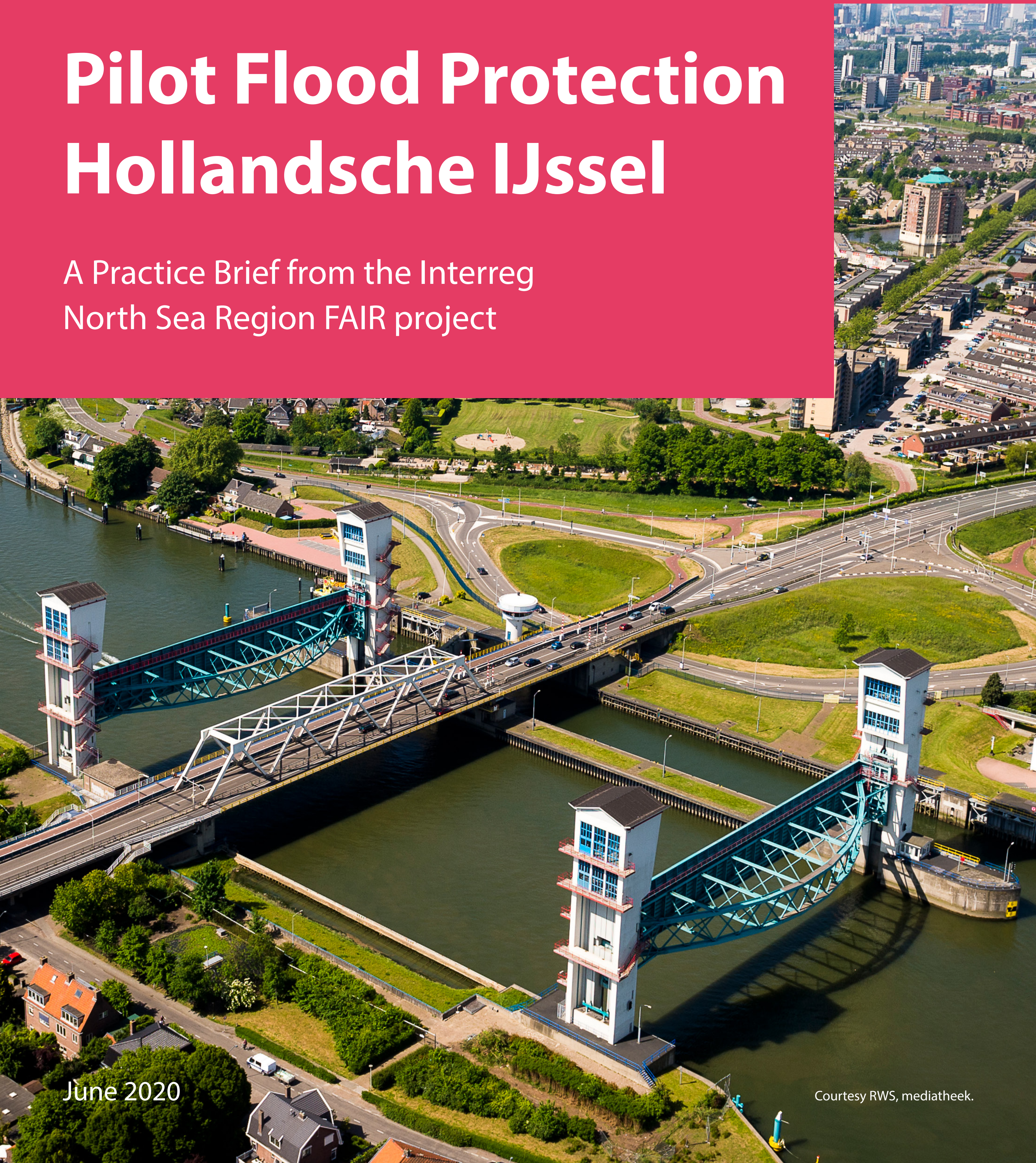
Interreg
North Sea Region
FAIR
European Regional Development Fund

EUROPEAN UNION

Pilot Flood Protection Hollandsche IJssel

A Practice Brief from the Interreg North Sea Region FAIR project



June 2020

Courtesy RWS, mediatheek.

