

uniform, comprehensive national database on the strength properties of flood defences and the characteristics of protected areas. The database is being created in close collaboration with flood defence managers and provincial authorities. The immediate use of the data in models, the interpretation and comparison of analysis results and feedback to flood defence managers and provincial authorities will lead to extensive checks and verification of the data gathered. The tools developed by VNK2 and the underlying knowledge and database will allow for a variety of future applications.

#### Relationship between VNK2 and current projects

VNK2 supplies information and insights in support of projects like the Delta Programme (Flood Protection Sub-programme, previously known as '21st-century Flood Protection') commissioned by the Ministry of Infrastructure and the Environment.

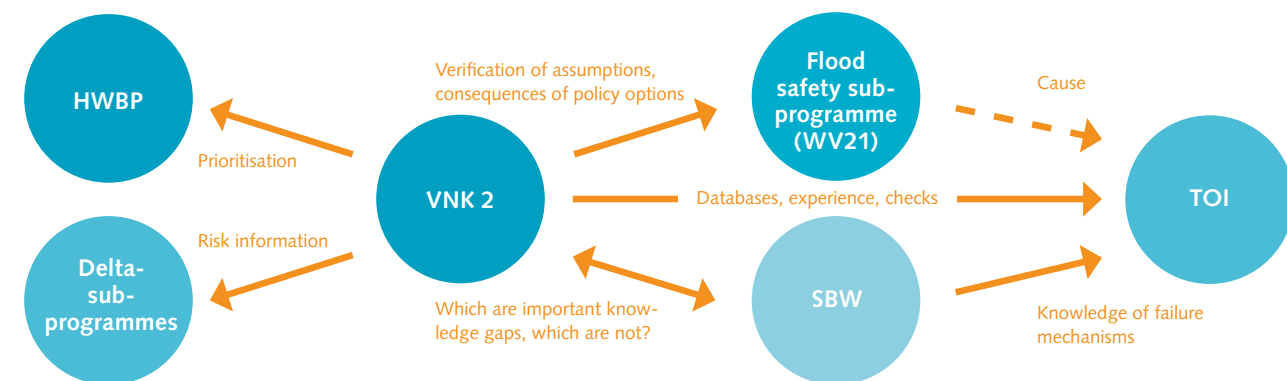


Figure 4: Relationships of the VNK2 project

FOR FURTHER INFORMATION GO TO [WWW.HELPDESKWATER.NL](http://WWW.HELPDESKWATER.NL) OR TEL. 0800 - 6592837

#### Flood Risk in the Netherlands (VKN2)

The Flood Risk in the Netherlands (VKN2) project is analysing current flood risk in the Netherlands. Using an innovative method, flood probability is being linked to the consequences of flooding expressed in terms of economic damage and potential casualties. The insights produced by the project will help authorities take more targeted, cost-effective measures to protect the Netherlands from flooding. The project is an initiative of the Ministry of

Infrastructure and the Environment, the Association of Regional Water Authorities and the Association of Provincial Authorities. *Rijkswaterstaat* is implementing the project in close collaboration with flood defence managers, provincial authorities, research institutes and engineering consultancies.

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# Flood Risk in the Netherlands



Ministerie van Infrastructuur en Milieu

Interprovinciaal Overleg



UNIE VAN WATERSCHAPPEN



## FLOOD RISK IN THE NETHERLANDS

The goal of the *Flood Risk in the Netherlands (VNK2)* project is to assist risk-informed decision-making by analyzing current flood risk in the Netherlands. Using an innovative method, flood loading, probabilities and dike performance probabilities are being linked to the consequences of flooding expressed in terms of economic damage and casualty numbers.

The insights produced in the project will help the authorities take targeted, cost-effective measures to further reduce flood risk in the Netherlands.

The project is an initiative of the Ministry of Infrastructure and the Environment, the Association of Regional Water Authorities, and the Association of Provincial Authorities. *Rijkswaterstaat* is implementing the project in close collaboration with flood defence managers, provincial authorities, research institutes and engineering consultancies.

### Lower risk, smarter investment

The insights produced by VNK2 will contribute to creating a smarter investment strategy to reduce flood risk in the Netherlands. Every euro can only be spent once, so investments are most effective if they are targeted first to improve the weakest flood defence structures that protect large population centers. Armed with the knowledge and insights from VNK2, we will be able to minimise the likelihood of damage, casualties and social disruption associated with flooding as efficiently as possible. In time, this will allow the greatest level of safety to be achieved at the lowest cost.



Figure 1: Flood risk approach

VNK2 results can be put to immediate practical use in:

- The prioritisation of reinforcement measures as part of the Flood Protection Programme;
- Understanding the results of the current statutory assessment of primary flood defences;
- Analyzing the effectiveness of multilayer safety measures;
- Identifying and analyzing possible measures for the Delta Programme.

### Prioritising reinforcement measures

The current statutory assessment rounds identify which levees require reinforcement. These measures then become part of the Flood Protection Programme (HWBP).

The statutory assessment does not however show which levees are the weakest and/or most important from a risk perspective. To prioritise the various reinforcement measures, it is important to know how a flood defence performs, potential consequences associated with poor performance, and the effect of any measures that may be implemented to improve the flood defence.

