# Adaptive asset management for flood protection: A perspective from the North-Sea Region

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Collectively the EU Member States invest on average some €3 billion per year on flood protection infrastructure. Yet the annual average damage caused by flooding continues to increase, largely in response to a combination of climate and socio-economic change. Increasingly complex and difficult decisions will need to be taken in response to these threats, especially in coastal regions as sea level rise challenges the sustainability of existing policies and plans. Providing an improved approach to the planning, design and management of new and existing flood protection assets will be central in responding to this challenge. While significant new ideas and methods are being developed to ensure best value asset management options are identified for both existing and new infrastructure, often the alignment of the important and parallel socio-economic policies and supporting governance systems is neglected. Hence getting the policy right for the future is essential. The FAIR project brings together flood protection asset owners, operating authorities and researchers from across the North Sea Region (NSR) in recognition of these challenges. This paper sets out the findings of this project and in particular, despite the heterogeneity of the NSR, the common challenges faced and the four priority Policy Recommendations that are necessary (but not sufficient) to make in flood protection asset management, including: Avoid the silo: Mind the gap: Prepare for change: Make space for innovation. This paper elaborates the drivers behind these challenges and highlights examples of good practice from across Europe.

## 1 Introduction

Collectively EU Member States invest an average of €3 billion per year on flood protection infrastructure. But a combination of climate and socio-economic change is increasing the annual average 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. These challenges are compounded by the ageing asset base and multiple demands on resources that exist across different sectors and countries.

In 2015 the EU funded the FAIR programme that 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. FAIR recognises that despite the diverse character of the NSR, asset managers face common challenges across the region; in particular around how to best manage flood defence infrastructure and ensure they are appropriately adapted to an uncertain future. planning, design and maintenance of flood assets. Although there is no single sliver bullet, there is consensus on the urgency of the issues to be addressed and what was needed to make real progress (FAIR, 2019. This, includes four Policy Recommendations, namely:

- **Break-free of the silo:** Align multiple planning processes within, and beyond, flood management;
- **Mind the gap:** Link strategic planning and operational processes through a tactical handshake;
- **Prepare for change:** Develop flexible strategies and asset designs that can be adapted to meet changing requirements in future;
- **Make space for innovation**: Embrace and manage risk to support the development of innovative solutions.

This are elaborated below together with the common issues and prerequisites or progress if progress is in 'making adaptation happen'.

## Avoid the silo

### Challenge #1: The institutional context for asset management is often fragmented

Flood protection is necessarily a multi-stakeholder endeavour, bringing together issues of place making through spatial planning, investment, aesthetics, acceptable risks and many more. Flood protection asset management seeks to balance these perspectives and trade-off issues of cost, risk and performance at multiple scales (from a single asset and to the system of assets that may act in combination to provide flood protection); a

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context that is familiar to all asset managers and reflected in the ISO 55000[a].
The demands of local communities for protection and the national desire for efficient investment are not always compatible. For some cases, it may not be viable (from a national economic perspective) to invest in improving flood protection locally (due to the relative cost and economic value of doing so). Understanding how to leverage local funding and private investment to supplement national sources and to ensure national choices are not simply based on maximum return (but consider broader issues of social justice and well-being as well as ecosystem health (Sayers et al., 2017) are common challenges.

The institutional context within which these challenges are responded to and flood protection assets planned, promoted and managed is therefore crucial. Typically, no single organisation is entirely responsible for asset management throughout all its stages (although exceptions do exist, for example Helsingborg Municipality, Sweden, see below). In most countries, roles and responsibilities are dispersed amongst many organisations and any mismatch between these responsibilities and the available capabilities and resources can undermine the provision of flood protection that is fit for purpose. For example, a self-assessment of asset management approaches by each FAIR partner points to the strengths of a decentralised governance model (in terms of coordination and problem solving between the different departments of an organisation) but also highlights the risks of adding responsibilities to municipalities without sufficient resources or knowledge to deliver (Gersonius et al., 2018).

### Policy recommendation #1: Align multiple planning processes within and beyond flood management

There are many complex chains, interacting processes and actors in effective asset management. There will be centralized processes in place and dispersed, localized deliverers and operators. Policies need to ensure that there are effective inter-linking strategies in place for asset planning, delivery and operation, such that the entire process, from centralized strategies to local delivery is managed as optimally as possible. This will require in many cases, a strategic oversight by one or more responsible authority or process leader who needs to be accountable. However, such oversight should ensure that local and dispersed functionality is appropriately utilised to inform the integrated planning, delivery and operational processes. For example:

- **Sweden, integrated city planning, Helsingborg:** The municipality of Helsingborg leads the coordination of all aspects of city planning. This context enables a series of major investments in the regeneration of the seafront and harbour area (including green space and beach access) and improvements to the flood protection standards to be considered simultaneously and plans adjusted in response to resources and changing needs.

