

Dutch Expertise Water Management & Flood Control



Delft, The Netherlands, November 2005

1 Introduction

The Netherlands wants to – and will – keep its feet dry

The Netherlands, water country. For centuries, we have been protecting ourselves from the water. The Dutch Government has historically been involved in dealing with water to ensure that we can live and work safely. Protecting the coast and preventing flooding, also inland, are day to day activities for us. We also ensure that our waterways are safe and accessible for shipping, trade and recreation.

We have been fighting to keep out the sea for centuries. We have implemented some extraordinary engineering feats to accomplish this in the past. Take the construction of the IJsselmeer Dam and the Delta Works. The Netherlands has more than 1500 miles of dikes to protect us from the water. Every year we remove millions of tons of sand from the sea to preserve our coastline. The Government makes sure that the necessary work and maintenance is carried out. Rijkswaterstaat is the implementing body of the Ministry of Transport, Public Works and Water Management.

On behalf of Rijkswaterstaat, I recommend this brochure to you!

Ir. L.H. Keijts
Director General Rijkswaterstaat

2 Aim of this document

To provide information on the Dutch flood management system and other related systems. We would like to share our 'lessons learned' and provide an overview of Dutch expertise and policies. We invite you to contact The Netherlands Water Partnership (NWP, www.nwp.nl). The NWP is an independent body set up jointly by the Dutch private and public sector to act as a national coordination and information point in relation to water activities overseas.

3 Dutch History in Water Management and Flood Control

- The Netherlands has centuries of experience in water management and flood control. Situated in the largest delta of Europe, one third (1/3) of the country is below sea level. Since 8 million people live below sea level, the Dutch have had to learn to live with the water. Without the protection of our levees and dunes, more than half of the country would be flooded. The first levees were built 1,000 years ago, lakes were drained, polders (tracks of land reclaimed from the sea or lakes) were created, and water levels were placed under control. Water management needed to be organized, thus our first democratic institutes, the public water boards, were founded in 1200 AD.
- Water boards are decentralized public authorities with legal tasks and a self-supporting financial system. Water boards are responsible for local and regional flood control and water management. The amount received by each water board depends on the level of taxpayer interest within each water board's jurisdiction. As of 1 January 2005 there were 27 water boards with approximately 10,000 employees.



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- To protect The Netherlands from flooding, the best expertise available on innovative flood control and water management was and is still needed today. This was brought to light by the floods of 1953 and in the 1990's. During that period, the world's largest flood protection works were built: the Deltaworks. Not only has **hydraulic engineering** expertise been developed by both public and private organizations in the Netherlands, but also
 - expertise on flood control,
 - flood planning,
 - risk-based flood protection standards,
 - institutional and legal embedding of policies,
 - crisis management,
 - integration of urban issues with environmental protection,
 - reconstruction activities and
 - dredging technologies

Facts about the Netherlands

- 1/3 of the country, where 8 million people live, is situated below sea-level
- Without dikes and dunes, 66% of the country would be flooded
- 1000 years of water management experience
- Our first democratic institutes were water boards first established in 1200 AD
- Deltaworks: the world's largest flood protection project
- To find more: www.nwp.nl ; www.uvw.nl ; www.minvenw.nl; www.waterinthenetherlands.org

4 Floods

In recent history, three major floods had a deep impact on how the Dutch manage flood and water issues. These disasters made it clear that we needed to improve our flood control techniques and water management policies and standards.

