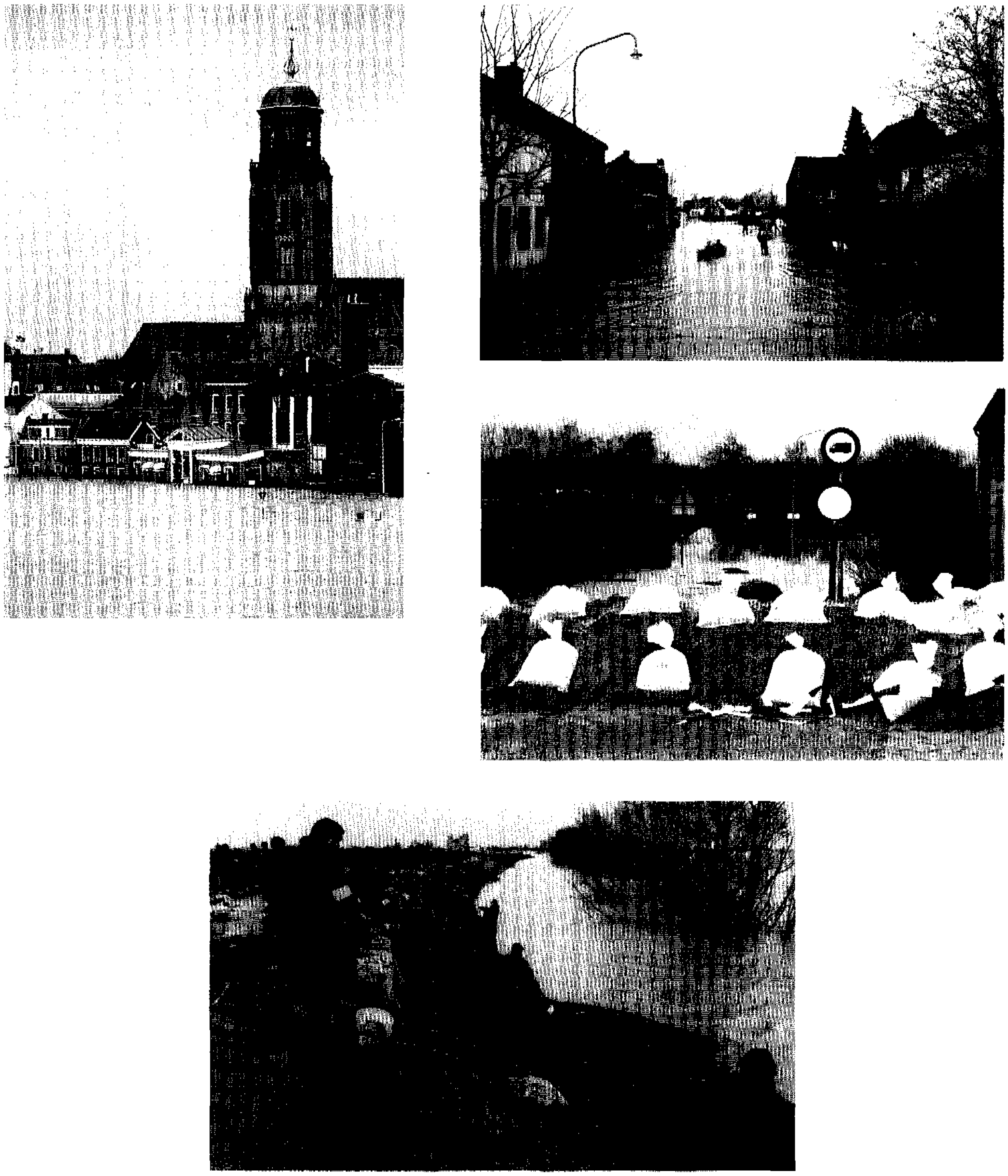


Figure 6 Recent river floods risk in the Netherlands: could a nuisance become a disaster again?

From top to bottom: **recent flood events in 1993 and 1995 provoked a debate on the actual flood safety enjoyed in the Netherlands. Parts of towns were inundated and provisional flood defence measures needed in many places. However, there were no dike breaches and no casualties. The floods caused significant economic losses and inconvenience, but not a disaster. The effect of the events was that they made clear that such a disaster could have developed, especially as higher discharges are easily imaginable (e.g. the peak Rhine discharge in 1995 was 11.800 m^3/s, while the 1:1250 year discharge is 16:000 m^3/s).**

- If the Dutch rivers experience lower flows in summer, this may increase concentrations of transported substances in solution, and hence in an increase in pollutant concentrations.

Surface water temperatures

- Climate change may affect the impact of water cooling by industry and energy production. If the frequency of water shortage events increase, this may lead to shortages of cooling water. These shortages may be enhanced when 'input' water temperatures are also higher: as the temperature of 'output' cooling water is strictly regulated (at 30 degrees Celcius), a few degrees rise in input water temperature over 20 degrees Celcius will mean that much more cooling water is required. The additional increase in surface water temperatures could have significant environmental impacts.

Salinisation by salt-water intrusion

- Periods of very low river discharges will become more common in summer. During such periods, the fresh/salt gradient in these rivers and the connected estuaries will move upstream. In some cases (e.g. Haringvliet) this may cause problems for drinking water supply.
- Sea level rise may cause enhanced seepage of salt groundwater to the deep polders along the coast, in the Western part of the Netherlands. On the other hand, increased winter rainfall and management actions may result in higher water tables in the polders as well, which would reduce the salt-water intrusion.

Sediment pollution by reduced 'flushing'

If the fresh/salt gradient moves upstream in rivers, this can cause pollution problems: a large fraction of the pollution transported by rivers is attached to sediment. These sediments 'flocculate' and precipitate at the mixing-boundary between salt and fresh water. If this process takes place further upstream it may cause greater problems.

4.5. Autonomous developments affecting climate change impacts in the Netherlands

In short:

The hydrological impacts of climate change are likely to be enhanced by other trends, both natural and societal. On the other hand, climate adaptation can be combined with other policy priorities, such as nature restoration.

The impact of climate change is a long-term issue and should therefore be assessed taking into account other changes that will occur. In the Netherlands, important developments are:

- Soil subsidence: in many parts of the Netherlands, the soil surface is gradually lowered by drainage and by gas production. Subsidence rates can be in the order of tens of centimetres per century. This causes changes in drainage conditions and an increase of inundation risk.
- The continuing spread of urban areas and economic development increases potential flood damage.
- Social and economic developments are reflected in developments in perspectives on water management; one consequence is a decreasing tolerance for flood risk and inundation nuisances.
- A change in the function of much rural land: from agricultural production to nature conservation and recreation. This provides opportunities for extra floodwater storage space but also requires sufficient water of high quality.

Aanleg calamiteitenpolders overbodig

Van onze verslaggever
AMSTERDAM

De aanleg van calamiteitenpolders om toekomstige overstromingen van de Rijn op te vangen, is overbodig. Volgens een studie van de Technische Universiteit Delft zijn de kansen op een extreem hoge waterafvoer van de Rijn in eerdere rapporten bewust te hoog ingeschat.

De studie, uitgevoerd in opdracht van acht Duitse en twee Nederlandse gemeenten, bestrijdt de conclusies van de commissie-Luteijn die eerder dit jaar adviseerde om de Ooijpolder bij Nijmegen, het Rijnstrangengebied bij Arnhem en de Beersche Overlaat bij Oss aan te wijzen als calamiteitenpolders. Ze zouden geopend moeten worden wanneer de Rijn meer dan achttienduizend kubieke meter water per seconde zou aanvoeren, wat volgens Luteijn eens per 1250 jaar zou kunnen gebeuren.

Volgens hoofddocent De Boer van de TU Delft (Openbare Werken en Waterstaat) is de grondslag voor die berekening nergens in het rapport terug te vinden en ligt de feitelijke kans op zo'n extreme afvoer op eens in de vierduizend jaar. 'De commissie heeft een rekenfout gemaakt en heeft daarna doelbewust toegewerkt naar de noodzaak om overloopgebieden aan te leggen. Vermoedelijk om ruimte te claimen voor de toekomst.'

De betrokken gemeenten zijn ongelukkig met deze claim en hebben De Boer ingehuurd. 'Maar dat betekent niet dat ik mij laat sturen', zegt hij. 'Ik zit niet in het complex van adviseurs die hier geld aan verdienen.' Volgens de hoofddocent twijfelen meer wetenschappelijke collega's aan de kwaliteit van het rapport-Luteijn, maar zijn ze er te nauw bij betrokken om kritiek te kunnen uiten.

Volgens de studie van De Boer, die eind januari wordt gepubliceerd, zullen de nu geplande noodoverloopgebieden ook landschappelijk grote gevolgen hebben. Bijvoorbeeld langs de Ooijpolder zullen hoge dijken aangelegd moeten worden om het water binnen de polder te houden. 'Het zicht op dit prachtige gebied is dan grotendeels weg.'

Eén argument voor het plan-Luteijn om voor de toekomst rekening te houden met extreem hoge waterafvoeren, is de verandering van het klimaat. Die zou in West-Europa aanzienlijk meer neerslag kunnen brengen, hoewel nog onduidelijk is hoeveel. Volgens De Boer is dit argument onnodig. 'Klimaatverandering is een zaak van de lange termijn en elke vijf jaar wordt de maximale afvoer opnieuw berekend. Wanneer de norm moet worden aangepast, kan dat altijd nog.'

Demissionair staatssecretaris Schultz van Haegen van Waterstaat neemt de kritische studie vooralsnog niet serieus. Ze kan zich niet voorstellen dat de commissie-Luteijn met een niet-onderbouwd advies is gekomen, zei ze maandag. 'Vooralsnog blijf ik voor gecontroleerde overstromingen in geval van extreem hoge waterafvoer.'

Figure 7 Worries about future river floods: how high can water levels rise?

Top: **High-water levels are well above the surrounding protected areas, and send a powerful message that dike raising may not be the only solution for flood risk management, in the long term.**

Bottom: **In December 2002, the discussion on what climate change will mean for the Netherlands became front-page news once more: one of the largest national newspapers reports on a heated discussion between water managers. One group has advised the construction of 'calamity polders', and this advice was accepted by the Government. Calamity polders are meant as a last resort: when all 'normal' flood control measures fail, and catastrophic uncontrolled floods are imminent, controlled flooding in selected inhabited areas will decrease river water levels and thus reduce the flood risk downstream. The likelihood of increasing peak discharges due to climate change is seen as a main reason for the need for such polders. However, others argue that such measures should only be taken once this increase is evident – hence the title "no need for Calamity Polders" ("aanleg calamiteitenpolders onnodig").**

5. The Dutch response to climate variability and climate change

The key question in the 'Dutch Dialogue' is how organisations are dealing with the weaknesses in the water management system, as demonstrated by floods and near-floods following extreme weather and hydrological events in recent years, and with the knowledge that these extremes are likely to get more severe while the sea level will certainly continue to rise. This is not an easy question to answer, not only because of the uncertainties in the weather and in climate development but also because of the complex way in which policies are developed, the long time it takes to actually implement plans, and the different actions needed to deal with different climate impacts.

5.1. How are policies formulated and measures planned in the Netherlands?

In short:

- ***The complex decision making procedure required for implementation of major water management measures may be democratic and thorough, but it is also very slow.***
- ***Not only 'objective' scientific evidence and cost-benefit analysis, but also the 'subjective' perspectives of organisations, as well as public opinion, are factors in the decision making process.***
- ***A comprehensive information campaign on water management issues (but not in relation to climate change) has resulted in increasing awareness of these issues amongst scientists and decision-makers, but hardly amongst local authorities and the general public.***
- ***The Dutch response to climate change may depend as much on international agreements and European policies as on national interests.***

Before discussing the way in which water management organisations are dealing with weather- and hydrological extremes, and with the prospect of climate change, it is necessary to describe the context in which this is happening. Who decides what problems have the highest priority, what measures should be considered, and if and when they should be implemented?

The Dutch 'consensus model'

In a decision making process typical for the Netherlands, the aim is always to reach a high degree of consensus before a decision is actually taken. This consensus-oriented approach has produced such a complex system of consultation and feedback mechanisms that it is recognised in other countries and scientific circles as a special model for decision making: often called the 'poldermodel'. In fact, it is sometimes said that the need for integrated and widely supported management in polders, which has been a matter of survival for centuries, has actually created this system. Whether this be true or not, the 'poldermodel' is definitely the basis for decisions on spatial planning and water management in the Netherlands. A whole range of organisations is involved at each stage of the planning process – including Rijkswaterstaat, several ministries, provinces, municipalities, the 'water boards', NGOs and concerned citizens. The advantage is that a decision, once it is taken, is more likely to be widely supported, reducing the amount of public and political controversy that often accompanies major infrastructure measures. Also, the chance of a measure being inefficient should be reduced if it is so thoroughly evaluated. A drawback of the 'poldermodel', however, is that it stretches the decision making process to many years or even decades. In some cases, it prevents a timely decision from being taken.

The advise of the "Commission Water Management 21st Century", the policy document underlying many current plans and developments in Dutch water management (see below in this section, and Text Box 9), is also a result of years of consultation and feedback. This has resulted in broad support for some rather drastic ideas that would otherwise have created a lot of resistance. However, the next step is to actually implement the measures proposed, and it is now seen that a considerable effort will be needed to do this.

Text Box 8 Climate mitigation or adaptation: international solidarity versus national interest?

The present Dutch (and international) response to climate change: mitigation

It has been discussed in this report that the official Dutch policy with regard to climate change is still one of mitigation: through international treaties and national policies we are committed to a reduction in the production of greenhouse gases. This has resulted in stimulation programs for energy conservation supported by national public information programs through the media. No such national policy or program exists for adaptation: though the issue is seriously considered by many organisations, this is as part of a general reconsideration of our water management policy, not as a high-profile issue in its own right.

Increased international interest in climate adaptation

International interest in adaptation to climate change is now increasing. The Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (2001) states: "adaptation is a necessary strategy at all scales to complement climate change mitigation efforts". This conclusion is based on the insight that even if all planned mitigation measures are implemented, climate change is to be expected. When the mitigation targets set by 'Kyoto' are not met, which seems increasingly likely, these changes will logically be even greater.

Linking climate adaptation requirements in the Netherlands to progress in mitigation

Sometimes, it is claimed that it makes economic sense to focus on mitigation, because adaptation measures would be costlier. However, while it is undeniable that in the long term, and at a global scale, the success in implementation of mitigation measures influences the need for adaptation measures, this can not be translated into a cost-benefit analysis for the short or medium term: there are too many uncertainties in the climate trends, economic developments, the impacts of mitigation measures and even the effectiveness of adaptation measures. Therefore, when it comes to actually taking measures, mitigation and adaptation will be seen as separate issues for some time to come: mitigation is primarily driven by international solidarity, adaptation by our national need for safety. Moreover, as concluded in the Dutch Dialogue on Water and Climate, the current and planned adaptations of water management in the Netherlands are not driven primarily by the prospect of climate change but by current weather- and hydrological extremes (caused by climate variability) and by socio-economic and ecological factors.

Adaptation in the Netherlands and in developing countries: two different sides of the issue?

The IPCC TAR report also states that "those with the least resources have the least capacity to adapt [to climate change impacts] and are the most vulnerable." From the perspective of developing countries therefore, adaptation measures in richer countries, that will make them less vulnerable to weather extremes in the future and therefore less inclined to focus on climate mitigation, is not necessarily a positive thing. The increasing demand from developing countries for more international attention for adaptation measures is therefore a different issue from the discussion on climate adaptation in the Netherlands: adaptation measures in the Netherlands are seen as a matter of national interest, support for adaptation measures in developing country as a matter of international solidarity.

Social context of water management: perspectives of stakeholders in water management
Water management does not happen autonomously, but in a society where many groups have different views on how water management should contribute to safety, nature conservation, economic growth, health and the landscape. The perspectives of these groups on desirable developments are linked to their role in society. The different roles of many organisations are evident and will not be discussed here, apart from the observation that they can cause different approaches to the same problem. For instance: the fact that different time horizons are relevant for different organisations (e.g. < 10 years for a municipality, >25 years for the State) means that some pay more attention to long-term developments than others do. In recent discussions and publications, in is often assumed that water management organisations can adopt one of 3 perspectives:

1. some groups believe that the natural system is robust and can deal with control measures,
2. others believe the natural system is sensitive and measures should aim to allow natural functioning of water systems, as much as possible,
3. still others simply believe that the cheapest measure will be the best; free-market principles should lead to objective cost-benefit analysis for measures.

Clearly, not only 'objective facts' play a role in water management, but also views on what the Netherlands should look like in the future!

Social context of water management: public opinion and public awareness
Apart from the perspectives of the organisations involved, the position of the 'general public' should also be taken into account in decision making. In the Netherlands it is increasingly realised that while experts and decision makers, even though seeing things from different perspectives, may aim to discuss and select the 'best' measures on the basis of the best available information, what counts most in the end is the public opinion. Clearly, public opinion is influenced mostly by the easiest available and understandable information, provided by the media in the form of reports of disasters and near-disasters (see Text Box 6). As a result, the interest of the general public in water management is limited to 'disaster management', and the public tends to prefer those measures which seem to promise the most safety in the short term – not sustainable water management in the long term. After a near-flood disaster along the Rhine or Meuse, for instance, there will be an emotional appeal for higher dikes, while most water managers agree this does not necessarily decrease risk in the long term.

Even if the general population would have a deeper interest in water management issues, they can not be expected to grasp the scientific uncertainties and technical complexities involved. In recent years, the Dutch Government and organisations involved in water management (including NGOs) have clearly seen it as their task to make relevant information freely available, in a format that can be understood by non-experts (see Figure 10; Text Box 5; Text Box 7; Text Box 9). A great number of glossy folders and reports was published and put on the Internet, dedicated information websites were created and discussion meetings organised. This certainly had some effect; especially policy makers and the media have benefited from the information available. However, the possible impacts of climate change are not detailed in this information. Moreover, it is often heard that the public is still insufficiently aware of the problems facing water managers, and still expects clean water, 100% safety and a landscape that is not impacted by water management measures – without realising the cost. This point of view is quite accepted: as recently as 26 September 2002, the Vice Minister for Transport, Public Works & Water Management (Mrs Schultz van Haegen) stated on National Television that the Dutch population "...should be made more aware of the risk and cost of living several metres below sea level..." (see also Text Box 9).

River basin and European context
Water management is increasingly seen on the river basin scale, and it is clear that management of transboundary rivers requires co-operation by countries. In the case of the Netherlands, most of the Rhine and Meuse river basins are located in countries upstream: Germany, Switzerland, Belgium, Luxembourg and France (see Figure 2). Being in the delta of these two rivers, the water the country receives is affected by the water management in these upstream countries. Therefore, there are a number of bilateral and multilateral agreements that aim at closer integration of management activities along both rivers. Importantly, the International Commission for Protection of the Rhine (ICPR), in which all Rhine-countries are represented, has produced several policy documents.

