Interreg
North Sea Region
FAIR
European Regional Development Fund

EUROPEAN UNION

LSBG
Landesbetrieb Straßen,
Brücken und Gewässer
Hamburg

Pilot flood protection gates Hamburg

A Practice Brief from the Interreg North Sea Region FAIR project

June 2020

Courtesy LSBG.

Preface

The FAIR project

Collectively, EU Member States invest an average of €3 billion per year in flood protection infrastructure. Nevertheless, a combination of climate and socio-economic change is increasing the average annual damage caused by flooding. Complex and difficult decisions will need to be taken in response to these threats, especially in coastal regions, as rising sea levels challenge the sustainability of existing policies and plans. An improved approach to the planning, design and management of new and existing flood protection assets will be crucial to address this challenge.

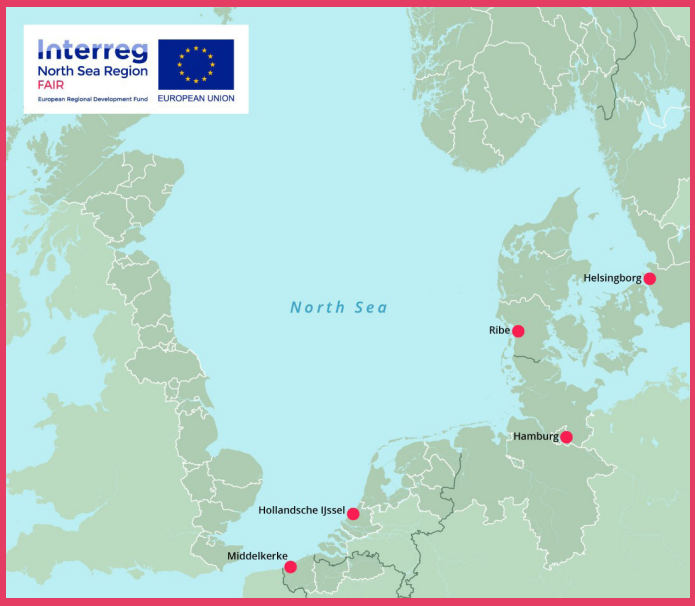
FAIR brings together flood protection asset owners, operating authorities and researchers from across the North Sea Region (NSR) to share policy, practice and emerging science of flood protection asset management.

This Practice Brief

This Practice brief presents;

- **Why** this project is proposed.
- **How** we dealt with the challenges that we are confronted with.
- **What** we achieved within the FAIR project.

It also considers the FAIR Policy recommendations and approaches presented in the FAIR end report.



The FAIR results

The storm surge protection facilities in Hamburg, including some very complex structures, are working effectively due to good maintenance by qualified experts. Nevertheless, it is essential for us to extend the lifespan of the assets and reduce the life cycle costs at the same time.

In the future however, we need a more condition-oriented maintenance strategy that, in addition to valuable employee experience, focuses on the condition of the facilities, the legal framework for operations, the available resources and operational requirements. Furthermore, adaptability, multi-functionality and the whole life cycle of an asset need to be taken into account.

In addition to setting up this future-oriented maintenance concept, it is necessary to find a suitable way to document existing data in a structured manner, to have direct access to all asset-related data. International exchange and collaboration with scientists and asset managers in FAIR is a valuable support to achieve this goal.

There are many complex and interacting planning processes and factors that influence effective asset management (often with centralised processes delivered by dispersed, local operators).

Well-aligned asset management is dependent on having a coherent strategy in place to link flood asset planning, construction and operation, with broader planning objectives. In many cases, strategic oversight by, for example, a responsible authority, is required to provide the bridge between these multiple planning processes and flood protection asset management.

