Integrated System-based Asset Management

The Business Case for scaling-up Building with Nature in the Netherlands

EcoShape

Contents

Summary

Building with Nature (BwN) works: the time is ripe for its definitive scale-up in Dutch water management. This paper discusses the essential findings that emerge from more than a decade of EcoShape experience in BwN knowledge development, projects and dialogue with key Dutch stakeholders.

BwN is an approach that makes active use of natural forces and processes to develop, implement and upscale Nature-based Solutions (NbS) for water-related challenges and infrastructural needs. NbS involve a combination of green and grey solutions. In addition to the primary function they fulfil for infrastructural purposes specifically, they maximise the combined benefits for society and ecology.

This paper advises the adoption of Integrated System-based Asset Management for mainstream BwN projects in the Netherlands. The authors hope the findings and the recommendations presented here will motivate Dutch water managers to embed a system-based vision with BwN at its centre in Dutch water policies.

A clear shift towards NbS rather than conventional infrastructure approaches can be seen both in the Netherlands and internationally. The global Climate Adaptation Summit on 25 and 26 January 2021 recognised water as the main challenge for climate adaptation and NbS as a critical way to achieve resilience and sustainable development in the future. Numerous NbS interventions and pilot projects have been executed in the last decade and others are still in progress. A large contingent of NbS ambassadors is developing in the young generation of scientists, engineering and industry professionals, as well as government officials.

Despite all these developments, mainstreamimplementation remains a distant goal and the full potential of NbS is certainly not yet being exploited. In this paper, drawing on more than a decade of on-the-ground experience and interviews with key players from the Dutch water sector, EcoShape has identified key lessons learned and enablers, to establish a compelling business case for the upscaling of BwN. Key lessons learned include:

- Proactive and early stakeholder engagement;
- Exploiting the broader range of benefits;
- Combining different sources of funding;
- Embracing dynamics and uncertainties;
- Developing flexible procurement and contracting procedures; and
- Leveraging political will and furthering institutional collaboration.

These lessons indicate that broader engagement, flexibility and collaboration are required, and also highlight the current compartmentalisation of the institutional structure of Dutch water management as a key obstacle to the definitive mainstreaming of NbS in the Netherlands. EcoShape therefore believes that the introduction of Integrated System-based Asset Management (ISBAM) is the way forward to realise the full potential of NbS. ISBAM involves managing assets in their broader geographical and socio-economic context: optimising the functions of the system as a whole rather than the functions of individual objects or networks. This means operating outside of the governance silos of the current water governance infrastructure, and engaging proactively with a wide variety of stakeholders, including asset managers, landowners, nature conservationists and water managers. The institutional embedding of ISBAM throughout the water management sector will not come naturally: the maturity of system-based asset management in this sector has progressed only slowly in recent decades, and there are still many challenges remaining in interorganisational cooperation and information sharing.To support the institutional embedding of ISBAM, it will be necessary to continue research looking at system-based, natural and socio-economic, dynamics to define risks and adaptive management needs better. The proactive involvement of stakeholders and funders will also be needed to establish stronger business cases with a broad range of parties, and it will be important to share knowledge and build capacity in key organisations, both in government structures and elsewhere. This paper recommends three practical steps to advance the embedding of ISBAM in institutions:

1. The formulation of a clear vision of ISBAM, for example in the form of a regional development plan, river basin plan or water management plan;
2. The establishment of a specific trial programme focusing on a specific system. That system should be located where there is the maximum potential to leverage ongoing activities that are easily compatible with the ISBAM approach; and
3. The identification of where the responsibility for setting up and managing ISBAM throughout the country should reside.

1. Introduction

The Netherlands has a special and long-lasting relationship with water. The country is located in a large river delta and one-third of its territory is below the current sea level. The first hydraulic interventions to manage water date back to the thirteenth century [1].