1953 Zeeland sea flood

- 67 embankment breaches
- Approximately 500,000 acres of land flooded
- 1836 people died
- Approximately 200,000 livestock drowned
- 3,000 houses and 300 farmhouses completely destroyed
- Over 40,000 houses and 3,000 farmhouses damaged
- After 3 months still 24,000 could not return home

1993 & 1995 Rhine and Meuse river floods

- Approximately 100,000 acres of land flooded
- 240,000 people evacuated
- A major highway was blocked for several weeks
- Casualties were limited



Improvement of our water management and flood control after the floods

- Deltaworks: closes and controls the Delta of Zeeland in case of a storm:
 - Dams
 - Provides storm surge barriers
- Legislation: Law on Flood Defense was introduced:
 - Enacted a powerful tool to safeguard the quality of our flood protection
 - Established clear design standards for a safe level of protection against flooding
- Investment in Research and Development on flood and coastal protection:
 - Developed models and decision support systems
 - Implemented probabilistic design (impact and frequency)
- 500 miles of levees (flood protection) raised and strengthened
- The condition of flood protection in relation to the most up-to-date legal standards are reported directly to the State Secretary every 5 years
- Contained and Compartmentalized risks
- Established protection levels based on economic damage potential
- Restored floodplains to provide more space for river floods
- Coastal management: focused on providing safety and environmental protection



5 General Dutch Flood Protection Expertise

Companies and institutes: some examples

Public sector

- Ministry of Transport, Public Works & Water Management
- Ministry of Spatial Planning, Housing & the Environment
- Rijkswaterstaat
- Water boards,
- Provinces
- Municipalities

And more ...

Research / Education

- Delft University
- Wageningen University
- UNESCO - IHE
- Alterra
- WL|Delft Hydraulics
- RIZA / RIKZ
- ITC
- GeoDelft
- TNO

And more ...

Consulting engineers

(Represented by a.o. ONRI)

- ARCADIS,
- Royal Haskoning,
- DHV,
- Witteveen+Bos,
- Fugro,
- Infram,
- Nedeco,
- Alkyon,
- And more ...

Contractors

(Represented by a.o. VBKO and by 'Bouwend Nederland')

- Ballast Nedam,
- Dura Vermeer
- Interbeton (BAM group)

And more ...

Pumps and Equipment

(Represented by a.o. VLM)

- Bosman Water management
- Paques
- Van Essen Instruments
- Nijhuis Water Technology
- Norit
- Landustrie
- SpaansBabcock
- Perialisie

And more ...

Dredging

- Boskalis,
- Van Oord

Key expertise and results we are proud of

Water management

Flood control

Flood protection planning

Environmental aspects of water control

Risk based flood protection approach

Crisis management

Reconstruction

Dredging

Preparation for climate change

Policy development

Risk management



6 Lessons Learned: Water requires Space

For centuries, spatial planning in the low-lying Netherlands has been a matter of maintaining the separation between land and water. The Dutch have benefited from this separation, considering that two-thirds of the gross national product is generated domestically. However, changes are brewing. Climate changes are increasing the likelihood of flooding and water-related problems. In addition, population density continues to increase, as does the potential for economic growth, and consequently, the vulnerability to economic and social disaster. Two undesirable developments that, in terms of safety, exacerbate one another – a growing risk with even larger consequences. As such, the safety risk is growing at an accelerated pace (safety risk = chance multiplied by consequence).

How do we deal with this ever increasing risk?

The Netherlands is changing its approach to water. This change involves the idea that the Netherlands will have to make more frequent concessions. We will have to relinquish open space to water, and not take back existing open spaces, in order to curb the growing risk of disaster due to flooding. We will also need to limit water-related problems and be able to store water for expected periods of drought. By this, we do not mean space in terms of the height of ever taller levees or depth through continued channel dredging, but space in the sense of flood plains. This approach will require more area, but in return we will increase our safety and limit water related problems. Safety is an aspect that must play a different role in spatial planning. Only by relinquishing our space can we set things right; if this is not done in a timely manner, water will sooner or later reclaim the space on its own, perhaps dramatic manner.

More space in relation to technological measures

Technical expertise and capability, in addition to continuing innovation, are essential to our success. However, we have learned that 'hard' technical measures are not sustainable and are not flexible. Technical measures need to be combined with other strategies to be truly successful. The Dutch have developed several strategies or building blocks with proven reliability to provide flexible long term solutions that fit local circumstances. We would like to introduce these strategies in the following pages.