Significant new ideas and methods are being developed to ensure best value asset management options are identified for both existing and new infrastructure. However, their alignment with socio- economic policies and supporting governance systems is often neglected. FAIR recognises these challenges and identifies the following four priority policy recommendations to advance flood protection asset management:

1. Break-free of the silo.

2. Mind the gap.

3. Prepare for change.

4. Make space for innovation.

Summary

Assets, which are in round-the-clock operation (24/7), require a different maintenance strategy than those, which are used only for a few hours per year. For this specific second case we selected three flood protection gates in the city centre of Hamburg as our pilots in the FAIR project. The overall objective, to which all further insights relate, is to increase the reliability of these assets despite reducing their maintenance costs.

Furthermore, the quality of the maintenance should stay high or even increase. **A constant asset availability is our top priority.** A well-thought-out maintenance concept, which explains the basic strategy as well as the schedules, gives the people responsible more confidence in their actions.

Manufacturers of components installed in equipment typically recommend maintenance instructions and intervals designed for 24/7 operation. This is precisely where an adapted maintenance strategy needs to be developed, addressing the needs of individual parts but also taking into account the entirety of the system. Changes compared to the maintenance instructions or recommendations of manufacturers are only to be carried out if they are not detrimental to the components. Usually, the manufacturer's warranty of the component will be invalid in these cases.

The experience from the last 5 years shows the tendency that (as of a certain point) with increasing complexity (automation, redundancies, external power supplies, etc.) the reliability of the entire system decreases, because failure of a single, small component can compromise the overall functionality. So one of the important goals in the future is to define which degree of complexity relates to the maximum point of reliability (see Fig. 1).

Due to the higher complexity and thus, an increased number of components, a gate is considered a vulnerable system.

On the one hand, we considered the failure of individual components in a gate (the entire system) and on the other hand the incorrect operation by personnel. The most probable reasons in case of incorrect function would be a lack of experience of the operation team. Another difficulty is posed by the fact that some gates are too complicated to easily perform troubleshooting if problems occur during operating. Nowadays, there are no in-house operation staff available and tasks have to be outsourced to external contractors. Incorrect operation can easily occur because of the high level of stress for the task force while operating the gates - especially if failures occur.

In addition, complex assets, even more so than simpler ones, require a clear process regarding action and strategy for maintenance. This needs a complete and action-friendly documentation and legal certainty. From the insights gained in the FAIR project, the development of such a system has been initiated. At

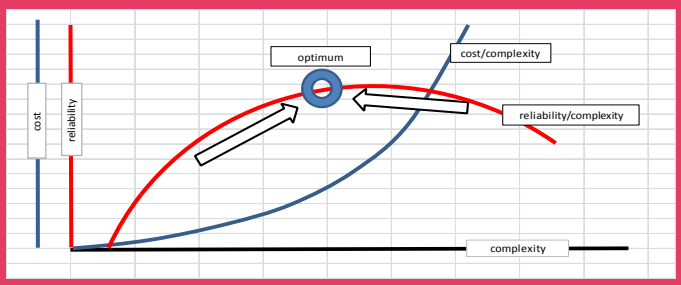


Fig. 1: Relations between reliability, complexity and cost (LSBG, 2015) Courtesy LSBG.

least for assets that are more complex and therefore much more expensive in investment and maintenance.

In summary, less complex flood protection gates with the same reliability are cheaper in terms of investment, maintenance and operation.