Text Box 9 'WB21': Background, Goal and Publicity

The Mission of 'WB21'
Adapted from introduction by F. Tielrooij, chairman Commission Water Management 21st Century;
From: http://www.nederlandleeftmetwater.nl/WB21
The Commission Water Management 21st century ('WB21') was formed in response to a number of floods and near-floods by the end of the 20th century. The question it needed to answer was: "how do we prepare our water management for the 21st Century?" The issues are not only the current safety, damages and costs: the way we are now dealing with water will not suffice in the future. This is all the more problematic as we must deal with the impacts of climate change, sea level rise and continued soil subsidence. Equally worrysome is the limited interest in water management amongst politicians and the public. Clearly, a different approach is needed. Too long have we relied on technical control. We now need integrated water management, with a clear focus and wide support in society. Water should be seen less as an 'enemy', more as an ally in nature restoration, agriculture and urban management. The Advise of the Commission is a step in the right direction. Room for Water is central, as is more participation from politicians and public, better co-ordination of activities and a real cost-benefit approach. The Advise is based on policy reports, a lot of research and consultations amongst a large number of people and organisations.

Presenting WB21 to the public
Several Ministries support publicity programs aiming to raise awareness of the changes needed in Water Management through publicity. An example is summarised here: the brochure 'The Netherlands are living with Water', which presents the main findings of the 'Water Management 21st Century' report to a wider public.

The problem
As in many countries, water is taken for granted in the Netherlands, and water management receives little interest: we think it is normal to have clean drinking water from the tap, to use it to water our gardens in summer, to never have a flood even though many of us are living 6 meters below sea level. We think these things are normal and we are shocked when water management fails: events like flooded neighbourhoods in Limburg and in several polders, or a near-flood along the Rhine, are major news items. It is increasingly assumed that such recent inundation events are no co-incidence, but the result of climate change causing A) increased local rainfall, B) increased flood discharges in rivers, C) sea level rise. In addition, parts of the Netherlands suffer from soil subsidence, due to drainage and gas exploitation, and the probability of inundation is further increased by unchecked urbanisation, reducing the retention capacity of water systems. Finally, the potential *damage* due to flooding also continues to increase more than necessary, due to economic investments in places that are most likely to be inundated. To what extent these changes will continue in the 21st century cannot be predicted precisely, but it is clear that we must prepare and adapt our water system. Not only 'too much water' is a problem in the Netherlands: sometimes we have 'too little'. Climate change affects not only our safety but also the quality of our surface water and potentially even our drinking water supply, as it is likely to lead to lower river discharges and water levels in summer. This could result in drying out of soils, water pollution and salt-water intrusion along the coast.

The solution
'More space for water' is the core of the new Dutch water policy. At all scale levels, space must be reserved for retention and storage of water. This involves storage areas along rivers and in polders, but also changes in urban infrastructure. The new approach has major implications for society: on the positive side, there will be more space for nature development in our direct living environment; on the negative side, some people may have to move and others may have less freedom in the ways they can use the land. Such a strategy can only be successful if it is widely supported in society. Therefore, increasing attention is given to public participation and awareness building, in order to get the new approach to water management across. A **three-stage strategy of *retention/storage/discharge***, expected to improve flood safety and reduce water shortages while creating opportunities for nature and recreation, is now accepted by all organisations in water management (see also Text Box 13):

1. The first stage is to retain excess water near the origin: this way, downstream inundation is reduced and local water shortages later in the year are prevented.
2. When the limits of local retention capacity are exceeded, water will be stored in allocated areas.
3. Only when retention and storage capacity are exceeded will water be discharged to the main water system.

The most important of these are the 'Convention on the Protection of the Rhine' (setting goals and targets for water quality and ecosystem management) and the 'Action Plan High Water' (setting goals and targets for flood risk management). While the targets stated in these documents are not strictly binding to nations, they do form a strong incentive to take action and stimulate co-operation between scientists and decision-makers (see Text Box 3). In addition to these 'basin-wide' agreements, there is also an increasing number of European Directives that Dutch practice must comply with: notably the Water Framework Directive and Habitat Directive. Both of these have a strong focus on water quality and ecological issues. These Directives are binding and have a significant impact on national policies and measures.

As a result of basin-wide agreements and European Directives, developments in water management in the Netherlands are not only driven by national and local policy, but must also increasingly be in line with international policies.

5.2. The role of climate research organisations in water management policy development

In short:

- ***Although the official Dutch 'climate change response' policy focuses on mitigation, adaptation-oriented actions are considered or planned by many organisations. However, such actions do not have the same level of political recognition (i.e. 'official' support by all ministries and other organisations) as 'mitigation' actions.***
- ***Information on climate change will be easier to use in water management when more is known about regional changes (and not only global changes), when the relations between climate change and climate variability are better defined and when there is a better understanding between water managers and climate researchers, especially on the subject of 'remaining uncertainties'.***

5.2.1. The national response to predictions of climate change

For a long time, the notion that the global climate is changing due to man made influences on the atmosphere was considered only by (climate-) scientists. The issue of Climate Change appeared on the international political agenda in the late nineteen-eighties because of warnings issued by the climate research community. The Dutch government responded by focusing and enhancing national research efforts, involving Governmental Departments, Universities, Technological Institutes etc. and by making sure that the Netherlands participated fully in the FCCC and IPCC processes of international negotiation and assessment.

Mitigation and adaptation

Until the Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (2001), policy makers were mainly focusing on 'climate mitigation'. The earlier IPCC assessment reports identified the impacts of climate change but did hardly pay attention to adaptation to these impacts. The TAR, however, concluded (Working Group II on impacts, adaptation and vulnerability) that "adaptation is a necessary strategy at all scales to complement climate change mitigation efforts". This means that policy makers should not only develop mitigation policies but also adaptation policies because even when mitigation measures are implemented, climate change impacts are to be expected. This complex international component of this debate is discussed in Text Box 8.

At present, the Netherlands has formulated and is implementing the Netherlands' Climate Change Implementation Plan (parts 1 and 2, 1999) which describes the different mitigation measures to be taken, but a national adaptation policy has not been formulated. At the moment, discussions are taking place on how to improve this situation, on which adaptation issues (such as costs) more information / research is needed.

Text Box 10 Public awareness and coastal protection: the example of coastal building restrictions

It would seem logical that the citizens of the Netherlands, who are after all famous for 'fighting the Sea' for centuries, would be very aware of the dangers the sea still poses and would prefer to live in safer areas away from the coast. In reality, however, the building rate in 'high risk areas' near the sea has increased drastically in recent decades (Figure 8) – it proves to be difficult to limit this.

People are living ever closer to the sea

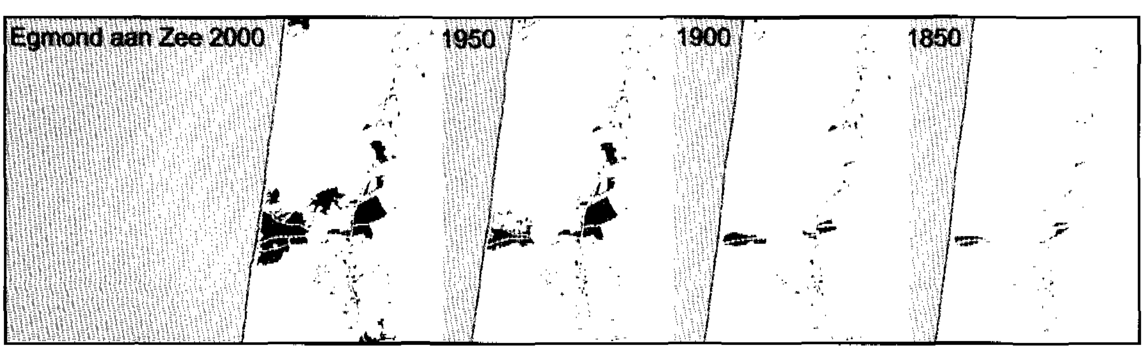
In the Netherlands, the location of a settlement is often a historic balance between convenience, economic opportunities and flood risks. Near the coast, harbours and coastal towns developed where the coastline provided natural shelter, e.g. in estuaries and rivers some kilometres upstream from the sea. Only the poorer fishing villages were located in the dunes. In these villages the fishermen lived close to the sea near their fishing boats that were pulled up the beach. With an eroding coastline, these parts were at constant risk to be swallowed by the sea. In the villages, more prominent residents lived more inland in the older dunes, where most of the expansion took place. In the middle of the 20st century, however, the expansion switched to the dunes and the seashore. Apparently the short term benefits from economic opportunities outweigh the long term risks from erosion and flooding. Or has the high flood safety standard resulted in an overconfident sense of security?

Justifying building restrictions on the basis of rare events is difficult

Dunes, dikes and dams along the coast protect a large proportion of the Netherlands from flooding. In the central part of the Netherlands this line of defence is sufficiently strong to withstand a 'superstorm' statistically expected to occur only once every 10,000 years. To maintain the current safety standard while preparing for climate change and sea level rise, it is expected that the defences will have to be reinforced at a number of sites. At these sites, an exclusion zone is defined to reserve room for future strengthening works. Other building activities in this zone are restricted by law, even if the strengthening works are not expected to be carried out within the next 100 years. These restrictions are not controversial in natural dune areas, but much more so near or inside coastal towns. There it proves to be a challenge to justify to stakeholders (developers, city councils or citizens) that coastal towns cannot expand because the area may be needed for coastal defence works in one hundred years to fight off a storm occurring only once in 10,000 years!

Figure 8 Urban development in unprotected coastal areas.

The example of Egmond aan Zee shows how building activities until 1950 were mostly restricted to the protected area behind the dunes, but investments in unprotected areas in front of the dunes are now ever rising. These areas are most at risk from coastal erosion due to sea level rise.



Climate Research and Water Management

Dutch water managers are now facing a paradox: on the one hand many policy reports – e.g. 'Water Management 21st Century' and the '5th Policy Document Spatial Planning' – state that climate change must be dealt with in water management and spatial planning. On the other hand the Government's official mitigation policy can seem at odds with adaptation plans (see Text Box 8). Nevertheless, Dutch water management and spatial planning organisations did start thinking about, and planning for, strategies for climate adaptation – as is documented in this section. But while the Dutch measures to reduce greenhouse gas emissions are directed 'top down' by dedicated national policy, the adaptation-oriented activities occurred in other contexts and were more 'bottom up', initiated by planning organisations rather than at government level. The necessary scientific input was achieved in the framework of the National Research Programmes.

5.2.2. New questions for climate research

The role of the climate scientists in the issue of 'Climate Change and Water Management' is now rapidly changing. In past decades, the focus was on prospect of *global* climate change and on convincing the general public and policy makers that the issue needed attention. Now, after the acknowledgement that climate is already changing, partly due to human influences (*IPCC WGI TAR*) and e.g. the formulation of the Kyoto Protocol, the scientists orient themselves to new targets.

The need to focus at the regional climate scale

It is widely recognised by climate scientists that the monitoring and modelling of (the effects of) *regional* climate (change) now need much more attention and emphasis. In the Netherlands a new National Research Program will co-ordinate and stimulate both fundamental and applied research in these areas. At the same time the issue of a climate (adaptation) policy is now taken up at a national level by an interdepartmental group (named ICES/KIS), that will assess the Netherlands' water management infrastructure. But the more important challenge for the scientists will be to *communicate* the scientific insights, to really meet the information needs of the user community (see Text Box 5; Text Box 19; Text Box 20) and to assist in policy development based on scientific data.

Change vs. Variability: learning to cope with uncertainties

As we begin to realise, one of the more important aspects of the changing climate may be a possible **change in variability**, rather than the change in average climate conditions. Changes in (the frequency of) *extreme* weather events, such as droughts, severe storms or heavy rainfall events will have more serious effects than underlying changes in the averages. Unfortunately changes in variability and extreme events are even more uncertain and difficult to detect and predict than changes in average climate.

Closer co-operation between climate researchers and water managers

A new assessment of climate change in the Netherlands, which the national weather service KNMI has prepared (KNMI Klimaatrapportage 2002), elaborates on the climate change scenarios of Table 1. This was presented to the user community of water managers and policy makers in a workshop (*"Weather and Water in the 21st Century: Dealing with Scenario's" – 21 November 2002, The Hague*) aiming to clarify the practical *application* of the scenarios, and to establish working relations between the users and the climate scientists. Two important benefits of closer contacts between climate researchers and policy makers are that the first group learns which information is most relevant to society, while the latter group learns about the uncertainties that exist in predictions in climate change – even using the best information and models available (see Text Box 5).

Text Box 11 The WIN-project: a management response to future challenges, including climate change.

It is recognised that both climate change and subsidence will affect the water management of the 'Wet Heart' of the Netherlands. In response a research project, including also interviews, strategy development and discussions, was set up by the Department of Transport, Public Works and Water Management as one of the studies supporting the 'WB21' government position. This WIN (*'Water Management in the Wet Heart'*) Policy Study could be considered 'typically Dutch': an interactive planning process with all of the non-governmental organisations and local and regional authorities involved. The result includes a long-term strategy (for the period up to 2100) and a package of so-called 'no-regret measures' for the short term (up to 2025). The final WIN Memorandum constitutes one of the building blocks for a broad discussion about the future water management in the Netherlands as a whole.

Water management challenges in the Wet Heart of the Netherlands

The 'Wet Heart' of the Netherlands consists of the IJsselmeer area (covering 2000 km^3, including the Markermeer), plus the water management regions that are hydrologically linked to it, such as the Canal regions to the west of the lake. Altogether, the area measures around 10.000 km^3. The IJsselmeer lake itself has many functions: it is the largest storage reservoir for fresh water in the Netherlands, it controls the discharge to the sea from the IJssel arm of the Rhine and from the rest of the Wet Heart area, it has a key ecological function for many species of bird and fish, it is one of the most popular tourist areas, and it also serves as a busy route for navigation. There are also potential threats: sea level rise may cause a rise in lake level and therefore in flooding risk of the surrounding land, that is protected by embankments. The prospect of increasing winter discharges from the Rhine (through the IJssel branch) and from adjoining regional water systems, plus increasing local rainfall, raises the question whether the discharge capacity to the Sea will be sufficient, especially when sea level rise means that the period during which gravity-discharge is possible (at low tide) will be limited. It is foreseen that the current water management system, based on gravity-drainage, may need to be upgraded to a pumping system. However, the expected increase in periodic droughts must also be dealt with. Linked to these issues are questions of water quality and social and ecological development.

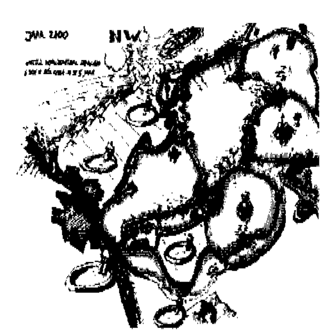
Scenarios for dealing with the prospect of climate change

A WIN-Decision Support System was developed (WINBOS): a series of models (hydrological, hydraulic and other) that shows the consequences of strategies for all of the recognised functions in the Wet Heart. A planned expansion of the pumping station capacity in the canal region (100 m^3 per second) has been incorporated in each strategy; this illustrates how 'water control' is still the basis. ***Three strategies are considered viable:***

Direct Discharge focuses on more efficient discharge and on maintaining the current lake levels. Additional discharge capacity - and eventually also pumping capacity - is required on the Afsluitdijk.

Vertical storage assumes that more water will be stored in the IJsselmeer and Markermeer, causing rising lake levels and necessitating dike raising and strengthening. There are benefits for nature and for freshwater supply. More pumping capacity will be required for the discharge from regional systems.

Horizontal water storage assumes storage of 'excess' water in the surroundings of the IJsselmeer. Areas reserved for this must be protected by new dikes. Lake levels will still rise a little - creating benefits similar to the 'vertical storage' option.



5.3. Recent challenges to the Dutch water management strategy

In short:

- ***The traditional water management strategy is mainly questioned because of A) changing perspectives in society and B) increased awareness that weather- and hydrological extremes still pose risks, after recent extreme events. The prospect of climate change is an additional reason why many water managers are convinced that the basic strategies need to be changed, but it is not the driving factor.***
- ***The new water management policy is defined by the Commission Water Management 21st Century ('WB21') through a national consultation procedure. The policy is described in the report 'WB21' that is now the basis for practical plans. In the WB21 report, several reasons are stated for the change in water management approach: socio-economic developments, 'natural' developments like subsidence, the need to be prepared for current climate variability, as well as the need to adapt to the hydrological impacts of climate change.***
- ***The 'WB21' strategy is still in the planning stage, implementation is only just starting, and many complications can be foreseen in realising these plans.***

The control strategy is being questioned

Water management in the Netherlands, in recent decades, relies almost entirely on water control measures. Most of the country is kept permanently dry using a network of dikes, channels and pumping stations, and water can be transferred in any direction and over great distances if necessary. A great technical capacity, as well as a strong belief in technical solutions, has created a system where water levels, water flows and water quality are controlled using technical means. However, this belief is increasingly tested, and water control strategies are not seen any longer as the only alternative, due to a number of developments:

- Many technical measures have produced unpredicted long-term side effects that have resulted in costs not only to society and nature, but also to the economy. There are examples for each aspect of water management:
  - in flood management, river regulation aiming to provide flood protection has also resulted in higher flood peaks downstream;
  - the removal of riparian zones due to straightening of even the smallest streams has diminished the water system's natural capacity to reduce nutrient loads;
  - and the 'over-drainage in agricultural areas have caused crop-damages and land-subsidence.
- The valuation by society (and decision makers) of different assets has changed: 'technological landscapes' (high dikes, straight canals) have lost popularity, water is not seen as an 'enemy' any longer, and natural, cultural and landscape assets are valued more than in the past.
- At the same time, economists are pointing out that in some cases it is much more cost-effective to accept a certain risk, and deal with an event when it happens (having taken proper preparatory measures) than to try to eliminate all risk at increasing costs.
- Technological developments allow more freedom in choosing alternative solutions. E.g. better river flood forecasting allows timely evacuation, and better understanding of hydraulics and sediment transport allows a more 'natural' floodplain system.
- Scientists in the Netherlands increasingly warn that a degree of uncertainty remains after even the best risk assessment. Therefore, it is not possible to design a technical water control system that is 100% capable of dealing with all eventualities. This was dramatically shown by the (near-)flood events of 1993 and 1995, that seemed statistically improbable and could have had catastrophic effects ('narrow escape').
- These floods and other events have also raised awareness of the deficiencies in the current water management system (see Text Box 6).
- *Last, but certainly not least, there is of course the prospect of* ***climate change*** *and its impacts on the water system. However, at the moment there is less unanimity on the severity of these impacts and the actions required to deal with them than there is on other arguments for a change in water management strategy.*

Text Box 12 Scientific studies: the future of flood risk management is better 'spatial planning'.