- **England, Strategic oversight and local delivery:** Following widespread flooding in 2007 arrangements were put in place to enable more effective working between the main agencies involved in managing risks. The Environment Agency[b] was given the responsibility of strategic oversight of all flood-related planning with delivery devolved to local municipalities designated as the Lead Local Flood Authority (LLFA). LLFAs are one 'department' of a local municipality and therefore local policies and activities need to balance the needs for local flood protection and a range of other activities including: education; public health; crime; highways *etc.* Overall these arrangements are broadly successful in enabling a more strategic approach to flood risk management (Defra, 2017) when adequately resourced but can be impeded when there is either a lack of resource; differing objectives, priorities and regulatory environments, within and between partners; a mismatch between public expectations and delivery; a lack of the necessary partner skills, capacity and knowledge.

## Mind the gap

### Challenge #2: Strategic planning and operational processes fail to align

Good asset management requires strategic plans and perspectives to link seamlessly with operational activities and perspectives. This is easier said than done. There is often a 'gap' in responsibility, with organisations tending to be divided between strategic and operational activities, making it easy to consider each as a standalone process. Without a clear line-of-sight from operation to strategy and vice versa, strategic objectives are likely to be undermined by operational realities and the operations may fail to reflect the longer-term direction set by the strategy. This mismatch can lead to poor targeting of investment and inappropriate design and maintenance choices.

### Policy Recommendation #2: Link strategic planning and operational processes through a tactical handshake

FAIR promotes the development of a 'tactical handshake' between strategy and operation. Establishing a culture of collaboration (inside and outside of any single organisation) is central to the success of this continuous process. But although necessary, this is not enough. A shared understanding of the assets to be managed is vital (including basic information on what and where the

[a] International Standard 5000 provides a useful overview of asset management, its principles and frameworks applicable to all organisations

[b] The Environment Agency was the first organisation worldwide to have achieved ISO 55000 accreditation for flood risk asset management.

assets are, to how they are likely to perform now and in the future). This includes, for example, the adoption of structured assessment processes (methods, monitoring and data bases) that progressively refine performance information and enable understanding captured through detailed level assessments to be reused in higher levels plans and insights from strategic assessments to inform more local analysis. FAIR highlights several approaches that are emerging to aid this process. Progressive approaches to performance (such as fragility assessments that enable uncertainty to be reduced without influencing the form of the performance data (Sayers et al., 2002)) and 'total expenditure' (TotEx, enabling whole life capital, maintenance, modification, and eventual removal costs to be assessed (Klerk and Heijer, 2016)) help bridge the gap between strategy and operation by providing a common assessment framework at each level. Developing a structured understanding of the indicators of asset performance is also central to ISO 55000, a finding reinforced here. For example:

- **Netherlands, reducing life-cycle costs through a more strategic approach to delivering the statutory protection standards:** The dykes along the river Hollandsche IJssel no longer meet the statutory standard. The river can be isolated from the main River Nieuwe Maas by a storm surge barrier; but the dykes are the responsibility of the regional water authority (HHSK) whereas the storm surge barrier is the responsibility of Rijkswaterstaat. The barrier controls the hydraulic loads on the dykes. Improving the reliability of the storm surge barrier also decreases the expected hydraulic loading conditions on the dykes; but investments in the barrier are needed to realise this. By working together, it has been possible to trade-off costs and benefits between dyke and barrier improvements operations in a way that reduces whole life-cycle costs without compromising standards; opportunities that a programme focused on dyke strengthening only would have missed.
- **Hamburg, Germany, developing a strategy approach to the management of 'on demand' assets:** Hamburg is protected from flooding by a range of measures, including a complex array of automated flood protection gates that are required to operate (on average) about 10hours/year and to a very high standard of reliability. Understanding the trade-off between the benefits of a highly automated approach and the potential increased chance of error (due to the complexity of the process) is a challenge. Data and information is central in responding to this challenge and LSBG Hamburg are developing a georeferenced asset information system that not only focuses on geometry and functions but also operational permits, as-built details, and the consequences of failure, to help understand the system behaviour and target maintenance.