The Context

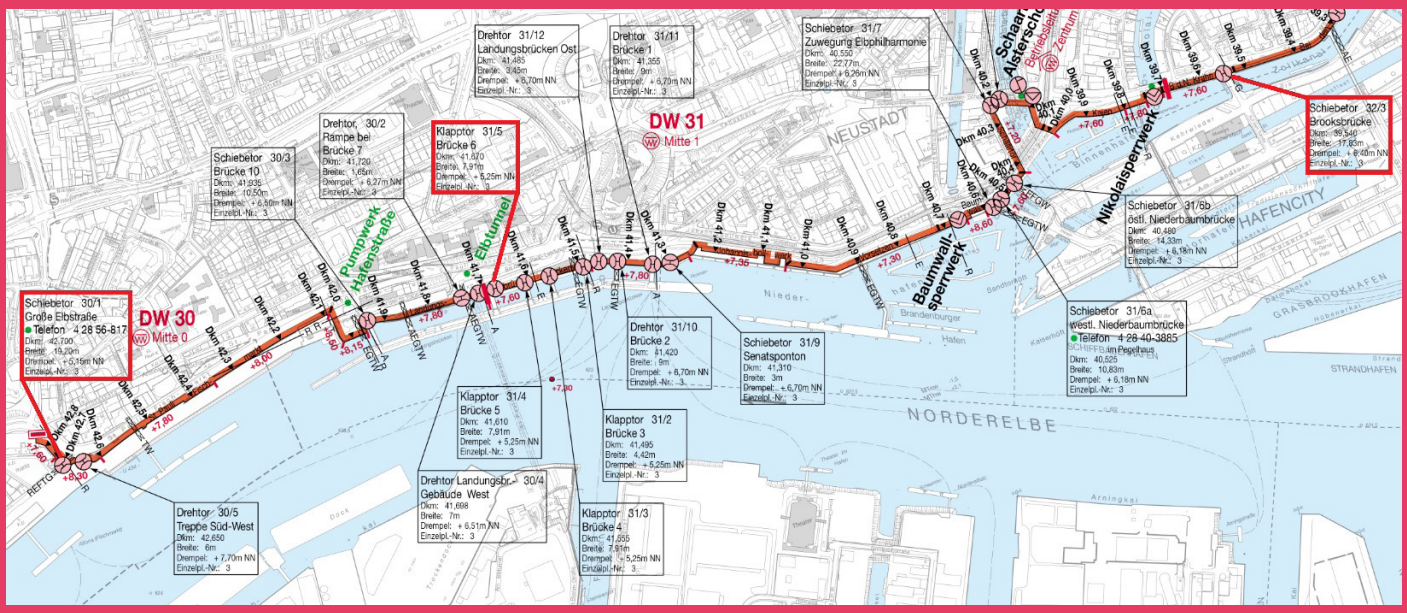


Fig. 2: Location of the FAIR Pilot Gates in the city centre of Hamburg (LSBG, 2015) Courtesy LSBG.

Among other tasks, the "Agency of Roads, Bridges and Waters" (LSBG) is responsible for the maintenance of most of the public flood defence gates in Hamburg. In the Interreg FAIR project three of these gates have been identified and selected as pilots. These gates were chosen because they feature the functional criteria present in the challenges we are facing (more information in chapter "Summary" first section and "The Purpose"). The base case is as follows.

The gates are fully automated and almost every component in the system is redundant. By design a stop lock system represents a second dike security line. In case of power failure the power supply is partly supported by an emergency power generator. All pilots are remotely monitored but not remotely operable. The operating time is approximately 10h per year, which is very seldom, but the gates must be highly reliable at these precise moments.

A previous strategic decision meant a large number of operational and maintenance tasks were outsourced and contracts were set up with external companies. These external companies are not as familiar with the assets as in-house LSBG staff would be and they do not have a similar in-depth knowledge of the gates.

Many documents including inventory documents, maintenance instructions and permits cannot be retrieved centrally and in some cases they are not complete or do not exist at all. Data, which is relevant for the flood protection assets are stored in different places so it is sometimes difficult to find out which data is available for a specific asset.

In the FAIR project we have realised that these problems are widespread and affect other partners as well.

Why: The purpose

The key challenges

The key challenges of the Hamburg pilot are to optimise asset management.

The optimisation essentially includes the improvement of the maintenance concept for the flood protection assets as well as the integration of all relevant data in one information system that is web based and can be operated intuitively. We need to start focussing more on a LCC oriented approach instead of an investment costs oriented one. Furthermore, we strive for a standardisation of solutions (e.g. monitoring of all assets, remote control and unified structure concepts).

We are looking for the optimum degree of automation of the flood protection assets and want to define this point. Another huge challenge will be the design and construction aspect of selecting a single contractor offering a warranty and complying with the EU machinery directive.