Scientific studies: multidisciplinary and long time horizon

It has been noted that the public and politicians tend to see the need for expensive and sometimes drastic changes in water management only directly after a major incident (e.g. a flood; see Text Box 6) and have a short time horizon. On the other hand, scientists and some government planners in the Netherlands tend to have a very long time horizon. This is illustrated by the way scientific studies on the future of flood risk management is taking into account developments over the next 50 or 100 years. The results of a few recent (2000-2002) studies are presented, all of which were considerable and multidisciplinary efforts supported by both research institutes and government organisations. These studies also produced summaries in Dutch and English (and sometimes German, French), in order to reach as wide an audience as possible and thus contribute to public awareness.

IRMA-SPONGE: Towards Sustainable Flood Risk Management in the Rhine and Meuse River basins

IRMA-SPONGE consisted of 13 research projects, involving 30 research groups in 6 countries. The projects were dealing with different aspects (hydrology, hydraulics, climate, climate change, ecology, social developments, flood early warning systems, public awareness, international co-operation) of flood risk management in the Netherlands and upstream in the Rhine and Meuse basins. Four 'main messages' were defined, briefly summarised as:

1. The future brings increasing flood risk, both due to climate change and economic developments.
2. Flood prevention measures taken far upstream can reduce extreme floods only at the local scale.
3. The most effective flood risk management strategy is damage prevention by spatial planning.
4. Flood risk management strategies should be part of integrated development of the river corridor.

Living with Floods: resilience strategies for flood risk management and multiple land use in the Lower Rhine Basin

The goal of the project was to assess the feasibility of several resilience strategies in flood risk management. The hydrological, ecological and social effects of 2 measures were assessed: compartimentalised retention areas and 'green river' flood bypasses. It was found that both strategies are sustainable and are cost-effective in the long term. (see Text Box 17). However, they require considerable investments in the shorter term, and are therefore hard to implement without a long-term financing plan for flood risk management.

Room for the Rhine in the Netherlands – summary of research results

The project looked at flood risk management with a specific focus on its ability to deal with higher sea levels and flood discharges in the future. The main concepts, problems and possible solutions of flood risk management along the Rhine are assessed systematically in a comprehensive 'state of the art' inventory. An important finding is that due to changed insights in flood frequency, dikes would have to be 0.2-0.3 m higher to maintain the target safety level. If the effects of higher discharges due to climate change are also accounted for, dikes would have to be 0.5-0.9 m higher. If a choice is made not to raise dikes even further than at present, there are many alternatives. The three most cost-effective of these are: 1) setting back the dikes, 2) construction of 'green rivers', 3) lowering of groynes.

Spatial Planning and supporting instruments for preventive flood management

An in-depth study was made of legislation in Germany, the Netherlands, France and Switzerland, and of the way this legislation was developed and applied. This to provide insight in the strengths and weaknesses of regulations used in flood risk management along the Rhine, focussing on spatial planning. Conclusion are that A) that regulations and 'spatial planning instruments' aiming to control developments in flood risk areas exist in all Rhine countries, but B) these instruments are not optimised to the specific flood conditions in each area, and C) they are insufficiently used, partly because local authorities give flood risk management only low priority. The use of a clear risk-zoning concept, supported by up-to-date flood hazard maps for the entire Rhine river corridor, would reduce investments in risk areas and enhance public awareness of risks. Despite having by far the greatest surface area at risk of flooding, the role of spatial planning in flood risk management in the Netherlands is no greater than in upstream countries. The fact that insurance in flood risk is not possible in the Netherlands (see Text Box 16) is also seen as problem, contributing to a lack of awareness and planning.

The Commission Water Management 21st Century and the report 'WB21'

When it was recognised at a political level that the traditional water management approach in the Netherlands may not be sustainable, policy makers saw a need for a thorough and objective assessment of the situation. To this end, the Commission Water Management 21st Century ('Commissie Waterbeheer 21e Eeuw', 'WB21' in short) was formed and a nation-wide consultation procedure was started, supported by the Ministry of Transport, Public Works & Water Management and by the Union of Water Boards. The work of this commission is generally considered to mark a turning point in the way the Dutch water management organisations are operating. The report with the conclusions of the Commission, published in the year 2000, has been the basis for a number of reports by water management organisations. Another report that has a strong national effect is *the Fifth National Policy Document on Spatial Planning*, published by the Ministry of Housing, Spatial Planning and Environment, this report is broadly in agreement with the 'WB21' report.

The advice of the Commission was to make some radical changes in water management practices: alternatives to the current 'water control' strategy have to be considered.

The new water management principles advocated by 'WB21'

The 'Water Management for the 21st Century' report gives a good insight in new ideas on sustainable water management, that are now generally accepted by water management organisations. Key concepts are (see also Text Box 9):

- '**Living with water**': the requirements for water management should be a controlling factor in spatial planning.
- '**More space for water**': this means that more space needs to be reserved for water-related functions. At all scale levels, space must be reserved for detention and storage of water. This involves storage areas along rivers and in polders, but also changes in urban infrastructure.
- '**Resilience**' is the keyword in the especially important sector of flood risk management along the coast, rivers and local water systems. This concept is the opposite of 'resistance', which aims at controlling and restricting natural processes. The basis for a resilient water management is that it can deal with, or be adapted to-, future developments that are currently unpredictable.
- **Multifunctional land use** is needed: changes in water management, be it for flood risk reduction, water quality management or water supply, will require changes in spatial planning and, in some cases, current land use. As land is scarce in the Netherlands, land can only made available for new functions if this is done in a context of multifunctional land use: the same area can fulfil 2 or more functions if this principle is applied.
- The WB21 report also urges that a basic concept of such sustainable management is the **'no-regret' principle**. One thing is certain: there are changes not only in the climate but also in the economy, technology and valuation of natural and cultural assets – the degree of change, however, is fundamentally uncertain. This means that we can not fully predict what will be required from the water management system in the future, and therefore we have to leave room for future generations to make further modifications without regretting our present modifications.

Implementation of the WB21 recommendations

The WB21 report strongly advises that a new approach must be implemented not only by the Government but also by other organisations which are responsible for Water Management: Water Boards, Provinces, Municipalities. So far, these organisations have generally responded positively to this advice, and translated it into practical plans for their particular water sector.

Wide support from water management organisations enhances the chance of implementation of the WB21 recommendations, but does not guarantee it. This new approach has major implications for society: on the positive side, there will be more space for nature development in our direct living environment (see Figure 11), and more long-term safety; on the negative side there will be economic costs and people may have less freedom in using the land as they wish. While the WB21 strategy can only be successful if it is widely supported, it is easy to see that many proposed 'room for water' measures will meet opposition: after all they require Water Boards, municipalities and individuals to agree and co-operate with periodic inundation of farmland, and to agree on building restrictions.

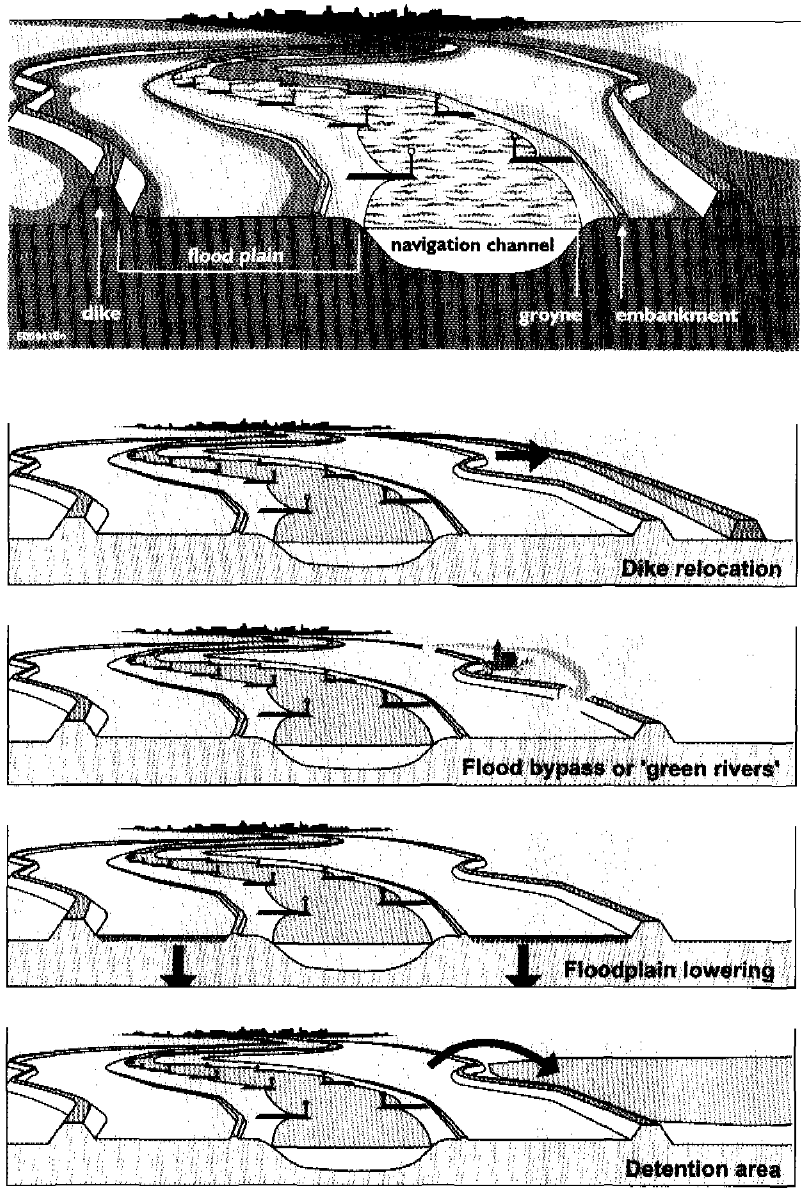


Figure 9 "Room for Rivers' measures now considered in flood risk management.

The effects on safety and other factors of a number of 'room for rivers' measures are now considered. Dike relocation measures have already been taken at a small scale. The first three measures create additional discharge capacity for flood peaks; the first two of these do so by increasing the flooded area: with dike relocation, the current floodplain is widened, while 'green rivers' are, in fact, new floodplains through what are currently polder areas. The 'detention area' measure will also require polders to be occasionally flooded, but in this case the goal is water storage for 'shaving' of flood peaks.

In the belief that better information will lead to better understanding and ultimately more support, increasing attention is given to public participation and awareness building (see Figure 10). However, it is also true that public awareness and participation are still very limited (see Text Box 10; Text Box 15).

5.4. Climate adaptation actions in Flood Risk management

In short:

- *In 'WB21'-oriented flood risk management strategies for all types of water systems, the keyword is 'resilience', as opposed to the traditional 'resistance' strategies. Management strategies should aim to follow natural – water and sediment – dynamics ('room for water'), not just try to control them. Where possible, 'water storage' functions should be combined with other functions (multifunctionality; 'living with water'). Risk management should not just aim to reduce the probability of flooding, but also the potential damages. This requires a different approach to spatial planning, which in turn requires stakeholder participation.*
- *In coastal flood defence management, the need for climate adaptation is not an important factor in current 'official' plans. Although the organisations involved are increasingly aware of the potential severity of the problem caused by sea level rise and increased storm activity, the economic interests are too great – and the consequences of a sea-flood disaster too dramatic – to publicly consider a drastic change in management approach. A particular complication is that of rapid urban development in unprotected areas, in front of the coastal defence. It proves difficult to convince local authorities to limit such development.*
- *The flood risk management approach along the main rivers has been intensively assessed and discussed in recent years; many experts and management organisations agree that the traditional 'control' approach is not sustainable in the long term, for reasons of safety, economy and ecological management. The new approach aims to achieve resilience by creating 'room for rivers'. The prospect of climate change is often explicitly stated as an additional argument for the need for change, but the safety targets have not been changed to reflect the prospect of higher peak discharges in future. Plans to adapt flood risk management are far ahead of actual developments: 'room for rivers' measures take space that is already very scarce in the Netherlands, and are therefore controversial. Only relatively small-scale 'room for rivers' measures like dike relocation and floodplain lowering are already being implemented at several locations.*
- *Organisations dealing with flood risk management in regional water systems are reconsidering the traditional approach in a similar way as river managers: a 'room for water' approach is favoured for many reasons, one of which is the prospect of an increasing frequency in extreme rainfall events, leading to inundations. Plans are made to increase local storage space and decrease the vulnerability of urban areas to flooding. Some small-scale initiatives are being realised, but it remains difficult to find space for these measures at a large scale.*

Even though the Dutch authorities are actively promoting integrated water management, flood risk management is the aspect that will always receive most attention, simply because the national safety is involved, rather than 'just' economic and ecological assets.

5.4.1. The goal of flood risk management

Before discussing the actions taken and planned by flood risk management organisations, in preparation of climate change, it should be made clear that the goal of these organisations is not just "to control floods and prevent flooding", as it is sometimes seen. Instead, the goal of flood risk management is best defined as: *"to minimise flood risk by implementing measures that reduce risk most efficiently"*. It is important to realise that flood risk is therefore not just a result of the probability of flooding but also a function of the damage due to flooding. Therefore, **flood risk management can aim to reduce the probability of flooding** (through flood control or prevention), **or to minimise the potential damage** (through adaptation and mitigation). It is increasingly accepted in the Netherlands that flood risk management should be a combination of both, which means a shift away from the traditional (20^{th} century) emphasis on flood control, and towards resilience.

Text Box 13 The Water Check: a tool for implementing integrated water management.

Background of the 'Water Check'

In order to make sure that the 'Water Management 21st Century' strategy is truly implemented, it must be ensured that water management measures taken from now on, at all spatial levels, fulfil the basic requirements of the strategy. To this purpose, a set of guidelines called the Water Check ('Watertoets') was developed and accepted by the Dutch Government (several Ministries), Provinces, Municipalities and Water Boards, in 2001. Not only water management organisations, but also spatial planning organisations are expected to use the 'Water Check' when planning and executing projects. Although not specifically aimed at climate adaptation measures, the 'Water Check' may be a basis for such measures when they are needed – especially at the regional level.

Goal of the Water Check

The basic philosophy behind the Water Check is "take care of water problems 'near the source'; don't transfer them downstream" (see Text Box 13). Too often have water problems, be it floods, pollution or water shortages, simply been left for the downstream neighbours to deal with. Often, the resulting problem is worse than if it had been dealt with near the source.

In practical terms, this philosophy translates into the recommendation to "first consider water retention (at the source), then storage (as close to the source as possible) and only then discharge (allowing water to flow downstream)". This recommendation can be applied in several ways:

- In local water systems such as polders: adapt to rising water tables due to intense rainfall, then try to store excess water within your basin (by creating reservoirs or modify ditches), and only then consider discharging it to the national water system where it can create problems elsewhere.
- In flood risk management: try to prevent a flood wave from developing, then try to store it in basins, and only then try to move it downstream as quickly is possible.
- In water quality management: pollution must be removed from water near the source.
- In water resource management: rainwater should be retained in agricultural areas in wet periods, so it will not be necessary to transfer water from elsewhere in dry periods.

Use of the Water Check

The Water Check consists of guidelines for each phase of decision making in spatial planning: information, advise, assessment and decision. It is expected that especially the 'early information' function can benefit the decision making process in two main ways:

- Improved management: in each planning document specifying a measure or plan, there should be a 'Water Paragraph' which motivates the decision with regard to the water management aspects. The advice of the local water manager should be explicitly taken into account.
- Mitigation and compensation: in some cases, negative side-effects can not be avoided. In these cases, application of the Water Check should provide a basis for fair mitigation or compensation measures because it should ensure that negative effects are identified and quantified in clear terms and numbers.

Implementation of the Water Check

As the Water Check has only recently come into use as a national spatial planning instrument, the experience of the users is insufficiently documented to assess its effects and efficiency, or the possible benefits it will generate in practice for climate adaptation.

A flood risk management strategy can only be truly sustainable if A) it provides sufficient safety now and in the future, if B) it is cost-effective, and if C) it finds a widely acceptable balance between the restrictions imposed by flood risk reduction measures on the one hand, and the conditions needed for economic, social and environmental development in areas at risk of flooding on the other hand. The 'ideal' sustainable flood risk management strategy may not be the same for every region: not only may there be physical differences between regions, but there are also important cultural, economic and ecological differences.

5.4.2. The coastal system

Present measures and policy development

A comprehensive policy on how to deal with sea level rise and maintain the legal safety levels has been in development since 1995. The present national policy on coastal protection aims at maintaining a coastal defence system (dikes and dunes) with a fixed safety level (defined in the second half of last century, as part of the 'Deltaplan' works), and at limiting coastal erosion. The latter approach is based on the principle that the resilience of the Dutch coast can be maintained partly by natural processes of sand transport by wind and waves. The net sand loss along the coast is compensated with sand nourishment from further offshore.

It is expected that where the coastal protection consists of wide natural dune areas, sea level rise will be compensated by natural processes. Additional policies are developed to maintain the legal safety levels in areas where the sea defences are narrow, man-made or in areas where natural processes are disturbed like coastal towns and harbours. Increased urbanisation of the Dutch coastline during the 20th century has decreased the total length of 'natural coastline'. Especially since the 2nd half of the 20th century the urban development has concentrated on the sea front itself (see Figure 8; Text Box 10), often seaward of the coastal flood defence system, in the zone that is not protected by legal flood safety standards. This development complicates coastal flood defence policies in two ways:

- Firstly, the penetration of urban areas limits the natural resilience of the coastal defences, as well as the engineering options for strengthening the flood defences.
- Secondly, the capital investment in the unprotected zone has risen to a level where potential damage may become politically unacceptable and may call for additional protective measures. Calculations based upon a scenario of 1,60 meter sea level rise in the next 200 years resulted in the identification of a number of "weak links" in the coastal defence system and the identification of coastal towns where property may suffer from storm damage.

Policy options

Plans to reduce the risk of storm damage or flooding can be divided into plans involving constructions inland or seaward. Inland plans are an acknowledgement of the fact that the coastline has receded over the last centuries. The plans involve little disturbance of natural processes, but may drastically affect human activities and properties. Seaward plans, reclaiming land from the sea fit within a long Dutch tradition. Extra space is created for sea defences without affecting the present activities and properties. The plans may influence the natural dynamics of coastal processes on location or further down the coast.