## Prepare for change

### Challenge #3: The future is uncertain but decisions we make today are long-lived

We can be sure that the future will be different from the past; but how it will be different is impossible to say. Developing flood protection infrastructure in this context presents several challenges, for example how much should be invested today in strengthening and raising assets and where it is possible to delay investments. These are complex decisions when the climate and socio-economic circumstances change (sometimes profoundly) over the life time of the decisions being made.. Short-term political realities and varying perceptions of risk compound these difficulties, and because of this, maintenance and monitoring typically receive a lower sense of urgency compared with large scale infrastructure investments, renewals or upgrades. This bias leads to solutions that may be unnecessarily costly or mal-adapted to the reality of the future as it emerges.

### Policy Recommendation #3: Develop strategies that are flexible and asset designs that are capable being modified.

Policies and associated appraisal processes should provide a platform for the development strategies that proactively plan for an uncertain future and can be modified as new evidence and insights emerge. Investments in monitoring and evaluation (assets, the loading conditions and the socio-economic setting) underpins the continuous process of updating both the strategy and operational delivery to ensure flood risks are well-managed and plans can be adapted in a timely manner.

Developing the capacity for future flexibility is not simply 'wait and see' but is a process of purposeful preparation and often comes at a price today (*e.g.* the cost of securing land for future set back of a dyke line or strengthen foundations in preparation for future raising). Various tools and techniques are available to help make this case (from visualising adaptive pathways to formally valuing adaptive capacity – see below). Using these tools and approaches can help asset managers balance performance, risk and cost over the short and longer term by maximising societal value and avoiding solutions that may be unsuitable for future conditions. For example:

- **England, developing an adaptive plan for the Thames Estuary.** The Thames Estuary 2100 project (TE2100) was established in 2002 with the aim of developing a long-term tidal flood risk management plan for London and the Thames estuary. The resulting TE2100 Plan (Environment Agency, 2012) sets out a management strategy that can be adapted in response to future change including climate and socio-economic change.
- **The Netherlands and England, visualising and valuing adaptive pathways:** New guidance and tools are being used to both visualise and value the flexibility offered by adaptive approaches. The guide

includes advice on considering adaptive approaches at different stages in appraisal and formally valuing the adaptive capacity (Environment Agency, 2018). Software tools are also being used to visualise and explore alternative pathways in an interactive way together with stakeholders, providing insights into the adaptation options available, the sequencing of options over time, potential lock-ins and path dependencies[c].

- **Denmark, embedding flood and erosion in local planning:** In 2013 Danish municipalities were required to prepare climate adaptation plans that integrate erosion and flood protection within their long-term strategic planning processes (including urban development, wastewater management and environment). Despite not being required to revise the plans, the importance of doing so is widely recognized and many municipalities continue to work with national organizations to reflect better evidence on present and future risks and potential adaptation options within local planning decisions.

## Make space for innovation

### Challenge #4: Innovation is often not embedded in standard working procedures

The UK's Chief Scientist's Annual Report 2014 (Walport et al., 2014) stated that to be successful, a society must learn to manage risk and not simply seek to avoid it. Innovative solutions, and how to generate the political momentum to deliver these, remains a central barrier to progress. For example, the policy in recent years within England and Wales has been guided by the principle of *'Making Space for Water'* (Defra, 2004), in the Netherlands providing *'Room for the River'*[d] and across the NSR the role of nature-based approaches as legitimate flood assets is increasingly recognised. The sentiment of these policy goals is clear but often at odds with the local political and public response that prefers conventional, tried and tested, solutions. Consequently, asset managers face challenges in promoting and delivering more innovative solutions that challenge accepted norms.

### Policy recommendation #4: Accept that with new approaches comes risk, managing rather than avoiding such risks can lead to innovative solutions.

Policies should provide the platform for the inclusion of innovation – from ideas to implementation, regulation to analysis and in the role of institutions and stakeholders. Central to the successful delivery of innovative solutions is to challenge the wisdom of conventional approaches and be positive in promoting new ways of working. This means rewarding innovation (through, for example, ring fenced innovation and pilot funds) as well as giving space to innovators from industry and academia to transition novel approaches into practice by accepting the potential for greater uncertainty. For example:

- **North Sea Region, learning from others**: New practice can emerge from interacting with others addressing similar challenges. FAIR uses Peer2Peer meetings to create an active open space to discuss approaches to reliability, responsibilities, information management and future developments in flood protection; challenging established practices and promoting opportunities for innovation.
- **England, natural flood management:** Promoting the role of natural features to slow the flow of flood waters through catchments and urban spaces, and realignment of the coast to maintain littoral processes are being proactively pursued across the UK and widely considered to offer multiple benefits. Based on limited quantified evidence (Dadson et al., 2017) on their ability to manage flood risk, pilot studies and demonstration project have been funded by central Government to encourage take-up and develop the evidence base (Defra, 2018).
- **Helsingborg, 'innovation of the year'**: The Municipality awards an annual prize to most innovative project initiated during the year. There is even a prize for the 'failure of the year' that goes to an innovative project that did not necessarily turn out as expected. The purpose is to reward those that challenge the conventional approaches and encourage staff to embrace innovative solutions across all aspects of their work (e.g. from conception to implementation and from public engagement to funding).
- **Netherlands, innovative dike reinforcement techniques proactively encouraged:** The opportunities provided by innovative approaches to dyke strengthening and emerging monitoring technology are widely available. For example, the national Dutch Flood Protection Program provides support funding for the development and testing of innovative dyke reinforcement techniques. Asset owners are also encouraged to use innovative sensor technologies to gain insight into dyke strength and performance (often in real-time an at a relatively low cost[e]) to maximise safety and optimise maintenance activities.
- **Belgium, multi-functional and adaptive dyke reinforcement:** In Middelkerke an existing dyke wall is being augmented with a dune system to provide a natural habitat and enhanced recreational opportunities. The dune also provides a natural adaptive capacity and can be widened or heightened to cope with sea level rise.

## 3 Making adaptation happen

Building upon the four Policy Recommendations from the FAIR project set out above, a process of expert discussion and elicitation (held in Oxford, February 2020) considered

[c] https://www.deltares.nl/en/adaptive-pathways/
[d] Ruimte voor de Rivier (2018) https://www.ruimtevoorderivier.nl/english/
[e] http://deltaproof.stowa.nl/Templates/pdf.aspx?rId=16

what was needed to 'make adaptation happen'. From the workshop several themes emerged:

### Recognising common issues

Adaptation is more than simply modifying a flood defence asset – it a process that requires innovative, whole system, longer term thinking. Achieving this relies on profoundly recognising:

- **'Our world is changing faster than our** thinking' – we need to catch up
- **Adaptation is a 'people thing'** – including individuals, communities, politicians, planners and engineers
- **Uncertainty is driven by more than climate change alone** – development (local and remote), funding, societal preferences an all have profound implications for the choices we make.
- **Change starts with you**! Flood management is in a pivotal (although perhaps not leading) position to influence change - we must 'break free of our silo – we all have to reach out.

### Addressing the prerequisites for progress

To make progress in flood and coastal management we must be better at:

- **Envisioning and visualising the future** - Storylines can be powerful agents in supporting buy-in to an alternative course of action.
- **Addressing the hard choices** - Adaptation 'at the edges' is easy but to address the hard choices (from realignment, to food security) is much more difficult, but are central issues.
- **Recognising adaptation as a purposeful process** – not kicking the can down the road - 'own (not make) future choices today'
- **Accepting adaptation is not a free lunch** – how much are we willing to pay for future flexibility/reduced lock-in?
- **Avoiding bear trap of 'paralysis by analysis':** We have many of the tools. We have much information. New data is not always needed (sometimes it may be) –we can use the information we have to make better choices today.
- **Delivering adaptation as a continuous process** - you can't get 'adaptation done'; adaptation is an ongoing process that balances the dual masters of ambition and practicality.

## The way forward – A knowledge agenda

FAIR is the knowledge agenda (FAIR, 2020) considered by the beneficiaries in the project to be the science and research has a role to play in enabling future adaptive asset management. Five important gaps have been identified by the FAIR partners that provide a 'knowledge agenda' to focus these efforts. These include:

**Gap 1 From (big) data to information:** Q1: How can we better measure asset performance and deterioration, and therefore better understand asset dynamics over time? Q2: How can we translate Big Data on all aspects of AM into good quality and valuable information for decision making?

**Gap 2 From uncertain information to AM policy**: Q3: How do we take robust and adaptive decisions now with uncertain and changing information about the future? For example, how can the greater inherent flexibility of natural assets be formally considered, and how blended (natural and built) asset systems be created that are able to cope with change.

**Gap 3 From AM policy to action**: Q4: How can we manage our organisation(s) to efficiently translate AM policy into actions?

**Gap 4 From stakeholder to shareholder:** Q5: How can we engage key stakeholders to take a real interested and engaged in AM, thus creating innovative financing opportunities and (better) sharing risk?

**Gap 5 Engaging Society:** Q6: How can we engage with society in the way needed to ensure that assets are delivered and managed in the best way?

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