A series of water management interventions followed, generally in response to a major flood or a near-miss. Some of the best-known examples include: the 1916 flood that led to the construction of the Afsluitdijk barrier dam and the reclamation of land in the Zuiderzee; the 1953 flood that led to the Delta Works; the 1993 and 1995 floods that resulted in the Room for the River programme; and the recent excessive rainfall events that have resulted in the development of new management principles for regional and urban water management. At present, the Netherlands is protected from flooding by an elaborate network of dikes, storm-surge barriers and soft coastal defences such as dunes. These physical defences are supported by well-funded water management programmes, and an efficient and experienced water governance infrastructure. However, traditional infrastructure management, which focuses especially on flood risk management, no longer meets today's needs. A water management system that favours fast river discharge to the sea may reduce flood risk but it also results in limited groundwater recharge, susceptibility to drought, and the loss of natural habitats and biodiversity. Large monofunctional structures such as dams and dikes cut communities off from the water and require abundant primary resources for their construction and maintenance. Deeper navigation channels and harbours result in more turbidity and poorer water quality. Climate change, which has already led to increased storm intensities and sea level rise – events that are expected to become more common in the future – will only aggravate the pressures on these systems. To meet the challenges of the 21st century and fulfil sustainable development ambitions, the water management system in the Netherlands needs to continue adapting and to progress from traditional to innovative solutions.

Over the centuries, people have been fighting water, and nature in general. In the past few decades, however, a shift away from this traditional approach has been seen, with successful examples of working and building with, rather than against, nature. Building with Nature (BwN) is an approach that makes active use of natural forces and processes to create, implement and scale up Nature-based Solutions (NbS) for water-related challenges and infrastructural needs. Those solutions do not imply green-only solutions; they involve the optimal combination of green and grey approaches depending on the specific system and natural process at play. They are intrinsically multifunctional, innovative, dynamic and context-specific [2]. They therefore provide ecological and social benefits in addition to meeting primary objectives such as flood risk management, safe navigation or water extraction, storage and distribution. The adaptive elements of NbS also provide the time and opportunities needed to manage uncertainty and acquire the requisite experience.

These solutions can therefore deliver the ideal tools for addressing uncertain developments. The Netherlands is playing a pioneering role in this shift towards NbS: projects such as Room for the River[1], the nourishment and flood risk management strategy for large parts of the Dutch North Sea Coast, the Houtrib Dike[2], the iconic Marker Wadden[3] and the pioneering Eems-Dollard 2050[4] programme are only some of the most relevant examples.

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1 https://www.rijkswaterstaat.nl/english/about-us/gems-of-rijkswaterstaat/room-for-the-river/index.aspx
2 https://www.ecoshape.org/en/pilots/hybrid-flood-defence-houtribdijk-sandy-foreshore-2/
3 https://www.natuurmonumenten.nl/projecten/marker-wadden
4 https://eemsdollard2050.nl/

The current water and climate challenges, the need for next-generation resilient infrastructure [3] and the political will to fulfil Dutch and international sustainability ambitions provide a clear opportunity for a definite change in direction for water management, with multi-functional NbS as a critical keystone. The time is right. The international community at the GCA's global Climate Adaptation Summit identified water as the main challenge in climate adaptation and NbS as a critical way to achieve resilience and sustainable development in the future. High-ranking Dutch government officials such as the current Minister of Infrastructure and Water Management, the Delta Commissioner and the Dutch Special Envoy for Water recognised NbS as the way forward for Dutch water infrastructure. A large contingent of NbS ambassadors is developing in the young and experienced generation of scientists, engineering and industry professionals, as well as government officials. Nevertheless, mainstream implementation remains a distant goal and the full potential of NbS is certainly not being exploited. Public and private organisations are calling for practical guidance to achieve the next step towards standard implementation [4].

This paper presents a guide for the definitive institutional embedding of NbS based on the accumulation of more than a decade of BwN experience in the Netherlands.