The intended effects

Within the FAIR project, we want to question the optimum degree of automation to either confirm our asset design strategy or adapt it in the upcoming building program. With a new structured process-oriented maintenance concept for Hamburg's flood protection assets we want to increase asset reliability whilst reducing maintenance costs. Furthermore, through the standardisation of solutions like monitoring, remote control or basic structure concepts, we can simplify the technical framework. This adaptation facilitates an easier operation and the long-term understanding of our assets by the operational staff.

By developing a web based "Dike Information System" (DIS) we aim to increase the efficiency of our staff and all shareholders through better accessibility of all relevant data related to the flood protection assets.

In the upcoming building program we strive for only one general contractor, for example a manufacturer of a flood protection gate. This will give the people responsible the necessary certainty to release/transfer/hand over a completed, legal to operate, compliant, asset to the operational team and avoid litigation regarding warranty.

To be able to provided focussed maintenance work in the future we assess the whole floodgate operation system. The System is divided into units such as flood forecasting, flood warning, mobilisation and closure. The risk-based approach enables us to zoom into the processes that a successful closure of a flood protection gate requires, hence critical processes can be highlighted and focal points regarding maintenance reorganised accordingly.

How: The approach

To get a detailed overview of our pilots we started to analyse and document our maintenance processes. For this, we were using the long-term experience of the responsible maintenance personnel as the basis of our analysis. After the first evaluation, we decided to question the manufacturers' maintenance requirements for specific components because we use these components in a unique way. The idea behind this action is that many components presumably do not need the requested maintenance intervals defined by the manufacturers. Additionally, we document all failure occurrences and sort them by technical or human failure to get an idea which kind of problem we have to handle or are confronted with.

Together with the Hamburg University of Technology (TUHH) we performed a risk analysis of emergency operation processes of flood protection gates. This action should give us more detailed information regarding possible failure sources including technical and human errors. We documented all possible sources of interference and gave them a probability of occurrence and an appropriate time value. Therefore, we can identify realistic delays for the operation process. With this data, we can define the time schedule for operating the gate and respectively the build-up of the second defence line.

What: The outcomes

The results of the FAIR project for LSBG are essentially an adapted, well-structured process-oriented Maintenance Concept, which takes into account the several particularities as well as the development of a web-based "Dike Information System" (DIS), which can be operated intuitively. For now, the DIS is already available for a specific group of people in Hamburg and provides all relevant data of the flood protection assets.

Furthermore, a performance analysis and the comparison with other non-complex flood protection structures to optimise the reliability and LCC of the flood protection gates have been carried out as a basis for construction decisions in the future.

As an extra benefit, we also accomplished several non-priority results, which are;