It is no surprise that developers and local politicians favour seaward plans. These safeguard present investments and may even provide extra space for new economic activities and high quality housing areas. Only in areas with a low population density is the landward option seriously considered. Residents often have mixed feelings about these options: they fear further erosion of the coastline if the landward option is chosen, but seaward expansion will also greatly alter their surroundings. From a national and long-term policy level the seaward plans involve a higher level of uncertainty in terms of cost, maintenance and sustainability. It is thought by many that any seaward strengthening will be followed by a seaward expansion of coastal towns, leading to a repetition of the present discussion in 20 years time.

Text Box 14 Example of Implementation of 'Room for Water' measures by a Water Board

Water Management for the 21st Century: Basin Visions and Water Tasks for 2015 and 2050
In preparation of the implementation of the changes in water management advised by the Commission Water Management 21st Century ('WB21'), 'Long Term Visions' are prepared for all basin areas in the country. Such a 'Vision' consists of 'Water Tasks' ('wateropgaven'): problems are identified, measures defined and the costs determined for two time horizons: 2015 and 2050. For the 'Achterhoek-Liemers' management area, the Water Board 'Rijn and IJssel' has done this in co-operation with the Province of Gelderland. The goal is to develop sustainable, resilient regional water systems in urban and rural areas. Three types of Water Tasks can be distinguished: those dealing with 'safety & inundation', with 'wetland development' and with 'water supply'. The Water Tasks aim to alleviate the current problems, in this case: heavy rainfall now causes extensive inundations, many wetlands and other nature areas have dried out, periodic water shortages cause damage to agriculture and water quality (both in ground- and surface water) does not meet environmental standards.

Water Tasks for the 'Achterhoek-Liemers' basin area
The priority in 'Safety and Inundation' Water Tasks is to store water upstream, 'near the source'. Apart from reduction of 'local' inundation events, assuming a certain climate scenario for 2050, the target is also to reduce peak discharge from regional streams to the IJssel river by 25%. The most important measure is to double the width of channels and ditches, while also making them shallower. This also contributes to ecological targets and water supply targets (the latter by raising groundwater levels). The area needed for this measure is 2000 hectares. In addition, 4900 ha of storage space is needed in detention areas away from the streams. The latter can not be combined with land-use intensification (urbanisation, some forms of agriculture), that clearly must be regulated and restricted. It is therefore essential to identify future detention areas as soon as possible and 'protect' them by planning law – this process has only just started.

Local authorities co-operate in the 'reconstruction process'
The planned measures are implemented in co-operation with municipalities, as part of the 'reconstruction process' which aims to optimise water management practice as well as other functions in the basin: agriculture, nature, recreation, urbanisation. As water detention can be combined with other functions, good spatial planning is as important as water management itself. Although there is broad support for the principle of 'integrated' water management and spatial planning approach, implementation will not be easy in practice as municipalities tend to see the 'water management' component as a 'Water Board problem'.

Detention areas: a traditional component of water management
Many ideas proposed by the Commission Water Management 21st Century are not new but build on existing concepts. In the Achterhoek Liemers area, several 'detention areas' already exist that provide 'room for water' during peak discharge events. Six of these can be considered 'large' at the scale of a regional water system: between 45 and 210 hectares. Although this is only a fraction of the 4.900 ha planned, they are good examples for development of new areas. Two of the existing areas were constructed in the late seventies, to decrease flooding in vulnerable areas downstream. Both consist of agricultural land with some recreation land, where flooding will cause far less damage than in the downstream areas. Four other have received 'detention area' status simply because they flood regularly and naturally, without human intervention – the only management action taken is to <u>not</u> protect them better against flooding.

Operational rules for existing detention areas
Only the upstream constructed detention areas are 'controlled'. Here, the Water Board is allowed to flood (and empty) them according to a set of rules agreed upon by all stakeholders. A financial compensation is given for agricultural damages after each flood; in one area, a one-time 'lump' sum compensation was agreed upon when the area was designated as 'detention area'. Damages to buildings and investments are assessed and compensated after each event. No inhabitants were relocated. In some cases local flood defenses (embankments, artificial hills) were constructed to protect existing buildings, livestock etc. Land use regulations in controlled detention areas consist mainly of building restrictions. Such restrictions also apply for the 'natural' detention areas, but no compensations for flood damages apply here.

While opinions on the best strategy may be different, most parties agree that, in a densely populated Netherlands where space is at a premium, strengthening of the sea defences should simultaneously serve to boost the "spatial quality" of the area. This may be done through the combination of defences with ecological zones, or through other multifunctional use of space. This does however create a new problem. For the realisation of integral plans, especially for the strengthening of larger weak links, funding would have to come from different ministries. This would require the identification of the specific contributions to the budget for safety, infrastructure, nature, recreation etc., a difficult matter that can only be solved at a political level.

Actions taken
From the above, it is clear that few true 'resilience' measures have been implemented in coastal protection. There are some locations where sea water is allowed to intrude to within the coastal defence system, by breaching the first row of dunes or by allowing sea water to pass a dike, but this is only an option if a second row of dunes or dike is available. No actions are considered where larger areas would be allowed to be flooded. Also, no regulations to restrict building activities in unprotected coastal zones have yet been implemented.

5.4.3. Main Rivers: Rhine and Meuse

Of all aspects of water management in the Netherlands, flood risk management along the Rhine and Meuse has been discussed and studied most in recent years; these activities were triggered by the 1993/1995 floods and near-catastrophes. Along the main rivers, the present flood risk management strategy aims at providing equal safety levels for all areas protected by dikes, by fully controlling floods. Along the Rhine, this target safety level is 1:1250 years, which is high by international standards. However, in recent years, this 'control' flood risk management aim is questioned by many: some consider it ecologically unsound, others too expensive in the long term, and still others not safe enough in view of the events 1993/1995 and the prospect of increasing peak discharges due to climate change. Moreover, many experts now acknowledge that further improvement of safety through technical measures may be hard to achieve in view of increasing peak discharges due to climate change. In fact, it is stated by some that the unwanted effect of sticking to a uniform and very high safety level is that discharges above the design discharge may cause flooding *anywhere*. If controlled flooding is not allowed at any location, the course of events is fundamentally unpredictable instead of fully controlled.

In response to these concerns, many aspects of flood risk management have been assessed - as part of the national 'WB21' study (which, though looking at <u>all</u> aspects of water management, was triggered largely by the 1993/1995 flood events), but also in other contexts.

Before discussing the actual measures that are now considered or implemented, it helps to list the sometimes confusing number of measures and instruments that is available in flood risk management. By <u>type</u>, **six categories of measures** (and policy instruments) can be distinguished (other groupings are also possible):

- <u>Technical</u> measures (dikes, river regulation, detention basins, land use change, etc.).
- <u>Regulatory</u> instruments (land use planning, land use zoning, legal instruments).
- <u>Financial</u> instruments (burden sharing, subsidies, financial compensation, insurance).
- <u>Communicative</u> measures for awareness raising (brochures, DSSs, meetings, etc.).
- <u>Preparatory</u> measures (flood forecasting and warning and emergency plans).
- <u>Emergency</u> measures (crisis management, evacuation and local emergency protection).

When developing flood risk management strategies, different types of measures can be combined. In the Netherlands, **4 'best strategy' options** are often discussed:

1. Flood **generation prevention**: according to some, the development of disastrous flood waves can be prevented in some cases by reduction of surface runoff into streams (mainly through land use changes), by reducing the speed of flood waves in tributaries (e.g. through restoring meanders and floodplains upstream), and potentially by desynchronisation (aiming to let flood waves from tributaries arrive at different times, this is a technical measure with a very uncertain result).

Text Box 15 Research: limited role for public participation in changes in water management

The need for public participation in change management
The fact that consensus, i.e. broad support from society, is needed for implementation of the 'Water Management 21st Century measures' in the Netherlands means that 'public participation' should be a priority amongst policy makers: **Integrated Water Management requires Integrated Policy Making.** The way in which this is achieved is one of the subjects of a research project briefly (and selectively) summarised here: *'Integrated Water Management in Rural Areas'* that is now concluded by the research institute Alterra (Balduk, 2002 in press). The study focussed on A) how management decisions are the result of co-operation between government organisations and of public participation in three actual recent cases, and B) how the new 'WB21' water management principles, that seek to integrate water quantity management and spatial development, play a role in policy processes and decision-making for rural areas. Such a study is needed because *"knowledge of the participatory approach, that should be the basis of the Integrated Water Management practice and the WB21 principles, is far less developed than knowledge of technical aspects of water management."*

Still a lack of co-operation, communication and public support
Implementing changes in water management often depends on efforts and co-operation at the *regional* level: Provinces, Water Boards and Municipalities. It is concluded that these efforts and co-operation are developing only slowly, causing **delays in planned activities.** There are several reasons for this:

- Commitment to the 'WB21' principles is limited to organisations at central government tier and to a lesser extent provincial government, municipalities and the general population are less involved and therefore less supportive. An important lesson therefore is that **true Public Participation is very limited**, even when Stakeholder Participation is happening.
- Both top-down and bottom-up feedback mechanisms in policy making are not utilised at all.
- NGOs are only involved in the implementation phase, when decisions were already taken.
- Integration is hampered by a lack of knowledge within the parties involved, on decision-making processes as well as on the division of competencies and responsibilities.
- Provinces that should 'direct' these processes, and the Water Boards that should implement them, have a different perception of the speed of decision making required. Water Boards lack knowledge of land-use policies and current spatial development needs of society.
- Involvement, awareness and knowledge on water management at the municipal level is especially limited; this is an important factor in the implementation of measures.

Progress and opportunities
However, it is also concluded that some real changes are taking place, and that solutions for the observed stagnation in policy making and implementation of measures are available:

- There is increasing awareness amongst stakeholders that new, integrated, water management measures also require a new, integrated, approach.
- There is a **shared will to develop management plans on a basin basis** involving interregional co-operation, instead of an administrative basis.
- Especially decentralised governmental bodies have shown to be effective in bridging regional differences in water management, in order to achieve integrated management.
- Co-operation between stakeholders is increasing, and this is resulting in **conflicts of interests becoming more transparent**, a crucial step towards solving them.

2. Flood **control**: once a flood wave has developed, the risk of flooding can be reduced by minimising the inundated area (through dikes) or by enhancing discharge (through river regulation measures). This strategy relies heavily on technical measures.
3. Flood **resilience**: this is an integrated 'adaptive' strategy which aims to reduce overall risk by 1) creating more room for rivers (by dike relocation, detention basins, river bypasses), 2) accepting a higher flood probability at specific locations, where 3) a flood damage mitigation strategy can be applied.
4. Flood **damage mitigation**: when it is accepted that a significant probability of flooding always exists, many measures are available which reduce the damage potential of floods. A fundamental step is to accept flood risk as a basis for spatial planning, so investments and urbanisation can be steered away from the areas most at risk (using regulatory and communicative measures). Damage can be reduced further by improving the response to floods (using communicative, preparatory and emergency measures). Finally, the burden of the remaining damage can be taken away from individuals by financial compensation and/or insurance).

Measures taken since 1993/1995
The first response to the floods was to further control the rivers: along the Meuse embankments were raised at a number of locations where villages had been inundated, along the Rhine dikes were raised and strengthened in a number of 'weak spots' that had been close to overflowing or collapse. However, some other types of actions were also taken:

- The flood early warning system for the Rhine was upgraded and continues to be further developed. The latest version of the FloRijn forecasting system, which will be operational in 2003, has a lead time of four days at the German-Dutch border where there were two before, and this forecast is far more accurate than before as it is based on the latest hydraulic and hydrological models of the entire river basin.
- Emergency measures were also further developed after being 'tested' by the mass-evacuation of almost 250,000 people in 1995.
- The co-operation with the countries upstream of the Netherlands was strengthened. A notable example of this are the activities within the International Commission for the Protection of the Rhine (the ICPR Flood Action Plan; Text Box 3) and the IRMA program (INTERREG Rhine Meuse activities; Text Box 12). These have certainly improved the knowledge base and the degree of understanding, especially between Dutch and German organisations.
- The amount of 'official' publicity on flood-risk related measures has greatly increased through folders, web-sites and discussion meetings.
- It is now recognised at Government level that the allocation of large areas called 'calamity polders' for river water storage, in order to 'shave' extreme flood peaks that exceed the design discharge, should be at least considered, despite the opposition of local stakeholders. A commission was appointed to look at the possibilities and to propose concrete locations. The 'Commission Luteyn' (as it is commonly known, named after the chairman) has identified 3 suitable polder areas near the German border. An 'official' Government position is expected by the end of 2002.
- Furthermore, a great number of studies were initiated in the late 1990s, many being completed in 2001 and 2002 (see Text Box 12).
- Some relatively minor 'Room for Rivers' measures (mostly dike relocations) have been implemented.

Most of the activities listed above concern studies, publicity and plans. While a majority of scientists and planners appears to favour a shift from 'control' towards 'resilience' and 'mitigation' strategies, and the effects of resilience measures are now seriously studied (see Figure 12), few of these plans have yet reached the implementation stage. Care must be taken that progress will not slow down, to make sure that the 'WB21' policy will actually be implemented in an effective way. Examples of some key measures in river management – needed according to the 'WB21' advise – that are far removed from implementation are:

- Insurance against flood risks – which is seen as an important financial instrument to steer investments away from areas at risk and to enhance public awareness of flood risks - is not likely to be realised in the near future (see Text Box 16).

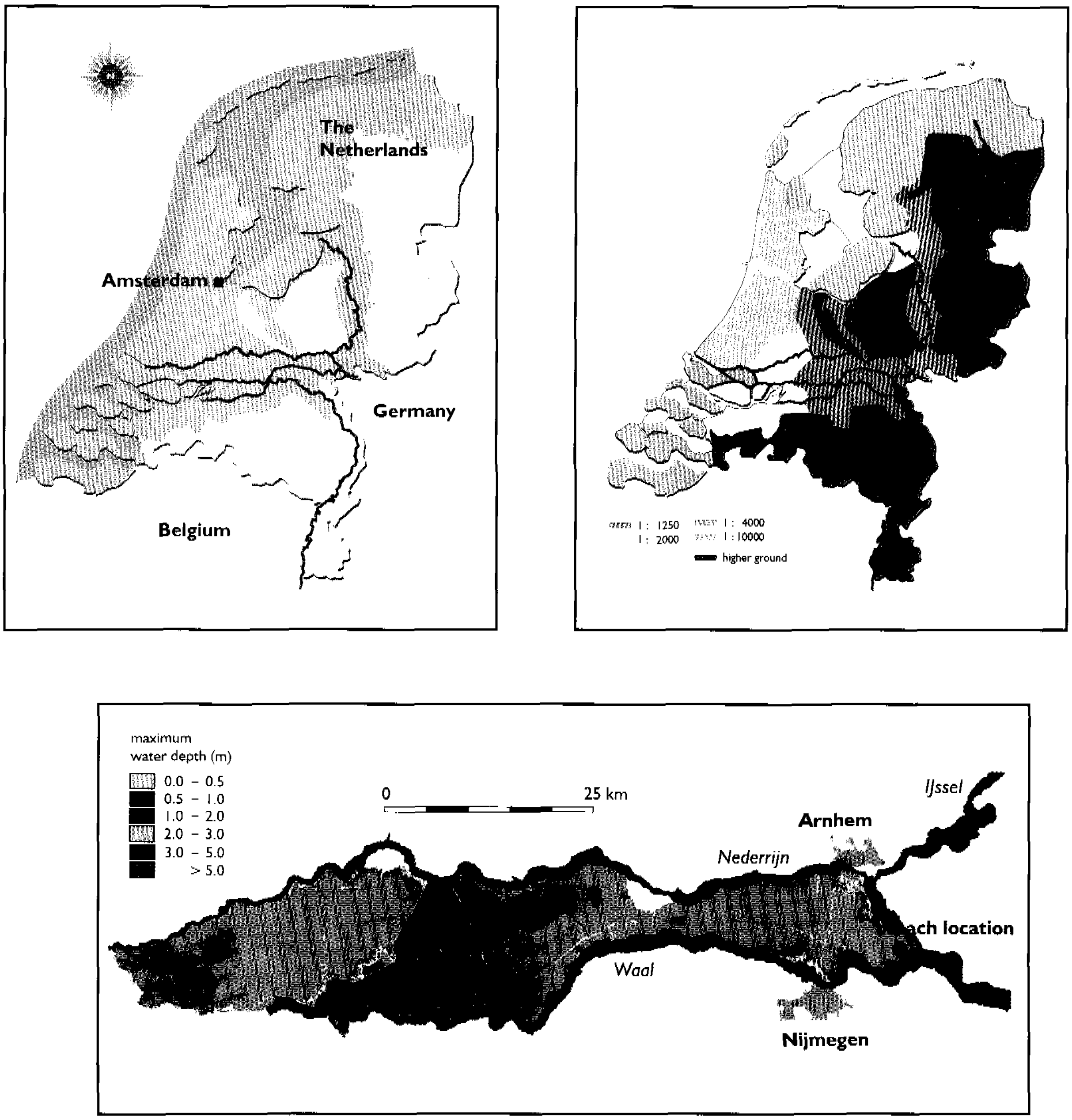


Figure 10 Raising public awareness by showing the flood risks.

One reason why public participation is lacking is that people simply are not aware of the real risks of flooding. Maps of flood risks are an important tool to change this.

Top: In order to raise public awareness, water management organisations now publish maps not only showing the area threatened by flooding from sea or rivers (top left), but also indicating the safety level which flood protection works are designed to provide (top right).

Bottom: A next step in public awareness raising is to show the consequences of what could happen if the flood protection system does not provide the required safety, by predicting the flooding patterns. This can be done using computer simulations. Shown is the modelled maximum water depth during a flood in the Betuwe area along the Rhine, after a dike breach during peak discharge of 18,000 m^3/s; this is well over the currently projected 1:1250 year discharge of 16,000 m^3/s, but climate change could make this scenario more likely. (Source: Living with Floods study).

- The debate on the 'calamity polders' is still ongoing – and stirring so much controversy (see Figure 7) that a Government decision, let alone implementation, seems unlikely in the near future.
- The implementation of many 'Room for Rivers' measures in general is still under discussion – some experts argue that dike raising is more cost-effective, others that further measures of any kind are unnecessary until climate change is really shown to result in higher peak discharges. In many cases, there is local opposition: stakeholder participation and public participation are very limited (see Text Box 15). As a result, implementation op these measures is only taking place at a limited scale (see Text Box 22). Similar measures upstream in Germany are also delayed (see Text Box 3).
- Also, there is only limited evidence of flood risk maps being used in practice for spatial planning along rivers; this is a precondition for a successful 'flood risk resilience strategy' and for true 'integrated river management'.