2. Key lesson learned: the business case of Building with Nature

A business case is a presentation of arguments that outline the rationale for implementing a project from the perspective of the entity or entities making an investment [5] [6] [7]. In traditional monofunctional projects, this usually means that the cheapest solution required for the function in question will have the best 'business case'. With NbS and for sustainable development in general, the business case is evident given the wider range of benefits and co-benefits in the larger physical, ecological and social system, and also in the longer term when the benefits of the resilient and adaptive nature of NbS become fully apparent.

The key lessons learned that will be discussed here are based on: the experience acquired during twelve years of EcoShape projects [8]; a series of interviews with a range of key Dutch stakeholders (for an overview of the interviewees, see Acknowledgements); a review of international experience [6] [9]; and a feedback session with the EcoShape partner network. These lessons show that proactive stakeholder engagement generates a wide scope of potential benefits from a project. That may result in a broader spectrum of funding sources. In practice, a governance, contractual and maintenance structure is required that can embrace the intrinsic dynamics and the broader scope deriving from this innovative approach.

2.1 Proactive and early stakeholder engagement

Nature-based solutions are multifunctional. They provide benefits that go beyond the individual primary function, which is often flood risk management. These additional benefits can include nature and biodiversity enhancement, carbon sequestration, recreational opportunities and the circular reuse of scarce resources. Each type of benefit attracts a different group of stakeholders, who may benefit directly or indirectly from the project and therefore be willing to support the project, possibly financially. This extends beyond stakeholder support for a project: it implies inviting stakeholders to engage in project identification and design, sharing their objectives, looking for synergies and making them an integral part of the project vision [4].

Aligning objectives with the bigger picture and a common goal can therefore improve the business case and commitment to co-funding. This process takes time, energy and experience: different stakeholders speak different languages, and their objectives and mandates may differ or even be contradictory [10]. Neglecting this process will make the successful implementation of a project less likely, and possibly result in a 'social paradox' where public resources are not spent in the way that benefits society most. In the Netherlands, the participation of stakeholders in the formulation of policy and projects is institutionalised and it includes the involvement of the general public and NGOs for nature conservation. Public bodies such as water authorities and municipalities are well versed in the organisation of, and participation in, processes of this kind.

However, participation may be more difficult for smaller public groups that have a direct interest but lack the requisite time and expertise. These groups are often only informed and they do not actively partake in discussions and design sessions. When all objectives relate to a common goal or programme, all stakeholders benefit and they will proudly support and celebrate achievement, as in the Eems-Dollard 2050[5] project. In this case, the larger common goal is to improve the natural value of the Eems-Dollard and the local economy of the region. This larger goal can encompass multiple stakeholder objectives: a port may wish to reduce sedimentation rates, a nature organisation may want to create areas where animals can breed, or the local water authority may hope to use ripened dredged material for strengthening dikes.

2.2 Exploiting the broad range of benefits

NbS and stakeholders therefore bring a broad range of benefits to the table. However, not all benefits are easy to monetise in order to demonstrate their economic value: benefits such as more habitats or biodiversity can be intangible and subjective and they may be valued differently by different stakeholders; not all benefits materialise immediately since natural processes may take time to develop; and the party that foots the bill may not always be the party that enjoys the benefits [11].

An accurate valuation of these benefits is important because it leads to a more complete, inclusive and fair business case. Increasingly, advances in the field of ecosystem service valuation are helping here.

5 https://www.pianc.org/uploads/files/EnviCom/ToR/ToR-EnviCom-195.pdf

A valuation is particularly relevant if a cost-benefit analysis (CBA) is used to support the decision-making process and identify potential beneficiaries who may be persuaded to co-fund a project. Although CBAs are commonly used in larger projects, they are not mandatory for all projects in water management. Whether or not they are depends on the scale of the project and the financier. In many cases, the selection of a given project alternative depends on other factors such as cost-effectiveness.