Preface

The FAIR project

FAIR brings together flood protection asset owners, operating authorities and researchers from across the North Sea Region (NSR) to share the policy, practice and emerging science of asset management. Despite the diverse character of the NSR, asset managers face common challenges across the region.

The FAIR project aims to develop and implement improved approaches for asset management of flood protection infrastructure. It will optimise investment planning by exploring mainstreaming of these investments with other policy domains, and by mapping planned investments across a wide portfolio of flood protection assets. FAIR will also identify cost-optimal adaptive infrastructure upgrades by exploring a variety of technical designs, with adaptability and life cycle costing for various performance levels.

This Practice Brief

FAIR supports the delivery of local upgrade or maintenance projects and schemes for flood protection assets or systems. This Practice Brief presents **why** the project or scheme has been proposed. It provides an overview of the key challenges and intended outcomes. It elaborates on **how** these challenges have been addressed, and presents **what** has been the outcome from implementing this approach. Finally, the Practice Brief reflects on the innovation of the pilot with respect to the best practices in the FAIR end report and the FAIR recommendations.

The FAIR results

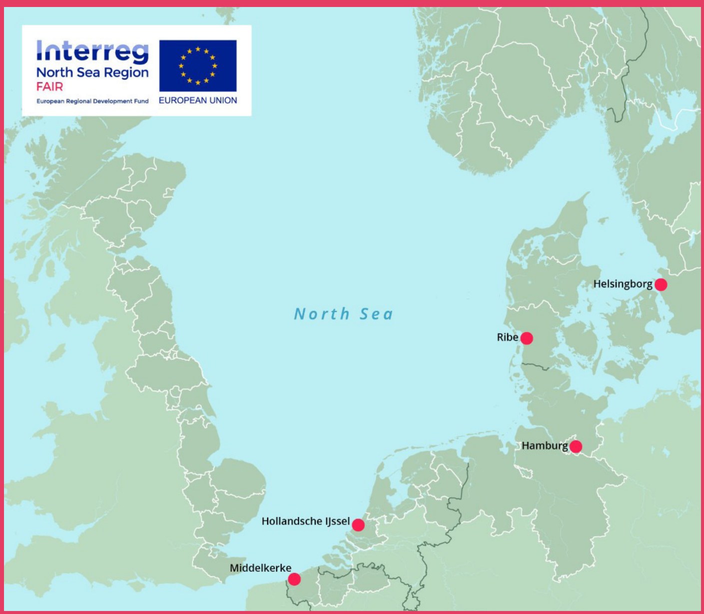
The demonstration and subsequent widespread implementation of the improved approaches and techniques will reduce the probability of flooding and minimise the impact of floods across the North Sea Region. This will improve the climate resilience at target sites covering most of the NSR. 'Target sites' are those areas being protected by entire flood protection systems (e.g. Danish coast, Swedish Coast, Flemish Coast, Dutch Delta) and individual assets (e.g. Hollandse IJssel storm barrier, Hamburg flood gates, etc).

The result indicators for the FAIR project are:

1. Reduce the life cycle costs of flood protection infrastructure through better targeting of investment;

2. Encourage the multi functionality of flood protection infrastructure through mainstreaming (that is, connecting) investments with other policy objectives;

3. Increase the life span of flood protection infrastructure through smarter maintenance and renovation.



Summary

This report is about pilot Flood Protection Hollandsche IJssel (FPHIJ), which is a pilot for project FAIR.