Results of recent studies into flood risk management issues

From the above it follows that while the practice of flood risk management still relies heavily on flood control measures, a resilience-oriented approach is being studied and advocated by many organisations. Although these studies cover a wide range of subjects and do, of course, sometimes yield contradictory results, it is possible to distinguish some viewpoints that are widely held by experts, and supported by organisations .Most are in line with the WB21 findings (see also Text Box 12):

- Many measures that create 'room for rivers' will have positive effects for both flood risk management and nature management (see Figure 11). Combining flood management functions with ecological functions fits well with the aim of the government (i.e. the WB21 report) to promote multifunctional land use (see Figure 12). Examples are 'floodplain lowering' that creates more vertical discharge space, dike relocation' that does the same laterally, and 'green rivers' that create space for peak discharges outside the current river floodplains (see Figure 9). However, many of these alternative measures not only take more space but are also more expensive. Therefore, they will only be favourable when the costs and benefits over long time period are considered (see Text Box 17). From this perspective, the current **time horizon for decision making is too short**.
- Flood risk is insufficiently taken into account in **spatial planning**. The feeling of safety created by the full flood-control strategy results in a lack of awareness, amongst spatial planners and the general population, on the implications of flood risk for investments. As a result, investments (in urbanisation and other types of land use intensification) continue in areas that are at risk of flooding, especially in areas protected by dikes (see Figure 12). Not only does this increase the flood risk (which is a function of both the flood probability and the potential damage) but it also rapidly, and often irreversibly, reduces the room available for implementation of 'resilient' flood risk management measures, such as compartmentalisation for retention or 'green rivers'. This limits the opportunities for a future development of a sustainable flood risk management strategy for the whole lower Rhine River. The situation along the lower Meuse River is similar.
- Though there is now an official recognition that flooding is a real danger, there is not much openness on the degree of risk existing in individual areas. Several studies recommend application of the **risk-zoning** principle, linked to regulatory measures, to increase awareness of actual flood risks and discourage investments in risk-prone areas.
- Financial instruments that aim to reduce flood damage are insufficiently used. In fact, it is impossible to be insured against flood damage in the Netherlands (see Text Box 16), though **insurance schemes** have proven to result in very effective flood damage reduction elsewhere (e.g. Switzerland).

Text Box 16 Insurance against flood damages in the Netherlands – a difficult issue

Flood damage in the Netherlands: potentially huge but traditionally uninsurable

Flooding, that can be caused by inundation from the sea, rivers or failing drainage systems, can result in extensive damage to property, crops and productivity, apart from the negative impacts on human welfare. The potential direct material loss (that is: without business interruption) in areas at risk of flooding by the Rhine river alone is approximately 130 billion Euros (2001; ICBR figure). The 1953 Sea-flood disaster in the Southwest region of the Netherlands killed 1835 people and caused extensive property damage. At present, however, insurance against sea and river flooding is not possible in the Netherlands, as this peril is not covered by regular Property policies (both for Buildings and Contents). The Association of Insurers ('Verbond van Verzekeraars', VvV), which represents most Dutch Non-Life Insurers in the Netherlands, has maintained for decades that flood damage is uninsurable because of the risk of unknown accumulations of damages: as the extensive dike protection system provides uniform safety levels for all areas along the rivers (1:1250 years) and the coast (1:10.000 years), it is not known which, and how many, areas will flood eventually. Also, reinsurance coverage has been assumed to be difficult to arrange and overly expensive.

Discussions on best approach, following recent floods

Not long ago, there was a nation-wide discussion on the absence of flood insurance coverage in the Netherlands, following a series of (near-) flood events. Total direct damage in 1993 amounted to €107.0 million (1993 figures) and in 1995 almost 250,000 people had to be evacuated. Fund raising events had to be organised to collect money to compensate people who had suffered losses. In the end, much of the cost was covered by government organisations. By early 1995, the entire insurance industry was involved in finding an alternative solution, and several issues and options were considered:

- Should all policyholders contribute, or only those in areas at risk?
- Should only property losses be insured, or business interruption losses as well?
- What is the best mechanism for collecting premiums, in order to build up a fund?
- Who would be the ultimate treasurer of this fund?
- What would be the (remaining) role of the Government?

An alternative insurance solution was found, and rejected by the Supreme Court

In 1995 is was agreed, between the Ministry of Finance and the 'VvV', that a 'Flood Insurance Coverage' fund would be set up (approx. €240 million), for which special premiums of approx. €10 per Property policy would be charged for a number of years. The Government would manage the fund together with the Insurers. This insurance solution also works for floods in France, and for earthquakes in New Zealand. A surcharge on all Property policies (meaning that every policy holder in the Netherlands would pay) is needed to avoid 'anti-selection': if only the people and/or companies in regions at risk would take out a flood policy, spreading of the risk (an insurance objective) would not occur and the insurance premium for Policy holders at risk would get proportionally higher. This agreement was rejected by the 'Hoge Raad' (the Supreme Advisory Court of the Dutch Government) on the grounds that it is against basic democratic principles to oblige people to pay premiums for insurance coverage they are not likely to benefit from.

Present situation: the Government pays

Because the public demand for a damage compensation solution remained, the Finance Minister eventually decided to set aside an amount of approximately €450 million out of general means, to cover future flood losses. So instead of having an insurance solution in conjunction with the VvV, there is now a political construction, without further involvement of the insurance companies. A recent proposal for insurance of crop damage due to extensive rainfall illustrates the complexity of the issue: a maximum damage of €50 million is covered by a mutual insurance company and the government covers damages between €50-€100 million. Damages exceeding this ceiling would not be covered. However, this solution is not yet approved by the Dutch Government, and some think the European Union may object because the partial Government insurance coverage could be seen as a subsidy. Achieving a solution for floods, where potential damages amount to tens or even hundreds of billions of Euros, will be far more complex then this!

There is increasing support for 'resilience' strategies at the academic and decision making level, and a number of clear advantages over the present flood protection strategy are now widely recognised. However, a move away from 'full flood control' strategies to 'resilience' strategies requires support at the local and regional levels which would have to implement it eventually, and creating this support may require considerable effort (see Text Box 15; Text Box 21). When explaining alternatives to the current strategies it should be stressed that:

1. The core of *any* future flood risk management strategy will be flood control, and maximum flood protection for most areas. Increased flooding can only be allowed in some areas.
2. The room needed for resilience measures is not permanently lost for human land use or other (e.g. ecological) functions, as it is *only temporarily and/or incidentally* needed for storage or discharge of floodwater. In some cases, shared land use can bring economic benefits to local communities, e.g. by stimulating recreational functions in agricultural areas.

5.4.4. Regional water systems

Local stream catchments on the sand plateaux

Due to the infiltration capacity of the sand plateaux, floods in local streams are not common, and they are never very large or life threatening due to the small size and low gradient of the local catchments. Traditionally, only little flood risk management has taken place in these areas. Nevertheless, they have the potential to cause considerable economic damage and inconvenience, which is expected to increase due to increasing local rainfall intensities.

At present, many local water authorities are working on 'river basin visions' where flood risk management measures are integrated with other aspects of the water management (water quality, water supply), following the advise of the 'Commission 21st Century'. One proposed measure is to increase upstream water retention by blocking drains, thereby also reducing the chance of crop losses due to water table lowering. Another measure is to restore the original meanders of streams. Detention areas are also considered (see Text Box 14).

The polders

Like the local stream catchments, most polders are relatively small in size, and flood risk management measures aim to reduce the consequences of extreme local rainfall . Measures to prevent major disasters caused by other water sources are discussed in the Sections for 'Coastal Systems' and 'Main Rivers'. Although not life-threatening, floods due to rainfall can be very damaging in polders, and inundation is a constant danger, for the following reasons:

- Water retention capacity of rural lands is very low due to the permanently high water tables; in urban areas it is even lower because these are 'sealed'. Therefore, water levels in the very intensive drainage system will rise rapidly during extreme rainfall.
- Gravity drainage is not possible due to the location below the level of the sea, lakes and rivers: all rainwater than cannot be retained must be removed by pumping stations that, though they are often huge, do not have an unlimited capacity. Obviously, the network of main canals to which the polder water is pumped (the 'boezem', in Dutch) also has a limited capacity: if they receive too much water it will spill back into the polders.
- Most urban areas and most industries are situated in polders.
- In these flat areas with high water tables, a water level rise of 0.5 metre will already mean inundation of many houses and industries; a rise of 1 metre will cause complete inundation of many polders.

Traditionally, the flood risk management strategy for the polders has been one of 'control': dikes are keeping water out, pumping stations remove excess rainwater. To increase the retention capacity, water levels are kept low in winter (when the risk of prolonged extreme rainfall is greatest) and high in summer (when water is needed for crops: an unnatural situation with negative ecological consequences.

Figure 11 Nature restoration as an integral part of a resilient flood risk management strategy.

The 'room for water' strategy also creates room for nature, which has become very scarce in the Netherlands. This link is especially important in plans to increase the discharge capacity by floodplain lowering and floodplain widening through dike relocation; in fact, ecological concerns are a driving factor behind such plans.

In response to recent inundation events in many polders (notably in 1998) and the advise of the 'Commission Water Management 21st Century', a shift towards 'resilience' is considered for the polders, like for the main rivers. Discussions and studies are underway on the feasibility of a number of alternative measures aiming to increase the local retention capacity rather than the discharge capacity: e.g. widening of ditches and creation of 'water storage ponds', which could also have an ecological or recreational function. There are also plans to manage water levels in a more natural way. However, implementing such measures is technically complex and difficult to get accepted politically. Acceptance by the inhabitants of each polder is needed, as they also form a directly elected political 'layer'.

Water management in many regional systems will also be affected by changes in management of water levels in the IJsselmeer. This is currently considered in the WIN study (see Text Box 11).

Actions taken: the Inundation Frequency Standardisation Study
To determine what measures are needed as part of a new inundation risk management strategy in the polders, clear national standards are required, defining the inundation frequency (due to extreme local rainfall) that is unacceptable for each type of land use. Such standards do not exist at present although many Water Boards have guidelines in this respect. An agricultural polder, for instance, will require very different inundation standards than an urbanised polder. For the first land use type an inundation frequency of 1/10y is often found acceptable, for the latter it is clearly not. Determining frequency standards is complicated by the fact that most polders do not only have mixed land use but also more than one potential flood source, e.g. from rainfall and river water. At present, an Inundation Frequency Standardisation Study ('normeringsstudie') is carried out, involving a wide range of stakeholder organisations, to investigate the requirements and possibilities for standardisation. Though this study is future oriented, the prospect of more intense rainfall due to climate change is not the primary goal: the assumption is that if the water infrastructure (and land use) are optimised to provide the required safety during current weather extremes, it will also cope far better with future weather extremes.

Another development that may alter the water level management in polders is the identification of 'detention areas' and 'calamity polders', where controlled flooding by river water will be allowed in order to reduce flood risk in other areas. This measure is also discussed above, in connection with planned changes in flood management along rivers.

5.5. Climate adaptation actions in Water Availability management

In short:

Although probably much smaller than the potential increase in flood risk, the potential impact of climate change on water availability is considered to be serious enough to warrant the development of national policies. However, such policies do not exist as yet, and the issue is not high on the political agenda.

Water shortage problems in the Netherlands
Earlier in this report, it was stated that the Netherlands rarely had water shortage problems historically, and serious droughts are usually not considered a likely outcome of climate change. However, there are growing concerns that the efficiency of the Dutch water drainage system may have actually 'overshot its goal' somewhat: in some areas, water tables have been lowered so much that nature areas are drying out and agricultural crop productivity is lowered: drought damage occurs in these cases. There are also concerns that growing water demand, higher summer temperatures and lower summer rainfall may have more subtle environmental and economic effects.

Text Box 17 'Societal cost-benefit analysis' as part of a new water management strategy.

Most measures recommended by the 'WB21' Advise have one thing in common: they are expensive in the short term, while many benefits are seen only in the long term or are indirect, as measures also aim to improve natural or societal values. Such **long-term and often 'intangible' benefits are hard to express in monetary terms**, and therefore too often not sufficiently taken into account in management decisions because of short-term and direct budgetary constraints.

Intangible costs and benefits are often forgotten

This dilemma has been recognised for a long time, and some organisations have found ways to somehow explicitly weigh the non-direct benefits in their decisions: varying from attempts to put monetary values on all benefits, to finding out how stakeholders in a particular issue value the items involved. Amongst participants in the Dutch Dialogue, however, it was felt that these methods still have an academic character: they are not easy to understand, do not provide a generic or 'objective' valuation system, and in the end they are rarely the basis for real decision making. It is not hard to find examples of projects where aspects of resilient (long-term) safety, nature protection and landscape improvement were considered a priority during the early planning stages, but sacrificed later because of short-term financial considerations or public resistance. Even though conservation of nature and landscape are now widely considered essential not only for ecological reasons but also for a 'healthy' society, these aspects are still often at the losing end in decision making. Therefore, the search is still on for a true 'societal' cost-benefit assessment method: one that will convince accountants and the public of the need to invest in long-term safety and in natural values.

Living with floods: assessing costs and benefits for flood risk management strategies

An example of an attempt to weigh both monetary and intangible costs and benefits for flood-risk management strategies along the Rhine river is provided by the 'Living with floods' project. The question was: what strategy is preferable from a sustainability point of view?

1. The first step was to express the cost of measures (including maintenance) as well as the damages on an annual basis (the Present Value) so that can they be compared directly.
2. *The second step was to define sustainability criteria, which were intangibles:*

- flexibility: the ability to adjust to changing circumstances and to prevent future regrets.
- effects on and opportunities for economic development;
- effects on and opportunities for nature development; and
- landscape quality: only cultural and scenic qualities, to prevent overlap with nature values.

3. These criteria were given a score (1-10) by an expert team using the so-called Delphi method.

The result was a matrix of measures and evaluation criteria, which could be the basis for decision making. Colours indicate the relative score on each criterion (green = good; red = bad).

Strategy	Costs (€ billion)	Flexibility	Damage (€ billion)	Economy	Nature	Landscape
0. Autonomous Development	*0.9*	*4.1*				
1. Compartments						
a. up to 18,000 m3/s	*1.0*	*6.9*		*5.3*	*4.0*	*5.2*
b. up to 20,000 m3/s		*6.7*	*0.3*		*4.1*	*5.3*
2. Green river						
a. spontaneous development	*8.0*		*0.0*	*3.3*	*7.7*	*6.6*
b. ecological development	*8.0*		*0.0*	*3.4*	*8.0*	*6.6*
c. multifunctional dev.				*5.7*		*6.7*
3. RiverandLand			*0.0*		*8.7*	

Actions taken: The National Drought Study

One of the 'Water Management 21st Century' recommendations was to retain water upstream, as much as possible. This has led to studies into the possibilities of increasing groundwater levels in regional water systems, and in some cases concrete plans have been defined that are now under discussion. Another important initiative was the start of the National Drought Study ('Droogtestudie'): an evaluation of the possibility of seriousness of water shortages in the Netherlands by a broad platform of stakeholders, under supervision of the State, Provinces and Water Boards. Although climate change adaptation is not the main focus of this study, the importance of such changes (up to 2100) is explicitly considered in project documents. The study started in 2001 and will result in the following by late 2003:

1. Protocols for mitigating (government) actions needed in case of water shortage.
2. Recommendations for measures which will reduce the probability of water shortage, or increase the capability to deal with it.

The aim of the Drought Study is defined as "*the realisation of the smallest possible difference between supply and demand of water of the sufficient quality, against acceptable socio-economic costs*". It is recognised that water shortage problems are not uniformly distributed over the Netherlands, but can be specific per region. At this preliminary stage, the most important expected effects by region are:

North Netherlands:	*salinisation.*
Northeast Netherlands:	*dry areas due to absence of waterways for transfer.*
Central-east Netherlands:	*problematic water transfer from Vecht and IJssel rivers.*
East Netherlands:	*limited water transfer options in sloping areas.*
Central Netherlands:	*rarely water supply problems.*
Northwest Netherlands:	*limitations to sprinkler-irrigation; salinisation*
West Netherlands:	*salinisation; water supply is small-scale.*
Southwest Netherlands:	*salinisation.*
South Netherlands:	*limited water transfer options.*

From this list, it is already clear that the main problems foreseen are salinisation and shortages of water for agriculture. Further analysis of the precise magnitude and probability of these problems will be based on the use of models and expert judgement. As the National Drought Study is not finished yet, no concrete measures have been taken. Three types of response-strategies are being analysed, that are summarised as: 'acceptance', 'reaction' (adaptation), 'prevention' (mitigation). The final policy will be a combination of measures of all categories, based on a cost-benefit analysis. In this analysis, social and ecological aspects will also be taken into account.

5.6. Climate adaptation actions in Water Quality management

In short:

Water quality management is currently not taking into account the impacts of climate change, and there are no concrete plans to change this. However, the issue is receiving more attention recently and an inventory study has started.

Will climate change lead to water quality problems in the Netherlands?

The impact of climate change on water quantity (especially floods) has received more attention, both from scientists and from policy makers, than the impact on water quality. Adaptation to climate change does not play a major role in current water quality policies. However, water quality effects of climate change may be more serious than is now acknowledged, for several reasons:

- The lack of research into this issue, to date, may have resulted in an underestimation of the problem. As with other aspects of water management, it may take a 'disaster' (e.g. a dry summer with serious water quality problems) before the problem is studied to its full extent.
- Developments in water quantity management, stimulated by climate change, will have a significant effect on water quality and thereby on aquatic ecosystems and terrestrial ecosystems and wetlands. Examples of water quantity management measures are the plans to retain water as far upstream as possible, to increase water levels in some drained areas, to reduce flushing of regional water systems with river water, and to provide more flooding space for rivers, e.g. by (re-) creating wetlands for flood retention. These indirect effects of climate change are currently not considered.