A cost-effectiveness analysis, or a CBA with a limited scope that does not cover all the benefits may result in the perception that NbS are more expensive and so they will not be seen as serious alternatives at an early stage. Experience shows that green-grey solutions may be more cost-effective than conventional solutions but a wider scope is required to identify and demonstrate the rationale for NbS convincingly [9]. Examples in the Netherlands that include ecosystem benefits in CBAs show that NbS are serious contenders, and perhaps even more economical than traditional solutions, examples being the Prins Hendrikzand Dijk[6] [12] or the Eems-Dollard 2050 programme.

2.3 Combining diverse funding streams

The assessment of wider benefits provides a basis for identifying beneficiaries and therefore possible sources of funding. For example, when a wide green dike is built, a port authority may decide to provide dredged material on an in-kind basis, reducing the overall costs of the project. Alternatively, if a project can demonstrate that it will capture carbon, carbon credits may provide an additional source of revenue for the project. The Dutch government may also grant a subsidy that has been earmarked for the achievement of its full circularity ambition for 2050. This potential to attract multiple funding has been demonstrated in existing BwN projects. There has been a wide range of funders and motivations for investing: flood risk management, knowledge development, nature development, spatial quality and recreation, economy and water quality. EcoShape provides an overview of funding flows for EcoShape projects elsewhere [8].

Generally, water infrastructure provides public services. It is therefore funded by a range of public authorities [13]. The abundance of public funding in the Netherlands has kept non-public contributions to NbS projects to a minimum. However, new actors willing to contribute to NbS projects are emerging. For example, the Dutch Society for the Preservation of Nature (Natuurmonumenten) has been involved in the Marker Wadden project7 and the Wadden Fund has been a participant in the Eems-Dollard 2050 programme. These contributions have been critical in terms of getting these projects off the ground. Private funding is still limited to small-scale ventures or pilot projects, as in the case of the contributions of Groningen Seaports and EcoShape to the Clay Ripener project[8], which is part of the Eems-Dollard 2050 programme. However, in the scale-up of this programme, there has been an explicit effort to engage the private sector. Limitations resulting from Natura2000 regulations on activities that potentially generate cash flow streams, such as urban development, recreational parks and harbours, aquaculture, and wind and solar energy projects, limit the potential for co-investment involving private bodies.

The potential to attract multiple sources of funding has been demonstrated in existing BwN projects.

Synergy between local, regional and central public funding, in conjunction with non-governmental and private contributions, would seem to be essential to exploit in full the opportunities for broader benefits (see Marconi[9]). Until now, efforts to identify attractive co-funding models and win-win opportunities have been limited. As mentioned earlier, the party that foots the bill may not always be the party that enjoys the benefits and this consideration may further complicate efforts to attract funding.

2.4 Embracing dynamics and uncertainties

The design, effectiveness and implementation of NbS are intrinsically dynamic. The physical, ecological and socio-economic systems where NbS are implemented are constantly changing [14]. Hydrodynamic, sediment and ecological processes are subject to weather, seasonal and climate variations. Stakeholder behaviour, economic trends and changes in governance structures also affect the performance of NbS. How will a salt marsh or a willow forest perform in response to extreme storm conditions, seasonal variations and climate change? How will maintenance needs develop over time? Will changes in safety standards, building guidelines and legislation affect performance requirements? Will elections change the central government strategy and will this affect the availability of funds for NbS? Will economic developments affect the capacity and willingness of ports to invest in NbS?