7 – Water Management

Climate change and increased urbanization demand changes in our approach to water management. The starting point for flood protection is sustainable water management. It is essential to understand a water system in order to decide on the most appropriate measures for flood protection. In this context, we describe the range of river and coastal management sciences and expertise The Netherlands has to offer.

Due to our constant battle with the sea and rivers, the Dutch have had to study and intensively manage our rivers and coast.

Our river management expertise includes:

Policy development from a national to a local level; the complete range of river engineering and river maintenance works; river hydraulics and sediment transport modeling. Large scale flood event modeling in 3D GIS environment.

Our coastal management expertise includes:

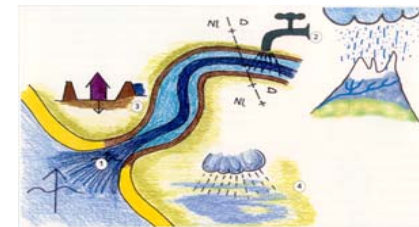
A high level of expertise in the area of waves, currents, sediment transport, coastal morphology, seabed - structure interaction, ship dynamics, navigation and statistics. We apply state of the art and proven numerical models and have access to a wide range of physical model facilities. We have specialized expertise in coastal protection, coastal development and coastal management, which are related to gravel, sand and mud coasts.

We offer expertise in the field of: coastal morphodynamics and design conditions for coastal areas; shoreline management, including analysis of coastal erosion problems and the design of coastal protection schemes; stabilization of tidal inlets, lagoons and estuaries; and shallow water wave modeling.

Solutions:

- Water management and monitoring program with a solid institutional base
- High-tech monitoring tools and methods
- Specialized software and tools

Current issues



1. The sea level is rising
2. The risk of floods increases
3. The sea level rises, river discharges increase and the soil is subsiding
4. Precipitation in winter increases



8 Flood Control

Providing protection against sea and river water by means of dunes, levees and canals. Protection may require embankment and reinforcement of levees, building water control structures or installing high capacity pump stations. Sometimes protection requires additional space for water in places where this is possible.

The Dutch have been constructing levees and flood control structures for many centuries and may be viewed as some of the best experts in planning, design, construction and maintenance of levees and flood control structures. In addition, through extensive studies and experience, we are specialists in failure-mechanics. By using specialized software and assessment techniques, we can predict potential levee failures. Levee reinforcement can be achieved with regular use of sediment, but the Dutch have also developed innovative techniques to strengthen levees which are located in urban areas where little space exists: sheet piles, mixed in place, expanding columns, nails in levees, automated counterbalance, flood relief drain.

The Dutch have built one of the world's most impressive flood protection structures under very challenging environmental conditions. We offer expertise and highly specialized equipment in the design and construction of such structures.

The Dutch coast is unique in the world in using 'soft' measures to prevent the coast line from declining. We offer expertise in this kind of no-regret measures.

Dutch companies can also design and provide high capacity pumps.

The Deltaworks:

The Deltaworks, established after the 1953 floods to protect Zeeland, the world's largest flood protection works, include the following: the Eastern Scheldt Barrier, a movable storm surge barrier, was constructed to protect against the sea without damaging the unique ecology of this estuary. The construction of 10250 miles of levees (1500 miles of primary levees and 8750 miles of secondary levees) along with 300 structures in main dikes. In addition, 13 estuaries were closed along with 1 inland estuary having several dams. Approximately 1650 sq km of land were reclaimed from the sea.

International:

Design and project management of the St Petersburg Storm Surge Barrier in Russia. Dutch engineers and contractors have also been recently involved with the construction of the famous Palm Island in Dubai, United Arab Emirates.



9 Flood Planning

Flood planning is the framework to transform the flood defense philosophy into a sustainable flood management system. The framework reveals the information and measures that need to be taken; as well as where and how it must be implemented.