Dikes along the river Hollandsche IJssel are operated by the regional water authority (HHSK), but they no longer meet the statutory standard. The Hollandsche IJssel river can be isolated from the main river, Nieuwe Maas, by a storm surge barrier (operated by Rijkswaterstaat, RWS) which controls hydraulic loads on the dikes. Part of the Dutch Delta Program was to make an integrated flood risk management plan for the entire river of the Hollandsche IJssel. HHSK and RWS worked together on this plan. The main outcome was to improve the reliability of the storm surge barrier while decreasing the expected hydraulic loading conditions on the dikes. Additional investment in the barrier would be needed to achieve this.

Figure 1: The Hollandsche IJssel storm surge barrier. Courtesy RWS, mediatheek.

By working together, HHSK and RWS have managed to trade-off costs and benefits between dike and barrier improvements to reduce entire lifecycle costs without compromising standards. The cost reduction is expected to amount to approximately 5% of the total of dike and barrier improvement cost (30 M€ on 600 M€). This also includes smaller dikes with less impact on the existing landscape. A program focused solely on dike strengthening would have missed these additional opportunities.

At the end of 2019, the Dutch Flood Protection Program (HWBP) has indicated that they are positive on the exchange of financial means (e.g. savings in the costs of dike reinforcements are used for investments in the barrier). HHSK and RWS are now working out the details to get the final approval for the exchange of means in the middle of 2020.

Figure 2: The Hollandsche IJssel dike. Courtsey © Hoogwaterbeschermingsprogramma / Tineke Dijkstra.

The Context

In this report about pilot Flood Protection Hollandsche Ijssel (FPHIJ), actually two pilots are being described; the dike reinforcement project KIJK (abbreviation for strong Ijssel dike Krimpenerwaard) and the project WHIJ (abbreviation for integrated flood risk management Hollandsche IJssel):

- KIJK is focusing on the dike reinforcement of 10 km dikes along the Hollandsche IJssel. The project is run by the regional water authority Hoogheemraadschap van Schieland en de Krimpenerwaard (HHSK). Dikes are assets for HHSK, but the Dutch Flood Protection Program (HWBP) finances 90% of the reinforcements.

- WHIJ is working on an integrated flood risk management plan for the entire Hollandsche IJssel, in which the water system is broadly analysed and all possible measures are looked into. The project is part of the Dutch Delta Program, and run by Rijkswaterstaat (RWS, the national agency for roads and main waterways including storm surge barriers) and HHSK.

The main reason for one pilot report for both pilots is that we (RWS and HHSK) are working together on a cost-effective solution for flood resilience of the Hollandsche IJssel river system, including the dikes of KIJK.

Struggle to get the collaboration started

In 2014, it was agreed to start a joint study under the Delta Program on the flood protection of the Hollandsche IJssel. In the first years, it was a struggle to get both authorities enthusiastic to start working together on this. It was seen as a risk that a broad analysis of the system would result in a delay of the necessary dike reinforcement. Also, in the beginning the benefits were not so clear due to the type of reinforcements being proposed. It was expected that the stability of the dikes needed to be improved and not the height (the stability of dikes is not influenced by a better storm surge barrier).

Triggers

In 2017, the urgency to start the dike reinforcement increased with the introduction of new legislation and different standards (based on national flood-risk assessments) and the incorporation of the failure rate of the storm surge barrier in the models. The new standards meant that on top of stability, the height of these dikes didn't meet the standard.

In June 2017, in a meeting between HHSK and RWS, all parties finally saw the benefits. HHSK really wanted to collaborate with RWS as the dike reinforcement turned out to be very complicated and RWS suggested a possible solution could be found, although no thorough study was immediately available. At this meeting, both parties talked openly about problems and options, and this was the final trigger to get the joint study started. Since then, both parties have been jointly researching integrated flood risk management plans.