These dynamics are intrinsically bound up with uncertainty. However, dynamics and uncertainty are not unique to NbS. Conventional grey infrastructure includes major uncertainties as well. Risk management tools and procedures are in place to deal with these uncertainties. Despite the fact that those tools and procedures provide a close conceptual match with the requirements of NbS, they cannot always be used for the latter without adaptation. However, because most NbS include a hybrid combination of green and grey elements that are the best fit for a specific system and functions, there is considerable potential to leverage abundant technical and risk management experience relating to traditional grey infrastructure. It will certainly not be necessary to re-invent the wheel. Furthermore, NbS are generally associated with high risk and uncertainties but research shows that green-grey solutions can sometimes be more effective as a way to reduce flood risk than grey solutions [15]. Nevertheless, it is important to recognise that there are limitations to the effectiveness and applicability of NbS and that there are indeed still unknowns relating to the performance of NbS, especially under extreme events or long-term and large-scale behaviour. Even more research is needed to establish links between socio-economic uncertainties and physics and ecology in order to provide a comprehensive picture of the risks associated with NbS projects.

The evidence base for the effectiveness of NbS is an important pre-condition for a sound business case.

The Clay Ripener pilot project

As part of the Eems-Dollard 2050 programme for the revitalisation of the Eems-Dollard Estuary, the Clay Ripener pilot project is assessing the technical and financial feasibility of transforming locally available salt dredged material into clay for the construction of a dike nearby, the Green Broad Dike. If successful, this will be a sustainable solution, converting excess dredged material that is locally available into clay that can be used for purposes such as dike construction and raising land. The decision to launch the pilot project was based on a multi-criteria cost-benefit analysis. The project's aims match the objectives of various partners: the disposal of dredged material (Groningen Seaports); the procurement of clay for strengthening dikes (the local water authority); improving water quality in the Eems-Dollard region (Province of Groningen and Rijkswaterstaat); nature development (Het Groninger Landschap); and the development of innovative knowledge (EcoShape). The contracting for the project focuses on the delivery of two key results: 70,000 m3 of clay which will be used for a dike strengthening pilot; and knowledge about the technical and financial feasibility of turning salt dredged material into clay for dikes. The preliminary results from this project indicate that there is a competitive business case for clay ripening over standard procurement.

6 https://www.hhnk.nl/prinshendrikzanddijk
7 https://eemsdollard2050.nl/project/brede-groene-dijk/
8 https://eemsdollard2050.nl/project/pilot-kleirijperij/; https://www.ecoshape.org/en/pilots/clay-ripening-pilot-project-4/
9 https://eemsdollard2050.nl/project/marconi/; https://www.ecoshape.org/en/pilots/saltmarsh-development-marconi-delfzijl-9/

At present, funders and financiers say they are reluctant to invest in NbS after the pilot stage due to uncertainties about costs, effectiveness and revenue stability for their investment. Uncertainties about performance also raise the risk profile and result in higher costs for overdesigned protection. This is particularly relevant in relation to the high-water safety standards in the Netherlands. A good strategy to reduce risk while coping with the limitations in the available knowledge is to start with pilot projects and then scale up. This was done in, for example, in the Hondsbossche Dunes[10], Marker Wadden and Houtrib Dike projects.

2.5 Develop flexible procurement and contracting procedures

We need not need to wait for the results of the continuous development of knowledge to further our understanding of the dynamics and uncertainties of NbS projects before scaling up NbS in water management. The key to development in this direction is embracing uncertainties proactively and establishing a system for dealing with those uncertainties, for example in the formulation of tenders and contracts [14].

There is experience with contracting and procurement that follow the NbS dynamic, innovative, multifunctional and site-specific characteristics. More and more clients, key stakeholders and contractors are working together from the outset of projects using adaptive risk management approaches. Projects like the Marker Wadden and the Clay Ripener are just two of the recent examples where the deliverables of the projects are formulated in adaptive management based on extensive monitoring and on discussions between the client and service provider, or in a project group that includes all partners. Here, deliverables and commitments are set out in a relatively simple contractual document. Details relating to execution, monitoring and deliverables are adjusted during the project, with the key commitments and objectives being kept well in mind