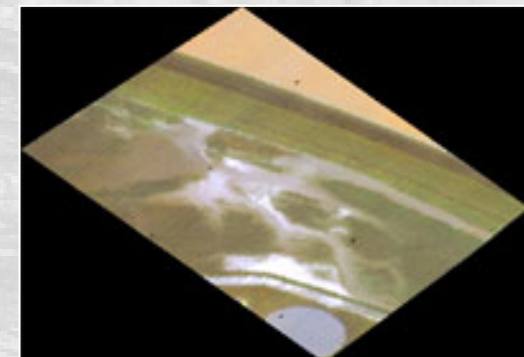
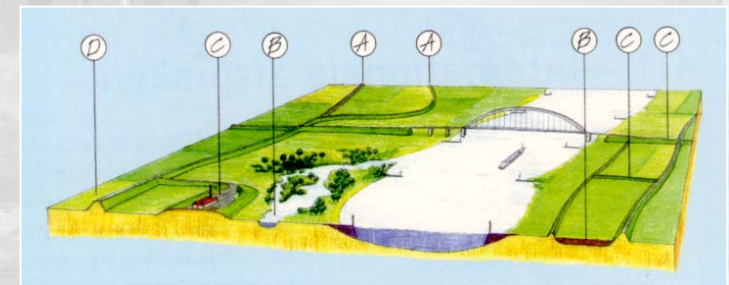
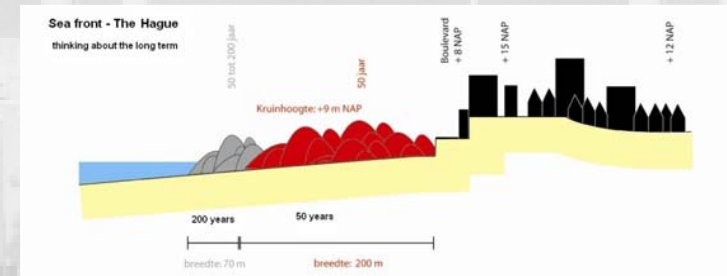
The Dutch have developed several innovative data systems to gather information continuously on the strength of their levees by using remote sensing, fiber glass optics and GIS modeling.

Responsibilities for flood management from different government levels are legally embedded in our policies. Provinces are responsible for authorizing procedures and for safety and spatial planning aspects of flood management. Consequently, they have a lot of experience in flood planning.

The Dutch have a long tradition in urban and environmental planning, from national to local levels, which is scientifically praised world wide.

Flood management plans are formulated with a scope duration of 50-100 and even up to 200 years.

- Dike relocation to widen the bottleneck from the Waal river at the city of Nijmegen
- “Room for River” Act: a national program to give our major rivers more space
- Thermal infrared spectroscopy in order to track groundwater flows that may undermine flood barriers
- Legal framework of urban and environmental planning
- FLI-MAP: levee strength data base and data collection system
- Digital Levee: using glass fiber optics for continuous monitoring of any changes in levees
- Dutch Atlas on the of river basin management organization
- GIS supported mapping of integrated flood protection levels in the Netherlands



10 Environmental Aspects of Flood Control

The design, construction and maintenance of flood control systems is not just a technical matter. There are many stakeholders! Environmental aspects include ecology, culture, landscape, archeology, recreation & tourism, water quality and geomorphology.

The Netherlands is a very densely populated country, with many stakeholders. With generations of experience in combining functions, the Dutch have developed expertise ensure integrated solutions. Specialized knowledge includes:

- Strategic Environmental Assessments for large coastal and floodplain projects
- Environmental Impact Assessments for levees, coasts and structures
- Structured combination of flood control improvements with improvement of environmental quality (quality of local life)

A major advantage of these strategies is public support.

- SEA for the improvement of the North Netherlands coast
- Nature compensation for all lost valuable nature due to levee construction/ strengthening
- EIS's for levee and coastal reinforcements, both urban and rural



11 Risk Management Approach

We are developing a new risk management approach that includes determining how far the government can and should go in providing protection against high water levels and how much it can and should spend for that purpose. We will base the approach on factors including the "Safe Netherlands Roadmap". In that project, the Ministry has joined forces with provincial governments and water boards to gauge the likelihood and consequences of flooding in each levee "ring" (an area that is completely surrounded by levees).