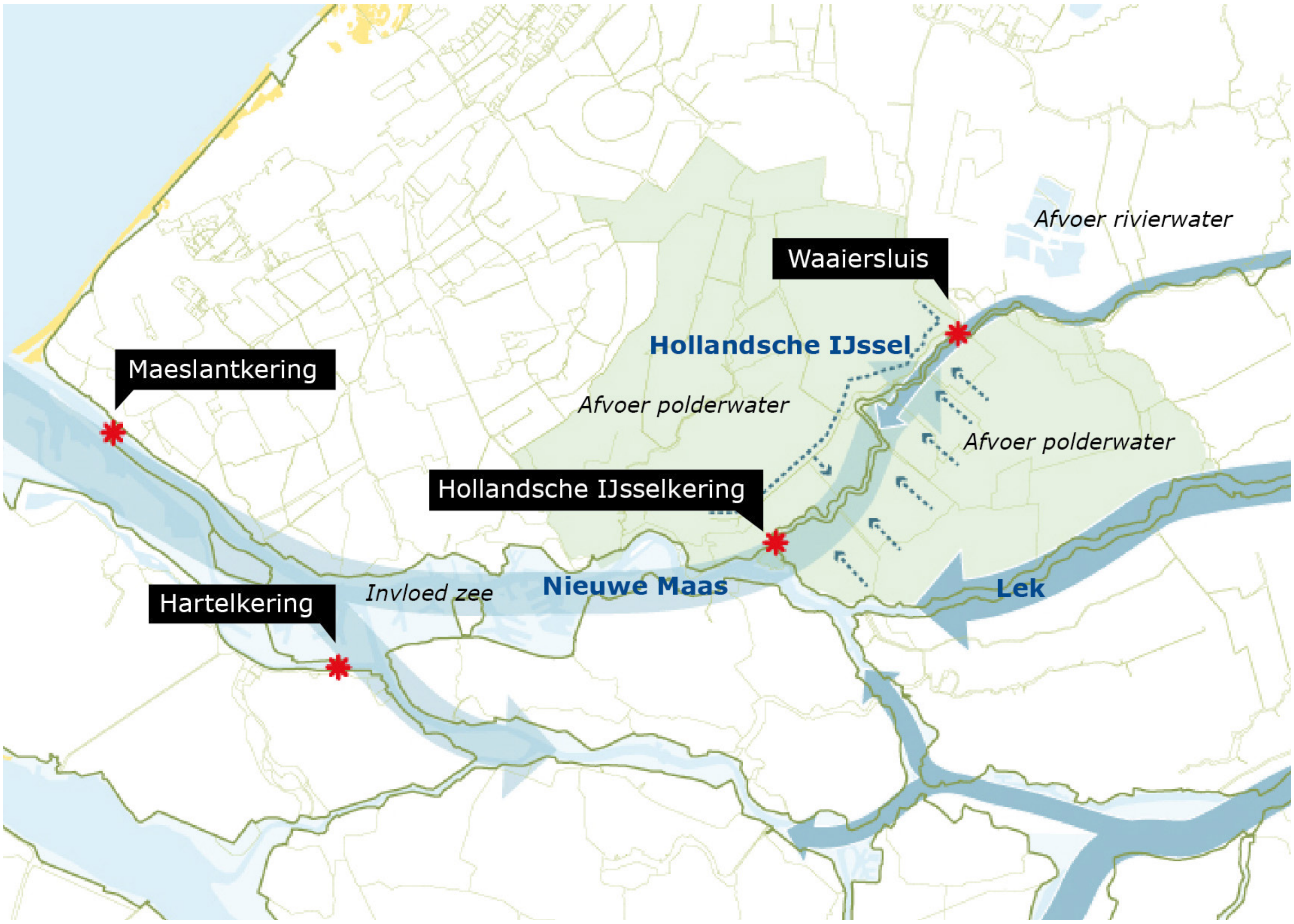


Figure 3: Factors of influence on the water system Hollandsche IJssel. Maeslantkering and Hartelkering are also storm surge barriers. Waaiersluis is a lock at the beginning of the Hollandsche IJssel. Courtesy Karres en Brands.