2.6 Leverage on political will and increase institutional collaboration

The nature of BwN speaks to high-level political agendas. Nevertheless, BwN is not well fitted to, or embedded in, the current water management governance structures. BwN projects that have been completed often benefited from political will and urgency (relating to factors such as flood risk and circularity ambitions), with on-the- ground critical support from enthusiastic and visionary champions who saw opportunities in the intricate web the water management governance is currently structured.As the transition from the pilot phase towards scaling up BwN proceeds, institutional compartmentalisation and the lack of cooperation between organisations' compartments and external stakeholders represent keyobstacles. Even individual organisations include separate compartments with distinct, and sometimes conflicting, goals, mandates and budgets.The wide variety of specific interests and agendas, planning cycles, capacity, financial resources and the willingness to pay complicates the process of finding an integrated solution that complies with everyone's wishes, sometimes with suboptimal compromises as a result. While institutional compartmentalisation is understandable, the issues originate from the lack of an overarching entity that commits to the common goal and facilitates collaboration between compartments.
In some cases, this situation can also result in institutional disincentives affecting NbS. For example, in the financing structure for flood risk protection projects in the Netherlands, project capital expenditure is funded by a central budget (HWBP – High Water Protection Programme), while regional authorities cover operational maintenance expenditures. This provides regional authorities with an incentive to select projects with higher capital and lower maintenance costs, typically favouring grey infrastructure rather than NbS since the latter often involve less capital but higher maintenance costs.

Projects should be selected on the basis of the largest socio-economic and ecological benefits rather than cost-effectiveness. For example, the design of the soft defence proposal for the Markermeer dike11, even though this was not a BwN project as such, focused on the best design possible which left the existing dikes[11] intact. The cultural-historical value of the dikes and the extra cost for their maintenance were, indeed, never a subject of debate.

> *Projects should be selected on the basis of on the largest socio-economic and ecological benefits rather than cost-effectiveness.*

10 https://www.ecoshape.org/en/pilots/hondsbossche-and-pettemer-sea-defence/
11 https://www.markermeerdijken.nl/

3. The way forward

The previous section highlighted the key lessons learned relating to the creation of sound business cases for upscaling BwN in the Netherlands. These lessons underline the current compartmentalisation of the institutional structure for Dutch water management as a key barrier to the definitive mainstreaming of BwN as the default approach for water-related challenges and resilient infrastructure needs in the 21st century. A transition is required in water management governance from object-based, monofunctional asset management to an integrated system-based approach [16].

3.1 Integrated system-based asset management (ISBAM)

Integrated system-based asset management (ISBAM) represents a concrete way forward for the upscaling of BwN. ISBAM means managing assets in their broader geographical, natural and socio-economic context: optimising the functions of the system as a whole rather than optimising the functions of individual objects or networks. This means locating the design of individual infrastructure or water management activities in the wider realm of regional development planning.
In the examples of the Double Dike and Waterdunen projects[12,13],ISBAM required cooperation between asset managers responsible for the dike, the natural foreshore, landowners in the hinterland and inland water managers. Interventions were designed, implemented and, if necessary, co-funded on the basis of a shared understanding relating to the functions and requirements of the natural and social system. This integrated perspective fits in with the BwN approach. Indeed, the requirements and benefits of NbS transcend the individual-objective approach.

Four stages define the transition from individual-objective and object-based asset management to fully fledged ISBAM:

1. Individual-objective, object-based asset management disregarding the impact on other functions.
2. Individual-objective asset management taking a wider range of impacts into account. Since the introduction of EIA requirements in the 1970s and SCBA in the 1990s, most Dutch water management finds itself in this stage.
3. Multiple-objective asset management optimising asset management to address multiple local, sectoral or wider social challenges and create added value. Several large programmes in the water sector fall into this category, examples being Room for the River and Weak Coastal Links.
4. Multiple-objective, system-based asset management in which the management of water-related assets is embedded in regional development planning. The Integrated River Management (IRM) programme[14] for the Meuse-Rhine area is a good example.