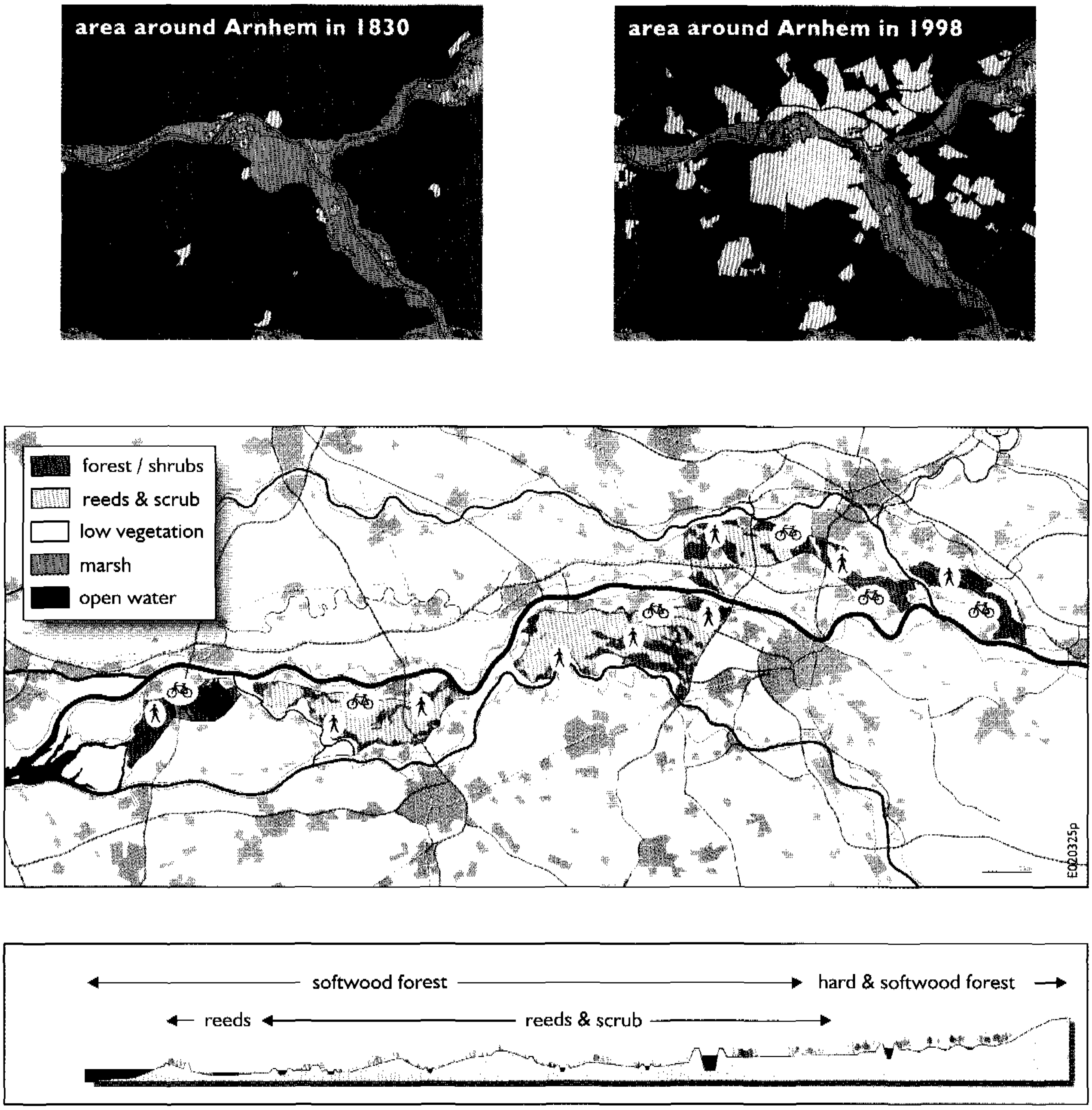


Figure 12 From uncontrolled urbanisation to multifunctional land use.

Top: **In past centuries, the area directly behind the dikes was increasingly urbanised, thereby reducing the potential for 'room for rivers' measures that require, one way or another, that more land can be flooded. At the moment, there are some real 'bottlenecks' along the Rhine where urban areas are in the way of the room needed for improved flood risk management.**

Bottom: **Some of the alternative flood risk management strategies that are studied, such as 'detention areas' and especially 'green rivers', require a full reorganisation of large areas. As space is already scarce, innovative solutions must be found if the interests of habitation, agriculture, nature, industry and industry are to be satisfied. One solution for this dilemma is that of 'multifunctional land use; shown is how this could lead to nature restoration and recreational areas along the Rhine. In this spatial planning scenario, an ecological network is developed alongside use for extensive agriculture, recreation and housing. (Source: Living with Floods study).**

- Finally, the focus of water quality management in the Netherlands is now on compliance with the European Water Framework Directive, which must be implemented in the Netherlands. The purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater, in order to achieve 'good ecological status' for all waters in the European Union. However, little attention is given to the possible impact of climate change on water quality.

Integrated management of water quantity and water quality

An integrated water management strategy, as is the stated goal of Dutch Water management organisations (following the recommendations by the Commission Water Management 21st Century) requires a strong linkage between water quantity and water quality management. At present these two are separated, but water management organisations are aiming to change this as much as possible when considering the effects of climate change. At central government level, the aim is also to adopt a fully integrated approach in the next few years, when management plans have to be defined for all river basins. In some current developments in water quantity management the possible impacts on water quality are already receiving attention:

- Water retention and water quality. If more rainwater is retained near the source, in response to changes in rainfall, this will have an impact on water quality. Water management plans should therefore consider both aspects. Land use planning should also be adapted: some agricultural pollution sources are best kept away from future water retention areas.
- Improvement of sewage systems and water quality. At present, urban rainwater and sewage water are discharged through a single system. With extreme rainfall events, this results in surface water pollution, and separate systems for the two water types are now sometimes built, storing rainwater locally as much as possible. The prospect of increasing rainfall intensities is seen as an argument to build more separate systems.

The National Study 'Climate Change and Water Quality'

In order to get a better understanding of the water quality impacts of climate change, the Ministry of Transport, Public Works and Water Management (through the RIZA institute) has started an inventory study in 2002. The result of this limited study will be used to determine whether further in-depth study is needed.

Text Box 18 Dutch Dialogue workshop discussion sessions

In discussion sessions on 'Facts', 'Measures' and 'Change Management', the key issues were identified that workshop participants associate with these inter-related topics. The aim was to make sure these issues would be sufficiently covered when finalising the report. One common comment was that there should be **more attention for difficulties (and failures) in climate adaptation**. Other outcomes were:

1. Facts: 'which problems do we expect and how serious will they be?'
Issues discussed were: What is the knowledge base (both on climate and on hydrology) for the discussion on the need for climate adaptatio in water management? What are the main uncertainties and knowledge gaps? Are facts interpreted in the right way by those that are responsible for measures? Are we talking about nuisance management or disaster prevention?
The main outcome was that not so much the amount of information on climate change (and associated uncertainties) is the limiting factor in climate adaptation, but rather the way this information is used in water management. The solution is seen in a better (interdisciplinary) **communication between climate scientists and water managers** in the formulation and resolution of climate challenges in water management.

2. Measures: what measures are needed to deal with climate change/variability?
Issues discussed were: Resistance & resilience; Adaptation & mitigation; Regulation & compensation; Flood protection & spatial planning
A first outcome was that not our knowledge of the effectiveness (or direct cost) of measures is the limiting factor in assessing what strategy is best, but our ability to assess (and present to the public) the full benefits in the long term. Therefore, political considerations are usually the basis for strategy development or decisions on measures in water management, not **true cost-benefit analysis**. Important questions are:

- how do we deal with **uncertainties** (in climate and society) when determining future benefits,
- how do we take into account **non-financial** (societal, ecological, cultural) values,
- while doing justice to different **perspectives** on these aspects?

'**Transboundary basin management**' was another issue identified, with an emphasis on flood risk management. There are intensive contacts between the Netherlands and the other main country in the Rhine basin, Germany, but according to some these were more political in nature than truly dealing with optimising management throughout the basin. Here, too, a sound cost-benefit basis is lacking.

3. Change Management: how do we make changes in water management?
The discussion group focussed on how necessary changes can be implemented in government and in the society in general. How do we make sure stakeholders are communicating properly? To what extent is (and should) the public be involved in these climate and water management issues?
Four main issues were defined:
Stakeholder participation is considered the most essential element. The need for a new strategy in water management is acknowledged at a policy level, but when measures conflict with local spatial plans, the process stalls. An earlier and real dialogue with stakeholders would help a smoother implementation.
Public involvement at an early and more conceptual level would also make stakeholder participation easier. Awareness of the issues and of potential measures, and transparency of the policy development process should prevent that an initial lack of interest is followed by resistance in the implementation stage.
Integration of sectors should be part of a more comprehensible and transparent policy development process and would help all parties in making more educated and effective decisions.
Adequate management support systems would provide the information needed to monitor the speed and severity of climate change, especially for less visible effects like droughts.

6. Lessons learnt in the Dutch Dialogue on Climate and Water

6.1. Introduction

This chapter

Earlier chapters in this report were based on published material: only ideas, events and actions that had been documented were described. While this guarantees objectivity – needed because the Dutch Dialogue project aimed to include and represent the Dutch water management sector as a whole – it is also a limiting factor because written material tends to either look back or to describe plans, not current practice. Also, these 'official' publications will rarely critically assess progress or targets. After all, few organisations like to publish their hesitations, problems, or even failures!

In this chapter, the members of the Core Group of the Dutch Dialogue will give their shared views on what we have learnt: in the project, from the discussions and outcomes of the Dutch Dialogue workshop and from our experience in different relevant organisations. Though these views may not be shared by everyone in the Dutch water management sector, we have learnt they are supported by many.

The 'Lessons Learnt' chapter consists of a discussion of the outcomes of the 'Dutch Dialogue' workshop as well as a critical description of the practice of climate change adaptation in water management, as discussed at the workshop.

What is the Dutch Dialogue, with hindsight?

The term 'Dutch Dialogue' may be understood to cover a truly participative and national event: *allowing a wide range of stakeholders to have an input in an open debate on how to deal with all aspects of climate change on all aspects of water management.* Though this clearly is an ambitious goal, the underlying idea was that such a dialogue was already established in the Netherlands, in the form of the activities (research projects, workshops, public discussions) leading to the Water Management 21st Century Policy. The Dutch Dialogue aimed to tap into this process and to present it to the rest of the world.

As stated in the introduction of this report, the Dutch Dialogue project consists **of 4 main components**:

1. An assessment of the **'State of the Art'** in water resources management in the Netherlands, in relation to climate change.
2. An objective **reflection**, supported by stakeholders in the sector, on both the positive and negative sides of the adaptive process in the Netherlands.
3. A **stakeholder workshop** that brings together the relevant Dutch parties and participants from several (delta) countries in the developing world, the outcome of which should be a further objective assessment of the current Dutch practice.
4. **Presentation** of the above in a comprehensive report, and at the World Water Forum.

Of this, tasks 1 and 4 are input and output of the process, while **tasks 2 and 3 form the actual 'Dialogue'**; here, the link with ongoing discussions on the future of water management was made. A first and major lesson learnt, however, is that the fact that such discussions have been going on intensively for almost 10 years in the Netherlands was not only a positive factor for the Dutch Dialogue. While earlier activities provided a wealth of information, it also limited the scope for the current Dialogue, in several ways:

- As water managers and stakeholders are now facing the complexities of implementing the new policy, after years of preparation, they appear less interested in further dialogue and discussions at the moment: a certain 'climate dialogue fatigue' was apparent.
- Moreover, now that abstract policies are translated into practical measures, Government organisations and NGOs have 'taken position' in this process and committed themselves to certain projects. Until it becomes clear which measures will work and which will not, there is little room for reconsiderations halfway the process, limiting the options for open discussions.

Text Box 19 How do water managers use climate change scenarios?

Full consideration of all possible climate scenarios, or should we 'keep the message simple'?

Climate scientists and water managers have very different perspectives on the issue of Climate Change. For the water manager, climate change is one of the many (risk) issues that he will have to deal with; probably it is not the most important (e.g. 'expensive'), nor the most urgent issue. Therefore, in the face of uncertainties in the climate projections, he will want to simplify or reduce the problem by looking for a 'worst case' or a 'most probable case'. For the climate scientist, understanding and 'predicting' climate change is his primary task, and he will tend to sketch a comprehensive picture of all possibilities, making sure that all may be considered. A good example of this bias occurred during the preparations for this 'Dutch Case' report, when the writers of this report were planning how to present and discuss expected climate change. Typically, the climate scientists favored a full exposure of all possible scenario's while at the same time representatives from the water management world tried to simplify the story by reducing it to one scenario only!

Example: a 'coastal defence managers' view on how to deal with climate change scenarios

As scientific evidence and understanding on global climate change will continue to increase, forecasts will further evolve as well. An even greater uncertainty remains in the forecasts for regional and local effects. In the Netherlands, policy makers on long term water management strategies therefore consider the bandwidth of climate change scenario's and their effects more relevant than what scenario is most likely to occur. The new water management strategies favour flexible measures that can be adapted to the speed and severity of climate change. For coastal defence, for instance, sand nourishment of beaches and the foreshore is a measure that can be evaluated on a yearly basis and can be stepped up if necessary. In contrast, concrete constructions should be designed for a longer time span (50 to 100 years) and any amount of over- or underdesign is bound to have negative budgettary consequences or adverse effects on spatial development in the coastal zone. The trend from concrete defence works towards more natural ways of coastal defence was already initiated in the 1980s because of ecosystem considerations. The prospect of sea level rise and climate change reinforced this new strategy for the 21st century.

Text Box 20 New models for co-operation between meteorologsts and water managers

The IPCC projections have indicated some tentative patterns on the large spatial and temporal scales, such as ocean-continent, intra-seasonal and latitudinal differences. Water managers, however, need much more detailed knowledge about what might happen in their part of the world.

The basis: a river flow forecasting system using weather forecasts

Regional climate models are now being developed: specialised versions of regional weather models that will be able to present a much more detailed picture of what might happen with the atmosphere in a specific region when a specific 'global change scenario' is assumed. In order to 'translate' the detailed precipitation and evaporation scenarios produced by regional models into river flow scenarios, the atmosphere model must be coupled to a runoff/river flow model. Such coupled models can only be developed via a 'learning mode' in which the model is made to simulate observed real weather events and consequent runoff and river flow. The most promising and practical way to achieve this, is to develop an *operational* daily forecast capability: a regional weather model, coupled to a runoff/river flow model, is made to predict runoff on a daily basis. In this way the weather/climate model can be improved and fine-tuned using measured data, and the accuracy and other characteristics of the coupled model can be estimated. If the model system is then used in a 'climate mode' (simulating 'future' weather) we know how realistic the simulated runoff/river response may be. Thus it seems that an operational forecasting system for runoff and river flow must be set up before realistic Regional Climate Change scenarios can be provided to water managers. In late 2002, the Royal Netherlands Meteorological Institute (KNMI) and the governmental water managers (RIZA) decided to start working on such operational capacity for the river Rhine basin.

- The Dutch Dialogue, therefore, was more a matter of reporting past and ongoing processes than of stimulating a new dialogue process. This could be a big difference with other dialogues in areas where interest in (and knowledge of-) climate adaptation in water management is a more recent issue.

6.2. The Dutch Dialogue workshop

The two-day Dutch Dialogue workshop (30 and 31 October, Delft, the Netherlands) was the most 'interactive' part of the Dutch Dialogue project. The outcomes are seen as representative of the current state of the dialogue on Water and Climate in the Netherlands, and therefore provide a suitable framework for this chapter. The components of the workshop are:

- Plenary **presentations** and discussions.
- 3 breakout **discussion sessions** on aspects of climate adaptation: 'facts', 'measures' and 'change management' (reported in Text Box 18).
- A **questionnaire** that participants at the workshop were asked to answer. This included questions on the implementation of climate adaptation policies, and on the Dutch Dialogue itself. The answers confirm the outcomes of the discussions during the workshop.
- A **comparison** of climate adaptation in the Netherlands with developments in China (Yellow River Basin), Mozambique, Egypt and South Africa (reported in Annex 2).

6.3. Opening address of the Dutch Dialogue workshop: what are the issues?

Before entering discussions, the main issues were summarised as follows:

- Action regarding water related problems generally needs a disaster to trigger politicians and public, and similarly changes of policy need such calamities or disasters.
- Recent events all over the world show the urgent need for action: disastrous droughts in North and East Asia, for instance (particularly) in Mongolia and China, severe flooding again in parts of China, Vietnam. Bangladesh, and Western European countries.
- Disasters in Flooding are generally much more 'visible' for policymakers and the general public than droughts or water quality effects, nevertheless the impacts of the latter may be quite serious and costly as well.
- After fighting against water for many centuries, the perception in the Netherlands presently is that we can not maintain this struggle anymore, land subsidence and climate change/ variability have stretched the capability to adapt with traditional technology and methods.
- Based on this perception, new concepts/technologies/policies such as 'Room for Rivers', 'Living with Water' the triple principle of 'Retention, Storage and Discharge', as well as the 'Resilience' concept have been developed, in brief this can be defined as a shift from control to management.
- Although it takes quite some time, it seems that after a while the whole society more or less accepts new policies, till it has to be done. Local politicians and inhabitants can frustrate implementation of new policies quite strongly if individual disadvantages overshadow the general benefits
- The process to realise a change in the conceptual thinking about flood defence and/or flood management are quite time consuming. New insights and or approaches first have to pass the level of researchers, then have to go through the political process of decision makers, to be issued to planners and finally to implementation agencies, meanwhile the public has to be informed and actions are needed to create acceptance and public support for new policies.
- Above mentioned process may last 15 to 20 years in total, meanwhile politics/government may change during the process and may threaten implementation of plans that may bear a specific political 'colour'.
- National Water Managers/Rijkswaterstaat have identified 3 potential locations for calamity storage of excessive flood waters from the Rhine and Meuse rivers, but both local politicians as well as Germany have already expressed strong opposition.
- Regional Water Managers are seriously searching for areas to store excessive flood waters and to find fresh water storage for water supply during extended dry periods, but existing spatial plans (municipal, provincial) may obstruct implementation.

Text Box 21 Observations of a disappointed Water Board Member

To an elected member of one of the Dutch Waterboards, the slow progress in the implementation of new measures, following the WB21 Policy, is quite disappointing. Local water management authorities in the Netherlands are investigating options for creating water storage (either calamity storage for flood waters or strategic fresh water storage) based on the nationally accepted 'Room for Water' concept that aims at a combination of functions in the water system, and at multifunctional land use. Many of these promising plans are frustrated by resistance of Provincial or Municipal Government; the argument is often that such plans do not comply with existing spatial planning. NGOs such as agricultural sector organisations also resist many plans, particularly those that require large areas of land.

Examples of conflicts between new ideas and old plans
An example of a discussion that at present seems to lead nowhere, is the plan to develop a large area in the 'green heart' of Holland into either a forest called 'Bentwoud' or into a water storage basin called 'Bentwad'. In both cases there is potential for the recreation functions that need to be developed in this area, but only the latter plan would meet the stated requirements for improvement of the water management system. After initial negative reactions to the plan from mainly the Provincial and Municipal side, now the Water Management Authority of Rijnland as well as the local Water Board seem to support the 'Bentwad' plan. The Province has shifted into the direction of a kind of compromise. However, compromises do not work in the issue of water storage, and now the discussion is in a deadlock position. There are numerous examples of similar cases where projects are delayed (and possibly cancelled) due to spatial planning problems, long procedures for land-acquisition and resistance from municipalities and farmers. Often, nobody takes the lead to promote or develop the plan but everybody is waiting for someone else to act.