Why: The purpose

The key challenges

In this pilot FPHIJ, our aim is to get a cost-effective solution for flood resilience of the Hollandsche IJssel river system, including the dikes of KIJK. While working on this aim, we experienced a number of challenges.

Challenge 1: Break free of the silo while working at the Hollandsche IJssel

The challenge was (and to date still is) to break free of the silo. Not to think of the self-interest of individual organisations but to focus on the bigger goal.

There is no external incentive to optimise the water system, apart from the Delta Program. As further described in challenge 3 every organisation deals with its own unique assets and risks which means resources are limited.

Challenge 2: Deal with the Hollandsche IJssel as a unique and complex water system

The Hollandsche IJssel is a unique and complex water system, with numerous factors playing a role for flood protection:

- High water from the sea (with the influence of the Maeslantkering Storm Surge Barrier and with potential sea level rise in future).
- High water from the river Lek (with potential higher discharges in the future).
- Regional water discharge at the Hollandsche Ijssel.
- Wind, causing waves at the Hollandsche Ijssel.
- Land subsidence (also under the dikes).

It was complex to really understand this system and to model it in order to work with it in our study. We used the Source-Pathway-Receptor Framework to get a mutual understanding of the system.

Next to this, there are various measures that can be taken for flood protection (dikes, HIJ storm surge barrier, flood plains, and limiting regional water discharge). These measures also interact, for example a better storm surge barrier ensures that more flood plains can be taken into account. These measures were included in our model to get an understanding of their impact on flood resilience.

Our approach was to include all necessary expertise, including the wider expertise within FAIR, in our project and have joint sessions to discuss and improve the results.

Challenge 3: Make space for innovation, together dealing with risks

The third challenge in this project is to make space for innovation: embracing and managing the risks of new approaches to develop innovative solutions. Both organisations (HHSK and RWS) are taking risks in this project. Our approach is to be open about these risks and discuss the best way of dealing with them.

- For RWS, the challenge is as follows. On the one hand, RWS has undertaken technical studies, indicating that the failure rate of the Hollandsche IJssel Storm Surge Barrier can become substantially lower. On the other hand, if RWS promises a lower failure rate, then RWS also wants and needs to fulfil this promise.

  How can you promise a failure rate that is not too conservative and not too promising?

- A further challenge is that RWS will get a lump sum amount for the investments in the storm surge barrier. Also, additional maintenance costs need to be paid for by RWS.

  How can you ensure that the financial risks are controllable?

- For HHSK, the challenge is that the current dike reinforcement is in preparation. On the one hand, HHSK wants to meet the deadlines; on the other hand, HHSK also wants to be flexible for new insights.

  How can you still be open for new challenges without losing sight of the end goal of the project?

- By working together, we are developing an approach that can deal with lower or higher failure rates than now expected. At the time of reporting work on this challenge is still on-going.

The intended effects

The intended effect is that the area around the Hollandsche IJssel is well protected against flooding with a cost effective package of flood resilience measures, taking into account climate change and other developments (e.g. soil subsidence).

It is an important boundary condition that the package of measures is accepted by all relevant parties (RWS, HHSK and the HWBP) as well as by society, and that it is financed appropriately with the risks being taken into consideration.

For KIJK, this means specifically: on going dike reinforcement anticipates the effects of the water system measures for the medium to long-term future. By doing so the project is more cost effective and fits better in the surroundings.

Another very positive effect of the pilot is that it has improved collaboration between the organisations involved.

Figure 4: Collaboration between RWS and HHSK at the office of HHSK. Courtesy HHSK.

How: The approach

We have used a number of different approaches in order to deal with the challenges of the project.

Solution 1: Cooperation

The challenge was to break free of the silo. Not to think of the self-interest of individual organisations but focus on the bigger goal.

The pilot project team was formed by members from RWS and HHSK with an approach from the outset to look for common understanding and to utilise and respect members' specific knowledge, connections and expertise.