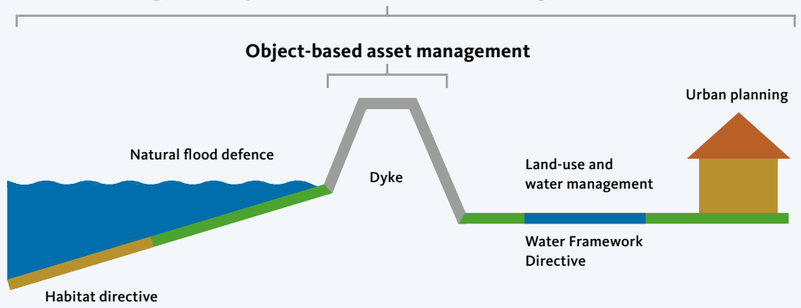
The design of a single infrastructure or water management activity should be embedded in the development planning for the wider region.

12 https://eemsdollard2050.nl/project/dubbele-dijk/ (2021)
13 http://www.waterdunen.com/sites/zl-waterdunen/files/brochure_waterdunen_2019.pdf
14 https://english.deltaprogramma.nl/regions/rivers

Example of Dutch ISBAM

Saltmarsh development on the foreshore can provide additional coastal protection, reducing dike maintenance costs [14], support the habitat development needed to meet N2000 Habitat Directive goals, and capture carbon and nitrogen to mitigate the footprint of the dike reinforcement. Meanwhile, the revitalisation of the dike presents an opportunity to install culverts to allow controlled water exchange with the hinterland. This can improve water quality and ecological connectivity in support of Water Framework and Habitat Directive goals, and create routes and habitat for migratory fish (as seen in, for example, the Double Dijk and Waterdunen projects), while providing opportunities for alternative land use – such as aquaculture, clay ripening or tourism/ecotourism – at the same time. All these concepts contribute to the objectives of multiple stakeholders, who can share the costs of the project. If all these elements were to be considered and funded separately, the costs would likely be higher and many solutions would not be implemented. It is only by cooperating on the identification and funding of a project that economies of scale can be achieved, objectives combined and the optimal solution for society be delivered.

Integrated System-based Asset Management ISBAM



3.2 Achieving ISBAM in practice

Scaling up towards the wider application of ISBAM throughout the water management sector will not come naturally. Maturity in asset management has progressed only slowly in recent decades [17] [18]. However, many challenges persist in inter-organisational cooperation and information sharing [17] [19]. The six EcoShape enablers published recently [2] provide a practical roadmap for the definitive institutional embedding of ISBAM and its implementation in practice. This roadmap covers: a system-based understanding of natural and socio-economic dynamics to define opportunities, risk and adaptive management needs better; the proactive involvement of stakeholders and financiers in a broad business case; capacity building in key organisations (including government) and, finally, institutional embedding.

3.2.1 Technology and system knowledge, and adaptive monitoring, maintenance and monitoring

The continuous development of system knowledge is needed to understand, define and predict natural variability in, for example, seasonal, extreme and climate-change-related conditions that affect the effectiveness, design and maintenance of NbS. Laboratory testing should be linked to long-term field experiences to understand the impact of extreme events at large spatial and temporal scales. More integration of knowledge about physical and ecological processes with the socio-economic and institutional environment is needed to support the development of practical, quantitative tools to be used in support of, for instance, the selection of alternatives, the development of a business case, and assessments of performance and risk.

The system is dynamic: nature, climate, people, economics and legislation are not static. Dynamicity should be accepted and exploited [14]. In all projects, and in NbS in particular, this means that there should be appropriate openings for monitoring and adaptive management, as well as a willingness to accept and exploit the opportunities for changes during a project.

ISBAM therefore needs to distribute and link capital and maintenance budgets appropriately in order to provide cost-effective solutions throughout the life cycle.