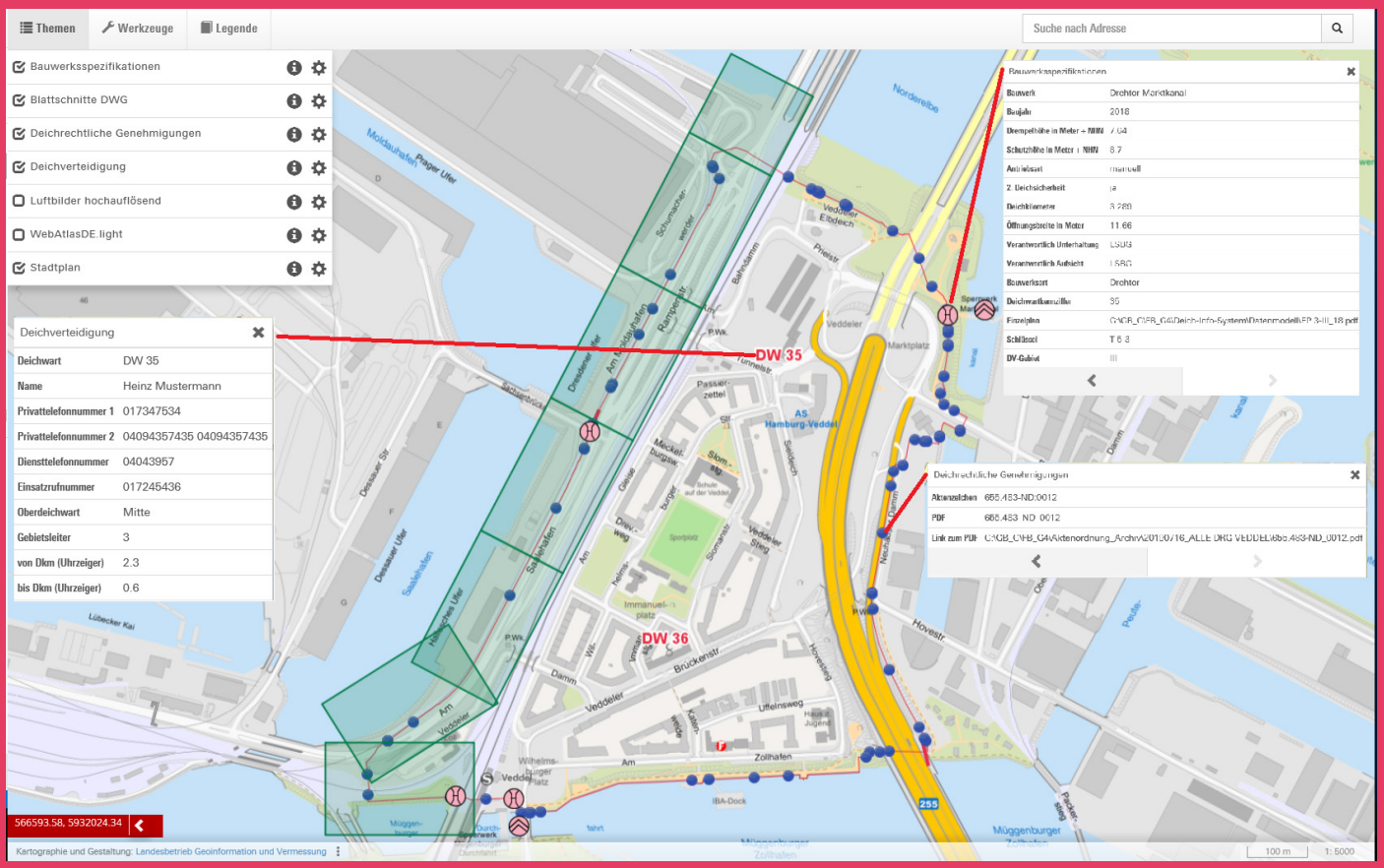
- LCC – start discussions internally.
- Improvement of the internal awareness.
- Policy Brief.
- Policy debate.
- Peer 2 Peer meetings/exchange experiences with partners.
- Improvement of internal collaboration.

Reflection on innovation

An essential part of the FAIR project was the innovative approach to look at the existing gates critically and from different points of view in order to get a better understanding of their function and operation. With these new insights we can optimise these assets in the future. Furthermore, it provides us with important information for the future improvement and design of new gates as well as for a legally compliant operation.

A special, innovative step is the development of a geo-referenced, web-based information system. Data, which is stored at various locations in the city of Hamburg, can be presented in an integrated way and used by authorised people in a fast and unambiguous way. This will result in a considerable work advantage in terms of quality and acceleration of work. In this context, it is also important that the data represents the current status of all information available on the flood protection asset (e.g. dike or gate) without exceptions.

In the course of the project work, a maintenance concept was developed that enables us to manage the maintenance of the facilities in a structured and sustainable manner. A permanent improvement process is the key to identifying and improving the strengths and weaknesses of the assets themselves as well as the maintenance work.



Early development stage of the DIS courtesy Freie und Hansestadt Hamburg, Landesbetrieb Geoinformation und Vermessung.

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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.