It was important to recognise that internal stakeholders including decision makers and their advisers were vital to the success of the project and needed to be involved and regularly updated from start to finish. This was achieved using stakeholder analyses and engagement techniques.

Solution 2: (Contra) expertise

Some of the studies touch on one of a kind knowledge (for example to determine the chance of failure for a storm surge barrier) for which there are few experts in the Netherlands. Because of this, the project team determined that for sensitive studies done by RWS or HHSK experts, independent experts would conduct second opinions.

For example, to determine the failure rate of a storm surge barrier is a very complex analysis (how big is the chance of failure of every part, how vital is that part for the whole barrier, what are the interdependencies between parts?). The outcome of these analyses is key information on which to determine the adaptation pathway for the whole water system HIJ.

This leads to the second challenge, the analysis of the water system. This can be achieved by collecting all of the knowledge from the surrounding water authorities and RWS, assembling all the collected information and analysis and combining this into different choices for adaptation pathways for implementation of water system measures.

The SPR framework was used in the pilot project to generate a common understanding of the system. After this, three separate analyses were conducted:

- Quantitative system analysis to analyse the impact of measures on the flood risk management.
- Failure rate analysis for the storm surge barrier.
- Cost-analysis of different measures, including investment costs, operation and maintenance costs.

Solution 3: No-regret dike design

For project KIJK it is important to design no-regret dike reinforcement. From the beginning of the project, changes of hydraulic loads in the future are foreseen. It was clear that around the expected end of lifetime of the storm surge barrier (probably between 2050-2100), the adaptation pathway for the HIJ would need to be updated. Also different progress scenarios of climate change play a role.

The way for KIJK to anticipate these future events is by adjusting design parameters along the way to a definitive design and to build a dike with the possibility of expansion.

Crucial design parameters are the potential failure rate of the storm surge barrier and the design period.

To ensure all decisions are based on the most up to date information available, KIJK and WHIJ have monthly meetings on the progress of studies and the conclusions.

Solution 4: Decision making process

The key parties were involved early in the process which enabled us to jointly formulate decisions and to discuss risks and potential conflicts and develop options to counter these.

To summarise our approach:

- Working in a project team consisting of team members from both organisations.

- Paying attention to stakeholder analysis and engagement.

- A communication process with the stakeholders.

- Managers and decision makers are involved from the start to the finish.

- Second opinions by authorities/experts on the subject being considered.

- The SPR framework was used to create a commonly accepted system image and identify the key parameters that influence the flood risk.

- Making use of each other’s expertise and connections.

What: The outcomes

The main outcomes of the pilot are:

1. A better and joint understanding of the water system.
2. Adaptable dike design that is better suited for the environment.
3. Options for improvement of the storm surge barrier.
4. Working towards a 5% cost reduction on flood resilience measures and future flood risk reduction.
5. Improved cooperation between the water authorities.

The outcomes are expanded on below.

1. Understanding the water system

The System analysis (SPR framework) and Performance analysis provided an overview and common understanding of the water system. This formed the basis of the further analyses.

Next to this, the project WHIJ delivered a better quantitative model that helps to understand the system, the impact of measures and already optimises the design of the dikes. The model is already implemented in the statutory standard for the dike design. For KIJK, according to calculations done by this model, the hydraulic loading is significantly lower, which was expected. The reduction of required height is around 30 cm.

The other analyses done by WHIJ give insight into the possible measures by providing:

- A better understanding of how to improve the failure rate of the Hollandsche IJssel Storm Surge Barrier and the feasibility.

- Conclusion on how to deal with closing the Hollandsche IJssel Storm Surge Barrier – closing at low tide is a very effective measure.

- A better understanding of the impact of water from the regional water system on the Hollandsche IJssel – the regional water system has relatively little impact on the HIJ and at the moment does not have to be taken into account for possible measures.

2. Adaptable dike design

Before the pilots, when looking at the life cycle of project KIJK, it was clear that around the expected end of lifetime of the storm surge barrier (2058), the adaptation pathway for the HIJ will need to be updated.