The consequences of flooding are also taken into account in the Dutch risk management approach. Human and economic values also determine risk standards. Which means that not just technical expertise on dealing with flood management is needed, but also socio-economic experience. We support the decision-making process by providing scenarios, alternatives and public relations advise.

The Netherlands is divided into compartments with different risk levels of flooding. High density areas with greater human and economic interest, like Rotterdam and Amsterdam, are surrounded with stronger levees than rural areas and therefore have a lower risk level from flooding than others. One of the most difficult policy decisions for the Dutch in the next decade is to decide what level of protection is necessary, acceptable and cost-effective for each compartment.

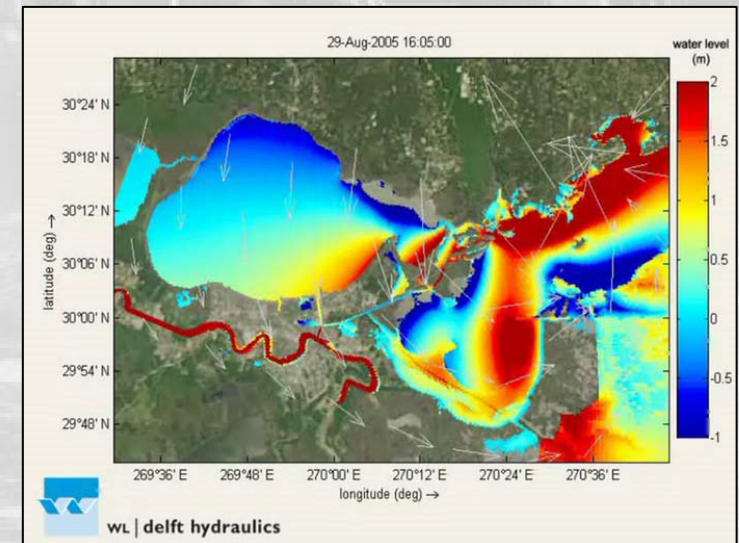


12 Crisis Management & Reconstruction

Crisis management is needed to decrease the chance of damage and casualties in the case of a flood. Unnecessary or unsuccessful evacuations can be prevented by applying flood calculations and evacuation scenarios during the planning phase.

- Development of contingency plans, evacuation plans and scenarios
- Public awareness of risks and evacuation routes
- Development of decision making models to improve the evacuation process before and during a flood
- Advanced 3D flood modeling
- Flood risk mapping
- 24 hour monitoring and prediction of river levels
- Dutch companies can offer comprehensive expertise for reconstruction: pumping, cleaning, building, infrastructure

- ESCAPE: development program resulted in a model for contingency plans, a public awareness model, high water level information system model and a decision support system for evacuations
- Every Dutch municipality has an evacuation plan for its inhabitants
- Every water board has a contingency plan
- Automated Manual addresses high-water levels



13 Other relevant expertise

■ Dredging

We have some of the world's leading companies in dredging. Dredging is an important corrective measure for our rivers. Dredging is also used to win sand for dune and beach maintenance and restoration. Dutch companies are working all around the world. Well known projects where Dutch engineers and contractors are working, are the 'palm tree' and 'world islands' in Dubai, United Arab Emirates.

■ Science & Technology

Water related science & technology is at a high level in The Netherlands. Public and private sectors cooperate in the development of new technologies. Universities like the University of Delft and the University of Wageningen have a rich tradition in high level water oriented education from 'hydraulic engineering' to 'disaster studies' and 'integrated water resource management'.



Acknowledgements

- Editorial Committee: I.M.A.A. Demmers (NWP) and P.T.M. Dircke (ARCADIS),
Delft, The Netherlands, October 2005

- Interested? For further information visit www.nwp.nl or www.waterinthenetherlands.org

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