Flood Risks and Safety in the Netherlands - NL

1. Policy Objective & Theme

- ADAPTATION TO RISK: Managing impacts of climate change and safeguarding resilience of coasts/coastal systems
- ADAPTATION TO RISK: Preventing and managing natural hazards and technological (human-made) hazards
- ADAPTATION TO RISK: Integrating coherent strategies covering the risk-dimension (prevention to response) into planning and investment

2. Key Approaches

- Knowledge-based

3. Experiences that can be exchanged

A new method makes it possible for the costs and benefits of investments in flood protection to be more carefully weighed against one another. It also offers the possibility for setting standards for high water protection in the future. The method can be applied to any dyke ring areas, to compare flood risk with other collective risks.

4. Overview of the case

The ''Flood Risks and Safety in the Netherlands'' undertaking has resulted in the development of new methods which can be used to calculate both the probability and consequences of flooding.

5. Context and Objectives

a) Context

One of the risks of living in the Netherlands is that the country is vulnerable to floods but because of major technological advances it is possible to make the flood probability very small. Therefore the Dutch no longer consider floods as a natural disaster, but as a disaster caused by humankind. It may never be possible to prevent flooding entirely, but people can largely determine for themselves to what extent they want to control the risk. This makes it possible and, indeed, necessary to make a conscious choice about the costs and benefits of high water protection. The benefits are fewer victims and less damage when flooding does occur. In the 1950s, the Delta Committee established that extremely high water levels constitute the greatest threat of flooding. This insight provided the basis for safety standards for water defences until the present. The current safety standards for water defences were derived on the basis of the size of the population and the economic importance of South Holland in the 1950s. For regions with fewer inhabitants and of less economic value, lower standards were set at the time. However, this assumption is now no longer universally applicable. The probability of flooding due to high water levels is now regarded as small compared with the risk due to other flood failure mechanisms. Therefore, in 2000, the Dutch government decided to determine the probability and consequences of flooding throughout the Netherlands of the so-called dyke ring areas. A dyke ring is an unbroken ring of water defences and high ground and the area protected by the dyke ring is called the dyke ring area. At the start of the study there were 53 dyke ring areas in the Netherlands. In 2005 the Water Defences Act was revised, with new dyke ring areas being designated and now there are 95 dyke ring areas in total designated in the legislation

b) Objectives

The purpose of the work was to gain an understanding of the consequences and the probability of flooding in the Netherlands. The underlying aim was that, apart from evaluating the probability of a certain water level being exceeded (which is the measure currently used to assess dykes), other failure mechanisms were also taken into consideration. At the same time, the potential consequences of flooding were also investigated. It was also used to calculate the consequences of flooding when deciding upon strengthening of the water defences.

6. Implementation of the ICZM Approach (i.e. management, tools, resources)

a) Management

The Flood Risks and Safety in the Netherlands (VNK1 or Floris) initiative was begun in 2001 at the request of the State Secretary of Transport, Public Works and Water Management. The project was conducted by the Road and Hydraulic Engineering Institute of the Directorate-General for Public Works and Water Management, in close cooperation with the Water Boards and Provinces. It ended in 2005 and, currently VNK2 (since 2007) is using an improved methodology and aims to have detailed information on flood risks and flood probabilities by 2014.

b) ICZM tools

The product of the Floris study is a method which can be used to calculate flood risks in a consistent manner. Four routes were taken to achieve the objectives:

1. determining the probability of flooding for all dyke ring areas;
2. gaining an understanding of the problems affecting hydraulic structures;
3. gaining an understanding of the possible consequences of flooding;
4. obtaining an impression of the uncertainties and an indication of how to deal with them.

During the work, it was therefore decided to undertake the assignment in phases. During the first phase of the project the probabilities of flooding, consequences and risks were calculated for 16 of the 53 dyke ring areas that defend the Netherlands from flooding. These 16 dyke ring areas were chosen because they would give a fairly representative picture of the national situation. The consequences of flooding were calculated at a detailed level for three of them and more roughly estimated for the remaining 13 areas.

Existing methods were adapted and new methods developed. These new methods were necessary, for example, to assess hydraulic structures and the impacts on wildlife, the landscape, cultural heritage and the environment. A unified method was also developed to be able to turn all water defences into data for input into models The loads from water levels, currents and waves were calculated in the same way for all dyke ring areas. For some components the methods will need to be developed further. For example, it would be desirable to include the effect of human intervention during high water levels in the flood risk, to reduce the uncertainties in the probability of piping where the water forms channels under the dyke causing it to collapse and to calculate the failure probability of several other water defences.