At the end of 2019 the need to improve the storm surge barrier by 2030 to a failure rate of 1:1000 was apparent. The final decision on this will be taken by RWS, HHSK and HWBP in 2020. It is very likely that in the long-term future a much better storm surge barrier or even a permanent closure of the HIJ will be implemented.

One of the conclusions of a broad perspective study conducted by KIJK in 2017 was that the implementation of water system measures on the HIJ would mean that lower hydraulic loads on the dike are feasible. Based on this study HHSK decided to also lower the design period for height of the dike from 100 years to 50 years. This is for a design solution for construction updates to the dike. For a dike reinforcement solution in soil, the design period was already set to 20 years because of soil subsidence. There is a fair chance that system measures in the future will help in further reduction of hydraulic loads on the dike. If so, then the shorter-than-usual design period will be prolonged up to its usual lifespan of 100 years.

But if for any reason there is a setback in the performance of the flood defences, the design should have in-built ability to be easily expanded to the new statutory standard. Causes could be faster than expected climate change in the future, or the failure rate of the storm surge barrier is not able to meet expected improvement. These risks or chances are incorporated in this design.

Also the other way around, HHSK is now looking for dike reinforcement where it is easy to collapse the top of the construction, because of even higher than anticipated performance of the storm surge barrier or faster policy changes around the storm surge barrier.

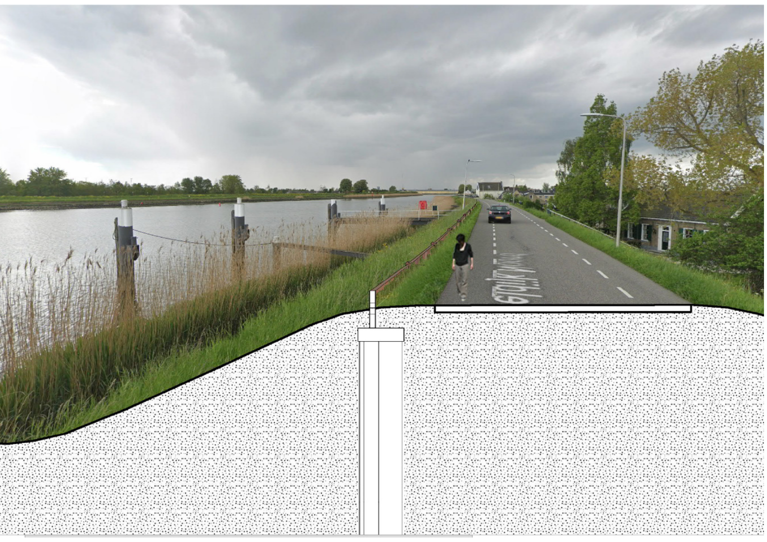


Figure 5: Adaptable design of the dike for the top of the construction. Courtesy Bosch Slabbers Landschapsarchitecten.

3. Storm surge barrier improvement

The water system analysis in 1 combined with a study on the improvement of the storm surge barrier concluded that it is feasible and cost effective to reduce the chance of failure from 1:200 (the current safety standard) to 1:1000. Dike reinforcement cost reduction will be 40 M€ and the expected cost for the barrier improvement is approximately 10 M€.

The next step is to look for finance for all measures, regardless of who the asset owner is. Dike reinforcements are 90 % financed by the national flood defence program. This program is for dikes that don't meet the safety standard. By the end of 2019, the HWBP had approved in principal on the exchange of financial means (e.g. savings in the costs of dike reinforcements are used for investments in the barrier). HHSK and RWS are now working out the details to get the final approval for the exchange of means in the middle of 2020.

Figure 6: One of the doors of the Hollandsche IJssel Storm Surge Barrier is closing due to a storm surge at sea. Courtesy RWS, mediatheek.