Too much delay may stall implementation of measures
As a result of such endless discussions, some Water Boards are already returning to (or simply continuing) traditional practices. It is so much easier to increase drainage systems or just to build new pumping stations with increased capacities. These discussions are similar to those seen at the National level: e.g. after the presentation of the 'Commissie Noodoverloopgebieden' report that recommends the construction 3 areas into emergency flood basins for river water, local authorities immediately objected: they do not accept restrictions to habitation, industry and agriculture in these areas. It seems that, at all levels, most agree that changes in water management are needed, bot no-one wants them in their backyard!

This elected Water Board member sometimes gets tired of all the endless discussions and a bit pessimistic on the prospects for implementing the new 'WB21' concepts.

- Particular initiatives for multifunctional use of space, combining storage of water with housing, industrial development, agriculture, recreation or nature development, are difficult to procure and even more difficult to implement.

6.4. Discussion: what do workshop participants think of the Dutch Dialogue?

Limited interest from implementation organisations?
More than two-thirds of the 35 workshop participants were 'scientist' or 'planner', as opposed to 'water manager', 'policy maker' or 'NGO representative'. The primary target group of the Dialogue on Water & Climate, the 'community' of (often local) water managers and decision makers who are responsible for actually implementing climate adaptation measures, was largely absent. When discussing causes for this absence, the term 'climate dialogue fatigue' was used – there have been many similar initiatives (workshops, research projects, discussion rounds) on aspects of water management in recent years, and some wonder what comes out of it Text Box 21.

Is a fully balanced representation of climate adaptation issues possible?
Difficulties and failures are often less well-documented than successes. Therefore, in these initial stages of implementing the measures recommended by the Commission Water Management 21st Century, little can be read about the difficulties encountered. Most publications present plans, some describe implementation of these plans, but where the rate of progress is questioned this is often done without quantifiable examples. During the Dutch Dialogue, it was often heard that an overview of problems encountered in climate adaptation would be of much value. The gap that was most observed was that of societal and institutional constraints on practical implementation of measures: the report was in danger of becoming too 'technical' according to some. An effort was made to find and discuss examples of such problems.

6.5. Discussion: what do dialogue participants think of Climate Adaptation?

What is climate adaptation in the Netherlands, really?
At the start of the Dutch Dialogue, it was agreed that the expected changes in climate (i.e. 'climate projections') would not be subject to discussion, for at least 2 reasons: A) because this would take away the focus from the <u>response</u> to expected weather extremes, and B) because no clear outcome could be expected from that discussion at this stage. Hence, the IPCC/KNMI scenarios were accepted. However, this did not answer the question "what climate change are we talking about?". The State-of-the-Art assessment of current climate adaptation measures, in this report, shows that policy papers principles (e.g. the 'WB21' Advise) justify the planned adaptations in water management on the basis of recent extreme events (the drought of 1976, Rhine and Meuse floods of 1993 and 1995, polder inundations in 1998). Furthermore, when asked what the driving factors are behind the change in Dutch water management, the following issues were chosen by respondents to the survey and participants in discussions:

- *observed changes in the water system (e.g. recent floods),*
- *societal considerations such as conservation and restoration of nature and landscape.*

Interestingly, the *<u>prospect</u> of climate change (according to predictions)* is rarely considered to be the driving factor behind current and planned changes in water management. This leads to the conclusion that a greater understanding and/or awareness of current weather extremes, and of the impossibility of fully controlling natural processes, may be a far more important factor behind the current changes in water management than is our knowledge of things to come.

In other words: water managers (and spatial planners) may become more aware of the need to prepare for truly extreme conditions rather than for the (relatively) near-average extremes that we have in our short historical records of climate and hydrology. While this is not the same as preparing for climate change, it may be just as effective in terms of measures taken. In fact, it may be a more effective approach in the longer term as it removes the need to 'blame' climate change for individual recent

Text Box 22 Progress report on implementing the 'WB21' water management strategy

The progress in implementation of the strategy outlined in the '4th Policy Statement on Water Management' ('Vierde Nota Waterhuishouding'), which is in line with the recommendations of the 'Commission Water Management 21st Century' (WB21), is monitored by the Commission Integrated Water management (CIW). In 2001, the CIW published progress report on water management in the Netherlands: Water in the Picture ('Water in Beeld'). Progress is reported on the following items:

1. Water Systems: Regional waters, Fresh State waters, Marine State waters.
2. Themes: Security, Water shortage, Water quality, Water and spatial planning, International water management.
3. Institutional issues: Organisation, Instruments, Financial consequences.

The focus is on progress and outcomes of planning studies, for example:

- A recommendation (from the study Water Management in the Wet Heart) to allow a more flexible water level management around the IJsselmeer, will be implemented after 2010.
- The project 'Exploration Room for the Meuse' (Verkenning Verruiming Maas) has shown that 'Room for the River' measures would allow 10% additional discharge; further studies are planned.
- A document with a long-term Vision for the Scheldt Estuary (Langetermijnvisie Schelde-estuarium) is considered a good basis for further planning.

On the actual developments in water management, the following observations can be noted:

- The improvement in surface water quality is stagnating.
- It is crucial that we now find and reserve the space needed to create more 'room for water' in the future; it is noted that this is still insufficiently considered in urban development plans.
- The communication between stakeholders in water management should be improved further.
- The area suffering from water shortages ('verdroging') has decreased by 3% in 2000. This is considered insufficient, as a decrease by 25% was planned.
- Development of a national safety assessment for water systems ('veiligheidstoets') is slowed down and will take more than 5 years.

Summarising, it appears that while the tone of the report is positive, **progress in implementing the 'WB21' recommendations is found mainly in further studies and developments in planning procedures**. Some successes in actual changes to the water management system are noted, but these are mostly minor measures compared to the ambitions stated in recent policy reports. This is not necessarily a problem: implementing major changes is a slow process because so many stakeholders are involved in the Netherlands (see Text Box 15). However, care should be taken to not create the impression that a 'new water management' is already implemented while the process is actually still in its very early stages and **success is not ensured**.

extreme events; doing so may be a good way to get short-term attention from the media (and hence politicians and the public) but may also lead to often fruitless discussions on climate scenarios (rather than the likelihood of extreme events) and could eventually lead to 'climate dialogue fatigue', as was already noted in the Dutch Dialogue. From past discussions on environmental issues (like 'acid rain', 'Brent Spar' etc.) it is known that 'crying wolf' too soon, too often or without sufficient proof can be counterproductive: if the situation turns out to be less bleak than the original doom-scenarios predict, public interest moves on to the next issue and the real problems are not tackled. Therefore, it may be wise to simply define 'climate adaptation' as **'preparing the water management system for weather extremes'** (Text Box 4 and Text Box 5).

Is the 'WB21' Strategy really a major change in the Dutch water management approach?

In recent publications, the changes in thinking on water management in the Netherlands that have occurred are sometimes presented as a radical departure from traditional practice, a true 'paradigm shift'. In the discussions (and survey) around the Dutch Dialogue, however, it was found that many in the 'water management community' (and all but one of the respondents to the workshop survey) consider recent developments a **modification of traditional practice rather than a drastic change** of direction: allowing experiments with innovative methods and natural processes in limited areas while the traditional methods still are the 'backbone'. Even if all planned measures would become reality, the Dutch water management strategy would still be based on 'control', aiming to provide maximum safety. In fact, many Dialogue participants do not see an alternative for this, in practice: the level of investments in the areas at risk of flooding, for instance, is so high by now that the scope for really 'living with floods' may be very limited.

Is the 'WB21' Strategy being implemented or is it 'more plans than progress'?

The recent definition of a national Integrated Water Management strategy ('WB21'), that explicitly takes into account the need to adapt to weather extremes and climate change, has created a lot of enthusiasm and led to the development of a considerable number of ambitious plans that would certainly contribute to climate adaptation. The cornerstones of this strategy are 'Room for Water', i.e. resilient water management instead of water control, and 'Damage Reduction' through careful spatial planning. In the Dutch Dialogue process, it appeared that there is uncertainty with regard to the progress made in realising such measures: there is a gap between the theory of planning, and the practice of implementing plans. Examples abound:

- Even in areas most visibly at risk of climate change, unprotected areas directly along the coast, it is very hard to apply building restrictions. Therefore, potential damages are increasing rapidly. The same is true for areas at risk of flooding along the main rivers.
- Only few minor measures that could be considered 'room for water' have been implemented so far: some dike relocations and water retention measures in small regional systems. The major measures planned, such as detention areas along the Rhine and in large regional water systems, are still under discussion.
- No progress has been made in developing financial instruments that would encourage less investment and more sound water management in areas at risk: through a transparent system of insurance vs compensation of flood damages.
- Government organisations responsible for implementing the measures required do not feel responsible to taking action; this is especially true at the municipal level.
- Public awareness of flood risks, even in areas at risk, has not been raised.

In some cases, it seems logical that changes take decades, not years. However, in some cases success is claimed for political purposes, before major changes have really taken place. This may be counterproductive: it would be better to make it clear to the public that adapting the water management system can be a slow and difficult process. If this is not done, there is a risk that the existence of so many plans and good intentions, rather than the implementation of these plans, is presented (and eventually accepted) as sufficient progress.

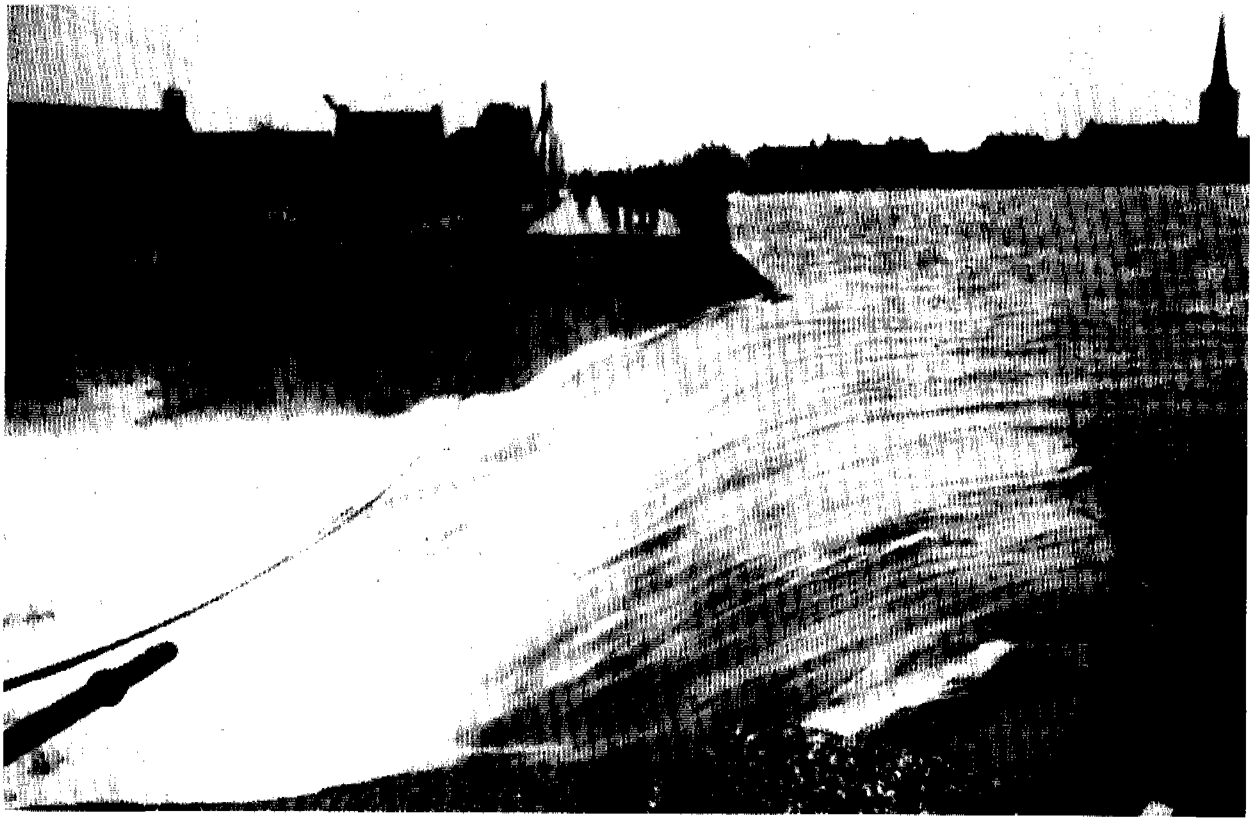


Figure 13 The 1953 flood disaster: never again?

In February 1953, the dikes that protect the southwest of the Netherlands from the sea burst in many locations at once. Over 20% of the country was flooded and 1800 people were killed. This disaster – still known as The Disaster by many – made protection against flooding an even greater priority in Dutch water management, and speeded the implementation of the Deltaplan, the most comprehensive coastal defence work ever. Due to the Deltaplan, the safety level with regards to flooding from the sea is now 1:10,000 years. However, in a country below sea level some risk always remains, and this risk will increase with sea level rise.

What are the limiting factors when it comes to implementing climate adaptation measures?

This question was part of the survey that workshop participants were asked to fill in, and answered as follows:

Table 2 Survey: the main limiting factors for implementation of climate adaptation measures.

	Severely limiting	Limiting	Not Limiting
Lack of awareness with			
scientists		*	**********
policy makers	**	*****	***
politicians	******	*****	
planners	***	******	*
executing authorities	***	********	
general public	*****	******	
Scientific knowledge	**	*****	****
Technical capacities	*	*****	*****
Lack of institutional co-operation	*******	****	
Funding	*****	******	

The outcome clearly confirms the outcomes of workshop discussions, despite the limited number of respondents: **a lack of institutional co-operation, linked to a lack of awareness amongst politicians and the general public, is considered the greatest obstacle to implementation of measures**. The awareness amongst scientists is considered the least limiting factor, as well as the scientific knowledge and technical capacities. This outcome may not be surprising in the light of the fact most Dialogue participants are scientists (including science-oriented planners): they do not consider themselves or their knowledge the limiting factor. Therefore, further discussion within this group of scientists and planners will not solve the greater 'co-operation and awareness' problem.

The lack of public and political awareness has already been identified as a problem by the Commission Water Management 21st Century: "*the limited interest for water management amongst public and politicians, until things really go wrong, is worrying*". This concern has led to publicity campaigns through the media and the Internet (e.g. http://www.nederlandleeftmetwater.nl/). Some Dialogue participants, however, consider these campaigns to be ineffective: they are too 'positive' (with little attention for problems in changing water management or for the real risks of climate change) and sometimes (especially in cases of websites) aimed at those already involved in water management, not the general public.

A risk of 'climate adaptation fatigue'?

Some feel that the debate with regard to 'climate adaptation measures' in water management is going in circles: initial enthusiasm is based on the presentation of win-win situations where safety, recreation, nature and even the economy are all seen to benefit from the same measures. Later, when it is realised by politicians and the public that space is needed for these measures, that costs are high, and that the burden on local communities can be considerable, the discussion goes back to questions on the actual need for these measures, questions that many thought were already answered in an earlier stage: "why do we need detention areas along the Rhine when the Germans are doing so much already upstream?", "why must farmers give up land for water storage in polders if we could improve the drainage system at lower cost?". This not only complicates the discussion, but also reduces interest and confidence amongst stakeholders. The observation in the Dutch Dialogue, that scientists and planners are more enthusiastic about these measures than actual water managers, may be a result of this. A clear presentation of arguments from the start, and a transparent policy development process, may increase interest and confidence again, and thus prevent real 'climate adaptation fatigue'.

7. ANNEX 1 - The knowledge base: inventory of available information

The number of organisations involved in water management, as well as the importance of the subject to Dutch policy making, is reflected in the large number of publications on water management and climate change. Especially in the last few years, tens of reports have been published in the aftermath of the Advisory Report of the 'Commission Water Management 21st Century'. All relevant organisations have stated their position with regards of this report, and many research groups have provided advice on how to implement the measures proposed by the Commission.

Such a wealth of information is, of course, a good basis for analysing and discussing the Dutch water management sector in relation with climate change. However, there is almost a risk of 'oversaturation': with so many reports on the same subject, often based on the same sources, there is inevitably a lot of overlap, in same cases even redundancy. Also, there is a risk of imbalance: e.g. stakeholders specifically involved in river management appear to have produced far more literature on the subject than organisations dealing with water availability issues. Finally, many reports only deal with policy but not practice, resulting in declarations of good intent but not always in a critical assessment of developments and possibilities. Below, an attempt is made to give a balanced overview of reports by organisations from all sectors, in the knowledge that many more sources exist. This is not a full bibliography but rather a selection of publications that were found of special importance or interest in the Dutch Dialogue.

As the advisory report '**Water Management for the 21st Century**' is widely considered the benchmark for things to come, it is summarised in the main text and in Text Box 9.

Policy Documents

3rd Coastal Policy Statement - Tradition, Trends and Future *(In Dutch Only: Derde Kustnota - Traditie, Trends en Toekomst) - 2000* - Ministry of Transport, Public Works & Water Management.

4th Policy Statement on Water Management *(in Dutch only: 4e Nota Waterhuishouding)* - 1999.

Changes in Water Management - *Water Management for the 21st century* (in Dutch only) - 2000 - Ministry of Transport, Public Works & Water Management.

Dikes for Eternity *(Only in Dutch: Dijken voor de eeuwigheid)* - 2001 - Ministry of Transport, Public Works & Water Management.

Making Space, sharing space - ***summary of the Fifth national Policy Document on Spatial Planning 2000 / 2020*** - 2001 - Ministry of Housing, Spatial Planning and the Environment.

New Value for Water - ***Discussion Paper*** *(In Dutch only: Nieuwe Waarde van Water - Discussienota)* - 2000 - Dutch Farmers' Union (LTO-Nederland).

The Netherlands are living with Water *(in Dutch only: Nederland leeft met Water)* - 2002 - Ministry of Transport, Public Works & Water Management.

Water Management for the 21st century - ***Give water the room and attention it deserves*** *(in Dutch only: Waterbeleid voor de 21ste eeuw)* - 2000 - Commissie Waterbeheer 21e eeuw.

Water Management for the 21st century - ***background, agreements and measures*** (in Dutch only) - 2002- Union of Water Boards.

Technical Documents/ publicity (sectoral / regional)

Administrative Statement on the 'Water Test' - *(Only in Dutch: Bestuurlijke Notitie Watertoets - Waarborg voor water in ruimtelijke plannen en besluiten)* - 2001 - Projectgroep Watertoets.

Considering Flows - water management plan 1998 - 2002 - *(Only in Dutch: Stilstaan bij stromen: Waterhuishoudingsplan provincie Noord-Holland 1998 - 2002)* - 1997 - Provincie Noord-Holland.