The calculated probability of flooding was shown to range from 1:2500/yr for parts of the Randstad or western conurbation to more than 1:100/yr. in the rivers region. The calculations do, however, provide the opportunity to analyse which failure mechanisms contribute most in the flooding probability and where the weakest locations are in the dyke ring. The work also showed that, in order to be able to interpret the calculated probability of flooding properly it is necessary to have a detailed knowledge of the area. For example, the calculations for Terschelling (a Wadden island) resulted in a failure probability due to piping of 1/600 per year. However, the extensive Wadden mud flats in front of the dyke would largely prevent this phenomenon. When this effect is taken into account, the calculations result in a failure probability of only 1/64,000. With the methodology, it is possible to get an impression of where investments in water defences will make the most contribution to reducing the risk of flooding.

7. Cost and resources

There is no information about the costing of the Floris initiative. With respect to flooding, the maximum economic damage of a failed dyke ring area ranges from €160 million in Terschelling to almost €300 billion in the province of South Holland. Flood risk (i.e. the flood damage multiplied by the probability of flooding) has also been calculated. The amount that should be set aside per year to be able, in the long term, to compensate for the damage caused by flooding in the three dyke ring areas, calculated in detail, ranges from €2 - 37 million/yr. In the other 13 dyke ring areas, a more approximate calculation shows a range from €100,000 - 180 million/yr.

8. Effectiveness (i.e. were the foreseen goals/objectives of the work reached?)

In most dyke ring areas, the failure mechanism of ‘piping’ was shown to constitute the greatest threat to the defence system. Although it is still difficult to turn complex flooding processes into manageable mathematical models, the calculations provide the most realistic picture of the probability of flooding based on current understanding. The calculated probability, however, is not yet robust enough for these figures to be considered absolute values. Further research and development of the method could help to make the method more robust in the future.

The use of new methods for determining the probabilities of flooding and the consequences along the considerable length of the water defences took more time and effort than had been envisaged, not least because the necessary data on the dykes was not always to hand in the right format or at the right time. It is possible to identify where the weakest locations are in the dyke ring and which failure mechanism is responsible. The dyke manager can use this soundly-based information to set priorities for the maintenance of a dyke ring.

9. Success and Fail factors

A great deal of data was needed to be able to apply the new methods, including information about the sub-soil under the dykes and engineering works. In some cases, this data is surrounded by many uncertainties. An essential element in the probability calculations is that the order of uncertainty is expressly included in the calculation. These calculations offer an opportunity to analyse what failure mechanisms have the most impact on the probability of flooding and where, relatively speaking, the weakest locations are in a dyke ring.

10. Unforeseen outcomes

As a result of the study, the Water Boards carefully check the water defences for signs of piping with each high water and are also prepared if signs of piping are found. From the results of the Floris project it appears that the probability of flooding is greater than the present standards allow for. Because the current standards must be maintained per dyke section, maintenance and investment may not always be carried out where they are most urgently needed or would be most cost-effective. Where there is a high probability of failure due to non-closure of hydraulic structures, this is due to procedures not being properly documented or sufficiently practised. The probability of flooding in such cases can be easily, effectively and cheaply reduced and many Water Boards are now implementing the necessary measures.

11. Prepared by

A. H. Pickaver, Coastal & Marine Union (EUCC), The Netherlands

12. Verified by

Niels Roode, Rijkswaterstaat Waterdienst

13. Sources

- Flood Risks and Safety in the Netherlands (Floris) Floris study - interim report (2005) Ministry of Transport, Public Works and Water Management
- Flood Risks and Safety in the Netherlands (Floris) Floris study - Full report (2005) Ministry of Transport, Public Works and Water Management (cover only)
- Flood Risks and Safety in the Netherlands (Floris) Floris study - Full report (2005) Ministry of Transport, Public Works and Water Management (text only)
- Veiligheid Nederland in Kaart Hoofdrapport onderzoek overstromingsrisico's (2005) Ministerie van Verkeer en

Waterstaat

- Veiligheid Nederland in Kaart Tussenstand onderzoek overstromingsrisico's (2005) Ministerie van Verkeer en Waterstaat
- Veiligheid Nederland in Kaart Tussenstand onderzoek overstromingsrisico's (undated) Ministerie van Verkeer en Waterstaat (pamflet)
- Veiligheid Nederland in Kaart: Wat, hoe en waarom? Ministerie van Verkeer en Waterstaat (folder)
- www.helpdeskwater.nl

VNK Hoofdrrapport (1.37 MB)

VNK Wat hoe en waarom folder (1.64 MB)

VNK cover EN (6.49 MB)

VNK full report EN (7.63 MB)

VNK interim report EN (2.51 MB)

VNK tussenrapport (1.91 MB)

VNK tussenrapport pamflet (991.59 KB)