4. Adaptation pathway update

Project WHIJ has worked on an optimal solution for flood resilience of the Hollandsche IJssel. In the analyses, we were not only looking at the investment costs but also at the operation and maintenance costs of the assets. The cost benefit analysis concluded that an investment in the storm surge barrier would result in substantial savings of the total costs for flood protection measures along the Hollandsche IJssel (approximately 5% savings in total costs, 30 M€ on 600 M€).

If the final approval on the exchange of means is made in 2020, the adaptation path will be updated and the investments in the storm surge barrier will be included. These changes will be for the middle to long-term period (10-30 years). This joint update of the adaptation path resulted in a better understanding between RWS and HHSK and a willingness to look further than the borders of each individual organisation.

5. Cooperation

Finally, the pilot FPHIJ contributed to a better understanding and cooperation between RWS and HHSK. In the future, we intend to keep collaborating as we did in the pilot, because new knowledge of sea level rises and of the water system will give us the ability to work on the next optimal solution.

The overall benefit of increased cooperation will be to align multiple planning processes.

Reflection on innovation

In our pilot, we experienced some new challenges. To face these challenges, we used different working methods and approaches, but also experienced knowledge gaps. Finally, we realised that some of the policy recommendations, given earlier in the Policy Brief, were also applicable to our pilot.

Reflection on best practices

During the pilots, the following practices worked very effectively:

- Firstly, the basis was an initial thorough analysis ensuring both parties had the same deep understanding of the system, which allowed us to improve the hydraulic loads for the development of the dikes.

- Secondly, we learned to consider the lifespan of our assets. HHSK lowered the lifespan of the dikes to be developed making it adaptable for future improvements within the system.

- Thirdly, a thorough analysis of failure rate improvement was done. This analysis was done with a number of representatives of the asset owner, which created support within the organisation for the possibilities for lowering the failure rate.

Reflection on knowledge gaps

During our work, we also experienced a number of knowledge gaps.

- Firstly, how do we engage key relevant stakeholders in asset management as shareholders and come to an innovative financing arrangement? For our pilot, we need to connect financial budgets across sectors (financial means for dikes need to be transferred to financial means for storm surge barriers). These budgets are both held by the HWBP and they are strictly separated. The transfer from one to another has not been done before in the Netherlands. To find the best way to do this we have held several meetings between HHSK and RWS and also with HWBP to discuss the best options. By the end of 2019, the HWBP had indicated that they are positive on the exchange of financial means (e.g. savings in the costs of dike reinforcements are used for investments in the barrier). HHSK and RWS are now working out the details to get the final approval for the exchange of means in the middle of 2020. Also we use the guidelines for Room for the River projects (in which this transfer might be done in the future). A challenge will also be to retain shareholders involvement in the future to keep the focus on the entire system (instead of on individual organisation's priorities).

- Secondly, there is a knowledge gap in how to communicate effectively with the public, specifically taking into account the uncertainties in our models and the translation from technical findings to create an understandable and engaging story.

- Thirdly, by permitting innovations on the design of the dike reinforcement, introduce the chance (or risk) of adjustment of the design of the dike but there remains a question of how to do this in the most efficient way.

Reflection on policy recommendations

- A key challenge at the outset of this project was to break free of the silo, which was achieved by collectively analysing the total water system to ensure the team started from the same place with the same information. This allowed us to plan the investments in flood defence, together with the water authority and RWS, and to make arrangements to cover finance and risk.

- The second policy recommendation is to make space for innovation. In our pilot we demonstrate how to embrace and manage the risks of new approaches. Our practice here was to be open about the benefits and risks for ourselves and discuss these collaboratively.

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Further reading

The documents relating to the FAIR project can be found on the following websites:

http://www.fairproject.org/

https://northsearegion.eu/fair/

Partners

FAIR brings together Asset Owners (facing real problems and challenges) and leading scientists (with domain expertise) to share and develop innovative solutions to the management of flood protection assets. In doing so, FAIR is the first collaboration of its kind.