Study of Future Water Problems - *(Only in Dutch: 'Studie toekomstig waterbezwaar')* - 2000 - Hoogheemraadschap van Rijnland.

Water in the Picture - 2001 - ***progress report on water management in the Netherlands*** *(In Dutch only: Water in Beeld - 2001)* - 2001 - Commissie Integraal Waterbeheer.

Water measured (Only in Dutch: Water langs de Lat) - 1999 - Provincie Noord-Holland.
Working together with Nature in the Dutch River Region - 1999 - Dienst Landelijk Gebied.

Scientific reports - climate, hydrology, water management, flood risk management

Climate of Europe - assessment of observed daily temperature and precipitation extremes - 2002 - EUMETNET.

Climate Change and water quality *(Only in Dutch: Klimaatverandering en Waterkwaliteit)* - 2002 - Resource Analysis, RIZA.

Development of flood management strategies for the Rhine and Meuse basins in the context of integrated river management - 2001 - NCR-publication 16-2001, ISSN 1568-234X.

DSS Large Rivers - interactive flood management and landscape planning in River Systems - 2001 - NCR-publication 13-2001, ISSN 1568-234X.

Extension of the Flood Forecasting Model FloRIJN - 2001- RIZA, NCR-publication 12-2001, ISSN 1568-234X.

Integrated assessment of vulnerability to climate change and adaptation options in the Netherlands
- 2001 - Alterra, ICIS (for: VROM).

Integrated assessment of vulnerability to climate change and adaptation options in the Netherlands. ***NRP report no 410 200 088, Dutch National Research Programme on Global Air Pollution and Climate Change*** - 2001 - Alterra, ICIS.

Integrated water management strategies for the Rhine and Meuse basins in a changing environment - 2001 - NRP project 958273; IRMA project 3/NL/1/164/99151830.

IRMA-SPONGE: Towards Sustainable Flood Risk Management in the Rhine and Meuse River basins - *summary of the research program* (Available also in Dutch, German and French; www.irma-sponge.org) - 2002 - NCR, IRMA.

Living with Floods - ***resilience strategies for flood risk management and multiple land use in the Lower Rhine Basin*** - 2001 - NCR-publication 10-2001, ISSN 1568-234X.

Planning processes in implementation of Integrated Water Management - 2002 - *(Only in Dutch: Kwaliteitsimpuls Beleidsprocessen Uitvoering Integraal Waterbeheer; Casus onderzoek naar de condities voor de kwaliteit van besluitvorming ten aanzien van de doorwerking van het concept Integraal Water Beheer).* Alterra - report by C. Balduk, W. Buunk and I. Neven.

Room for the River *(Only in Dutch: Ruimte voor de Rivier)* - 2000 - Ministry of Transport, Public Works & Water Management; Ministry of Housing, Spatial Planning and the Environment.

Room for the Rhine in the Netherlands - summary of research results *(Summary in English; Full report available only in Dutch)* - 2001 - WL | Delft Hydraulics, RIZA, IRMA, NCR.

National Drought Study - inception report (only in Dutch: Droogtestudie) - 2000 - RIZA.

Spatial Planning and supporting instruments for preventive flood management - 2002 - NCR, Darmstadt University of Technology (DUT-WAR).

The impact of climate change on the river Rhine and the implications for water management in the Netherlands. ***Summary report of the NRP project 952210.*** - 1999 - RIZA.

Weather and water in the 21st Century - ***a summary of the IPCC climate report for the Dutch Water Management*** - *(Only in Dutch: Weer en water in de 21e eeuw)* - 2001, KNMI (Royal Netherlands Meteorological Institute).

8. ANNEX 2 - The Netherlands compared

Part of the Dutch Dialogue on Water and Climate was a comparison of the situation in the Netherlands with that in several developing countries and regions, focussing on deltas and lowland/coastal rivers which share some natural characteristics with the Netherlands and could therefore provide a 'mirror'. After all, climate change and climate variability are global phenomena: all these countries are facing similar challenges in climate adaptation and each country may learn from solutions elsewhere. This is certainly also true for the Netherlands where, as has been found in the Dialogue, the debate on climate adaptation tends to be on the level of national planning organisations and scientists and sometimes focusses on nuisance control rather than disaster prevention. A good look at countries where climate variability already causes real problems, to which the implementing government bodies and population must somehow respond, may be a good 'mirror' for the Dutch.

This section was put together by participants from China, Egypt, Mozambique and South Africa at the Dutch Dialogue Workshop (October 30 and 31, 2002), in co-operation with the Dutch Dialogue Core group. It is based on personal views and does not provide a full overview of the issues, but rather aims to stimulate discussion and contribute to the Synthesis process within the Dialogue on Climate and Water.

Table 3 Overview of priority issues in climate adaptation in different countries.

As seen by country representatives at the Dutch Dialogue on Water and Climate Workshop.

Key issues		China P.R. Yellow River	Egypt	Mozambique	Netherlands	South Africa Thukela River
Water Quantity	Floods	+	+	+	++	++
	Droughts	+	++	+	+	+
	Groundwater	+	+			
	Transport	+	+		+	
Water Quality	Temperature		+			
	Salinity		+	+	+	
	Public health					++
	Recreation		+		+	
Land Use & Sediments	Erosion	+				+
	Irrigation		++	+	+	
	Siltation	++		+	+	+

8.1. *China P.R. Yellow River Basin*

Climate

The Yellow River Basin is located in a region with high summer temperatures and low winter temperatures (continental climate). With an average precipitation of 300-600 mm., and a high potential evapotranspiration, the basin has semi-arid characteristics. Although in the 2nd half of the 20th century a slight increase in average temperature has been observed, and a slight decrease in precipitation, the main change observed is a reduction in runoff. This trend is probably mainly due the increased population and water consumption. This includes an increased use of groundwater resources an as a consequence a reduced base-flow in the river. In general however there is a lack of information and reliable studies.

Water

The Yellow River basin can be divided in three reaches, each with their own characteristics and problems:

- In the upper headwaters the main problems are the shrinking of lakes and drying-up of main channels, together with degradation of grasslands.
- In the middle reach, the "middle Loess", soil erosion, deforestation and desertification are key issues. In addition storm-water flooding is occurring.

- The lower reaches suffer from sedimentation and reduction of flows, but at the same time flooding risks as a result of dike breaching is a serious threat. Generally speaking the main problems are the reduced river flow, the increased chance of droughts, and the erosion in the basin combined with sedimentation in the river.

Partly as a result of sediment accumulation in the river channel, there is also an increased risk of serious floods, especially in the lower reaches. Similarities with the situation in the Netherlands concern mainly the flood-protection aspects, with embankments and dikes along the lower reaches of the Yellow river. In the Netherlands the flooding threats in 1993 and 1995 were instrumental in initiating national interest and support for climate change issues, while in China the great flood of 1998 triggered the attention for strategies, policies and responses in water management.

Institutional aspects
The overall plan for the Yellow River water management (2001-2010) is based on the concepts of Integrated Water Resources Management. This has similarities to "WB21" and the views on "living with water', "resilience", "space for water, "multifunctional land use" and the "retention/ storage/ discharge" strategy.

Due to the difference in protection level, additional management measures and projects are still needed for the Yellow River. Apart from this the elevated position of the riverbed in the lower reaches, as a result of sediment accumulation in the past, very much limits the application of the "room for rivers" concept.

The new Water Law (October 1, 2002) assigns the responsibilities to 7 river basin authorities in China. In addition for the Yellow river, a management committee, consisting of the MWR, YRCC, provincial and local government, energy managers, enterprises and water users, has been proposed by the ministry of Water Resources (MRW).

Similarities and differences
In the Yellow River Basin Dialogue, similarities with the Dutch Dialogue include: Need for more co-operation between meteorologists and hydrologists, attention for flood forecasting and warning systems, and public information and involvement. Although the Yellow River Basin is not an international basin like the Rhine and the Meuse basins and the otherwise enormous differences between China P.R. and the Netherlands, there are still enough similarities in the field of water resources management for a mutually beneficial exchange of ideas and experiences.

8.2. Egypt

Climate
Egypt is located in an arid to semi-arid zone. This is characterized by high potential evaporation, combined with low precipitation and high summer temperatures. An increase in average temperature may have a limited effect by itself, perhaps with the exception that an increase in surface water temperature will have a major effect on the cooling system of thermal power plants. An increase in average temperature together with a rapidly growing population will result in a significant effect on water demand. Although water quantity issues are a major concern in Egypt, in the framework of water and climate water quality issues will be more strongly affected and are therefore of dominant concern.

Institutional Framework
With the water quantity aspects regulated by international agreements, the focus used to be on the effect of climate change on sea-level rise. In 1997 the Egyptian Environmental Affairs Agency (EEAA) established a committee coordinating national efforts, developing an inventory of policies and strategies to deal with climate change, and reviewing the National Action Plan for Climate Change. The experiences in the Netherlands, especially concerning integral water management and integrated catchment management, could contribute valuable ideas and concepts, while the Egyptian experience concerning droughts represents a potential source of expertise and knowledge.

On both regimes further studies are needed, with the basin-scale collaboration in the Nile basin still needing further expansion and development. The Nile Basin Capacity Building Network for River Engineering is an example of such a regional initiative.

Similarities and differences
Like the Netherlands, Egypt is a partly riverine, partly deltaic country. Unlike the Netherlands however, almost all surface water is derived from sources outside the country in the upstream Nile catchment area, up to 5300 km away in Ethiopia, Kenya, Tanzania and Uganda. With very little rainfall the annual floods were mostly beneficial, with a deposit of fertile sediment as a bonus. The key areas of concern therefore are, and always have been, periods of droughts and water scarcity. With the construction of the High Aswan Dam, the water supply to the whole country is now regulated, with excess flood water retained in the Toshka depression. At the same time this has reduced the sediment supply to the downstream and delta region, resulting in significant coastal erosion. Combined with the predicted sea level rise, this means that considerable parts of the Nile delta are threatened by the effects of climate change. With a total of 3500 km of coastline, technical and engineering measures will only be feasible to a limited extent.

With most of the catchment of the Nile in the 9 upstream countries (Sudan, Eritrea, Ethiopia, Uganda, Kenya, Tanzania, Rwanda, Burundi and the Democratic Republic of Congo), the possible impact of climate change on precipitation in Egypt itself is insignificant. Being at the downstream end of a river basin formed by numerous countries is again a similarity with the position of the Netherlands, although the main concern in the Rhine basin initially was water quality rather than water supply. The more recent developments in the Rhine basin towards water quantity aspects was triggered by a series of recent flood events. Water quality and the already developing measures for a more ecologically orientated use of the floodplain have now been incorporated in the retention, storage, discharge strategy described elsewhere in this report. In the Nile basin the management of the storage of Lake Victoria and the retention function of the Sudd swamps in the Sudan have played already for a long time an important role. The addition of the High Aswan dam, with the overflow to the Toshka depression completed a basin-wide storage and retention system. Upstream developments affecting the system would be an increased water use upstream for irrigation in the Sudan and Ethiopia, reducing the overall discharge volume. The construction of a navigation channel through the Sudd swamps would reduce the time lag for peak flows, just as the historical river bed modifications of the Rhine and its tributaries, and would reduce dry season flows. The significance of these developments depend on the magnitude of the changes in climate and land use in the upstream region in relation to the storage capacity of Lake Nasser and the Toshka depression.

Lower discharges will result in increased salinisation problems in the delta region due to salt water intrusion, combined with (possibly increased) evapotranspiration, and lack of flushing possibilities, a development that also might affect part of the Netherlands. A concentration of the population in the river valley and delta (forming only 5% of the total area of the country), again result in a situation comparable to the Netherlands, although the priorities in Egypt are water supply and food security rather than flood management and protection.

8.3. South Africa – Thukela catchment

Climate
In southern Africa there is a large degree of climatic variability both concerning short-term variations with devastating floods as a result cyclones, and more long term cycles with the occurrence of severe droughts, sometimes in consecutive years. El Niño Southern Oscillation (ENSO) events are superimposed on the already existing variability and may trigger unusual rainfall or may aggravate drought events in the eastern and southern part of the continent.

Although the Thukela basin is relatively small, it experiences most of the climatic variability mentioned above. Apart from that it is an area of extremes with the upper part of the basin in the Drakensberg mountains where snowfall and sub-zero temperatures are normal in winter and the lower part in the Mediterranean climate of the KwaZulu-Natal coastal area. The intermediate area is mostly sub-arid, with rather hot summers and cool winters. Rainfall ranges from 600-2000 mm and the Thukela basin is a water rich catchment by South African standards, although there is a high potential evaporation. The runoff ranges from 20-400 mm and a clear amplification of effects can be observed, including the results of (increased) variability. The area is a net exporter of water with considerable amounts coming from relatively vulnerable areas (e.g. "hot spots") in the Drakensberg mountains. Although the "hot spots" are the coolest areas, a relatively small temperature rise can have major impacts on the conditions in these Alpine regions. This situation is similar to the situation in the European Alps where the increase in average temperatures has resulted in a significant reduction in the area of the glaciers and the region of perennial snow. The long-term consequence in both cases would be a loss of upstream buffering capacity and a more pronounced effect of short-duration/ high-intensity rainfall events.

Land use in the Thukela basin ranges from large-scale timber plantations (especially Pine and Eucalyptus) and commercial sugar cane estates to small scale subsistence crops and animal husbandry. Climate changes would affect land use especially through lack of water for irrigation in summer. On the other hand the present land use obviously has an effect on the availability of water resources. In some areas the high grazing pressure of the domestic animals already exceeds the carrying capacity of the natural vegetation with degradation of the ecosystem and erosion problems as a result. Siltation of the smaller streams is one of the results, further reducing the accessibility of water during the dry season. This can result in serious health implications, with the recent cholera epidemics elsewhere in South Africa as a warning sign.

Institutional aspects

Despite the relatively high vulnerability of the Thukela region to increased climate variability and change, this had a low priority until recently. The main reason is the already existing variability with the associated floods and droughts. Recent flood events, together with the effects of ENSO, and the realisation of the vulnerability of the rural population and the economy of the region have resulted in an increased awareness and interest in climate change issues. This is demonstrated by the interest of a wide range of stakeholders, including national and provincial departments and directorates, in the workshop held in Pietermaritzburg in July 2002 on "Managing water related issues on climate variability & climate change".

Similarities and differences

The development is still at an early stage, and therefore the Dutch experience could provide a useful reference. This does not necessarily mean that the idea that in the Netherlands everything is under control, which is sometimes taken for granted, is correct. In fact the broad involvement of stakeholders, ranging from tribal chief to representatives from the Department of Water Affairs and Forestry (DWAF), could be a lesson for the approach in the Netherlands.

8.4. Mozambique

Climate

Mozambique is one of the Southern African Development Community (SADC) Countries, bordering South Africa, Swaziland, Zimbabwe, Zambia, Malawi and Tanzania. The country has a surface area of 799,380 square kilometres and a coastline of 2,470 kilometres long. The areas of higher altitudes, which are predominantly the north and the central regions of the country, have mean annual rainfall ranging between 1000 and 2000 mm. In the low lying areas, found mainly in the south, values range from 400 to 600 mm. Along the southern coast strip, the mean annual rainfall ranges from 1000 to 800 mm. The country receives most of its rainfall between November and March, with hot and wet summers followed by dry and relatively cold winters. The occurrence of hydrological droughts and floods in Mozambique is generally associated with tropical cyclones or the occurrence of El Niño or La Niña events.

Water
The basin areas of the Maputo, Umbeluzi, Incomáti, Limpopo, Save, Buzi, Púngue, Zambezi and Rovuma rivers cover 52% of the surface of the country. These are 9 out of the 15 shared watercourses in the SADC region. With Mozambique forming the downstream delta region, these watercourses are characterised by wide and shallow river valleys with low storage potential and large flood-prone areas and deep salt intrusion in the estuaries up to more than 50 km inland.

The estimated Mean Annual Runoff (MAR) was in 1986 216,000 million cubic meters (Mm^3), of which 116,000 Mm^3 (54%) originated from rainfall that occurred upstream, while the remaining 100,000 Mm^3 originated from rainfall inside the country. 106,000 Mm^3 originates from the Zambezi river basin, representing almost 50% of the surface water resources. About 75% of this is cross-border flow. In the southern region 80% of the MAR is generated upstream. As the surface water is the main source of water in the country, Mozambique strongly depends on water coming from the upstream countries.

Institutional framework
Under the Water Law (1991) the National Water Council (NWC) was created, an inter-sectoral coordination forum, analyzing relevant aspects of water management policy and monitoring its execution. The Council is a consultative body of the Council of Ministers and comprises the Ministries of Public Works and Housing, Agriculture, Tourism, Mineral Resources and Energy, Industry and Trading, Environment and the Ministry of Health. At the national level, the Ministry of Public Works and Housing (MOPH) is the National Authority responsible for planning and supervision of the water resources related activities. The National Directorate for Water (DNA) is the central institution of the MOPH in charge of the study, planning and management of water resources and protection of the environment.

An important aspect of the Water Law is the decentralization of the management of water resources through the creation of the Regional Water Administrations (ARA's). The five ARA's have the operational responsibility of managing water at regional level. The ARA-Sul and ARA-Centro have been established and the ARA-Zambezi is under process of establishment. The National Water Policy (NWP) of 1995 defines strategies to be followed in the Water Sector according to the political and socio-economic situation that prevailing at that particular time. The NWP gives priority to basic water supply and sanitation requirements, stakeholder participation, integrated water resources management and capacity building in the water sector. The Revised SADC Protocol on Shared Watercourses Systems provides for the establishment of River Basin Institutions to deal with water issues of common interest. Priority is given to the establishment of water-sharing agreements, dealing with water needs in quantity and acceptable quality, and also to protect the resource.

Similarities and differences
Like the Netherlands, the country depends for a major extent for its surface water supply on the upstream countries. A main difference is the range of rivers and countries involved. Unlike for the Rhine River, a key problem is the increased water use upstream resulting in a continuous reduction in MAR. For instance, the MAR of the Incomati river basin was reduced by 30% for the past 15 years. The associated reduction in sediment transport and siltation aggravates flooding problems at times of high discharges. In this respect man-induced changes contribute to river discharge problems during periods of high rainfall, which is to a certain extent analogous to the situation in the Rhine basin. Problems of water quality are also experienced, with increased salinisation as the most prominent factor, again an issue that also play a role in the river Rhine during periods of low discharge.

Climate change is not an issue that has a high priority in Mozambique. Poverty alleviation through the supply of basic services for people such as safe drinking water and sanitation are the main challenges at this point in time. Also the need to increase water storage is of paramount importance, to promote the practice of irrigation in agriculture and to ensure food security and human and livestock water supply.

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