The failure probabilities calculated in VNK2 give insights into the relative strength of flood defences. The VNK2 approach also reveals the relationship between a specific levee breach and potential damage and casualties (risks).

Considerable differences have been found within and between protected areas in terms of the strength of flood defences, flood patterns and potential damage and casualty numbers. This knowledge helps with the selection of levees for reinforcement, and in determining the impacts of those reinforcements. VNK2 results provide direct input to help answer flood defence managers' questions, including:

- Where are the weak spots in the levee system?
- Which of these most strongly impact the risk?
- What type of reinforcement is required?
- What is the effect of these measures?

### Understanding assessment results

The VNK2 method is innovative. Primary flood defences are being analysed with a great deal of extra knowledge and skill, taking uncertainties into account. The results of the performance analyses generally concur with those of the current assessment results. But in some cases the results differ significantly. This may prompt a reassessment of the need, type, and scale of planned reinforcements. Besides highlighting the magnitude of flood risk and the potential for reducing it, VNK2 results also provides some insight into what further information is required to properly manage the risk. For example a targeted monitoring programme can prevent unnecessary, or unnecessarily costly, reinforcements.

### Analysing effectiveness of multilayer safety measures

Besides prioritising and clarifying the nature and scale of required reinforcement measures, the VNK2 risk-based approach reveals the effectiveness of different types of multilayer safety measures (including prevention, spatial planning and disaster management) in terms of reducing flood risk. This allows comparative assessment of such measures to establish the most cost-effective, and thus optimise the various types of measure.

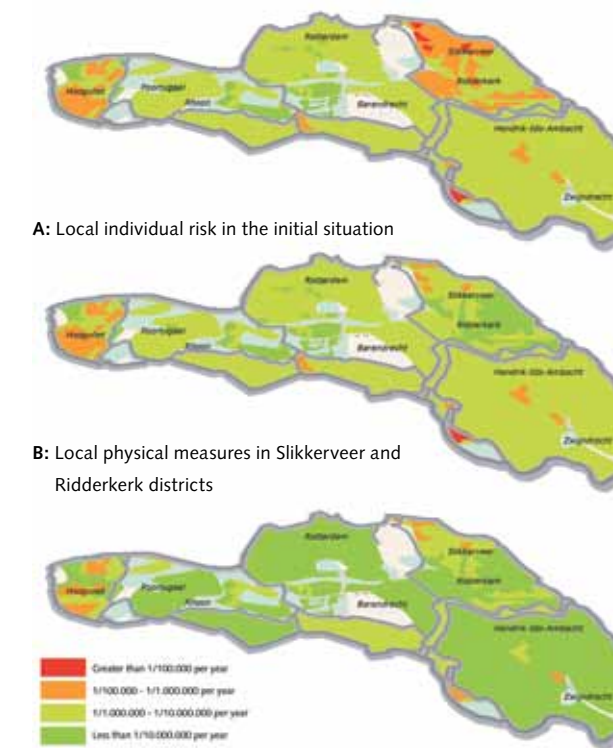


Figure 2: Local individual risk (LIR) can be reduced by various measures within a levee system

### Support for Delta programmes

VNK2 can reveal the effects of successive improvement measures. The law of diminishing returns applies to the successive reinforcement of relatively weak levee sections: after several rounds of improvements, safety can be improved only by upgrading the levee system as a whole (see figure

A: Local individual risk in the initial situation

B: Local physical measures in Slikkerveer and Ridderkerk districts

C: B + improved evacuation plan

Figure 2: Local individual risk (LIR) can be reduced by various measures within a levee system

below). VNK2 identifies this tipping point, which differs from one levee system to another. While, in one system, the probability of flooding is reduced considerably by several improvement measures, in another the impact will be limited, despite major investment. This information is very important for addressing both current and future challenges.

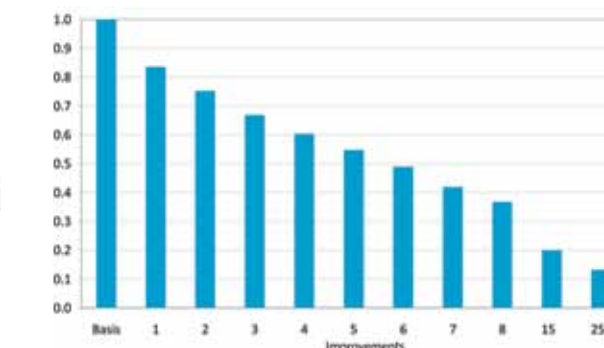


Figure 3: Diminishing returns

### Customisation

VNK2 can provide customised solutions to supplement existing instruments and procedures for the development and implementation of flood protection policy. These might involve the identification of effects of specific reinforcement measures introduced under the Delta Programme, analysis of operational crisis management measures, or performance of sensitivity analyses.

### Well-founded information

Besides the immediate results of calculations for each levee system, VNK2 will also make a key contribution to the development of the toolkit for flood protection analysis and to the knowledge and data required for this purpose. A by-product of the VNK2 assessment approach will be a compilation of a