3.2.2 Multi-stakeholder approach and business case

When a project is being identified and developed, proactive stakeholder engagement in the early stages is crucial. Budgets and capacity must be adequate to support this process. Some successful examples are the Integral River Management programme, the Programmatic Approach to Large Waters (PAGW)[15] and the Eems-Dollard 2050 programme. Supporting tools such as Life-Cycle Cost Analysis (LCCA), CBA or Multicriteria Analysis (MCA) will help to identify, demonstrate and quantify the full range of benefits. ISBAM will support a combination of functions for which individual funding is available, as is the case with flood risk management (High Water Protection Programme), water quality (Water Framework and Marine Strategy Directives) and nature conservation (Natura 2000, Habitats Directive). Co-funding should continue to be explored beyond these 'usual suspects', for example from philanthropic funds (the Groenfonds or Postcodeloterij in the Netherlands, for instance) and national or international climate adaptation budgets (an example being the EU Green Deal). The wider scope of ISBAM may also involve challenges and ambitions based by society not covered by water management such

Integrated River Management Programme of the Rhine and Meuse

For decades, the management of water quality, navigation, flood risk management and land use planning for the rivers Meuse and Rhine followed a sectoral approach, with limited cooperation across jurisdictional boundaries. This situation was further complicated by developments such as climate change, the increasing disruption of the natural balance due to anthropogenic drivers, limited space for development and limited coordination of key challenges. It therefore became increasingly clear that this sectoral approach no longer sufficed. In the IRM programme, regional and national authorities work together on a safe, navigable, dynamic and attractive delta on the basis of an integrated approach in a single, shared vision and striving for multi-functional assets. This has implications for the asset management strategy of all the organisations involved with a combined approach to the formulation of objectives, projects and performance assessment.

15 https://www.helpdeskwater.nl/onderwerpen/water-ruimte/ecologie/programmatische-aanpak-grote-wateren-pagw/

as the energy transition, agri-/ aquaculture and urban development, with the corresponding funding sources. To further the combination of these funds in projects, explorative and shared planning exercises for project identification, as well as better planning guidelines and protocols to encourage cooperation, would provide valuable incentives.

Particular attention should be paid to new potential and promising co-funding opportunities arising from national and international ambitions for the reduction of carbon emissions. For example, the development of freshwater wetlands in the Marker Wadden project and salt marshes in the Marconi project provide carbon sinks, which can be used to sell carbon credits. Initiatives such as Blue Carbon NL aim to develop methods that enable this form of co-funding [20] [21]. At the project level, with naturally available materials, re-using dredged material and using natural processes for sediment management helps to reduce carbon and nitrogen emissions from the mechanical transport that would otherwise be required (this can be seen in, for example, the cases of the Sand Motor[16], Mud Motor[17] and the Clay Ripener), reducing the carbon footprint of water management projects. Building on the concept of carbon emission trading, similar concepts could be developed for other environmental outcomes such as biodiversity offsets or habitat banking. The concept of habitat banking is that new habitats created or protected in one project can be traded or 'bought' in compensation for the loss of habitats or other ecological impacts elsewhere [22].

3.2.3 Capacity building and institutional embedding

Implementing and scaling up innovative ideas and concepts like ISBAM take effort, time and motivation.

Appointing ISBAM ambassadors or champions in organisations or departments is a particularly powerful way to motivate others to take up innovative concepts. Champions of this kind are key accelerators for capacity building and scaling up ISBAM. Organisations can further stimulate capacity building and knowledge sharing by, for example, developing and promoting courses, organising workshops at key events and sharing lessons learned in internal organisations and platforms.

The institutional embedding of ISBAM essentially means breaking through the rigid structure of Dutch water management organisations in order to establish true collaboration with central coordination. This is the most significant obstacle at present. Overcoming it will require commitment from all Dutch institutions working on water management, and foremost Rijkswaterstaat (Directorate-General for Public Works and Water Management), the regional water authorities, the provinces and municipalities. It is their duty to find the best solution for society in the context of water management. This requires looking beyond their institutional scope and specialisation, as well as involving civil society actors, such as nature organisations and private entities. This development is in line with that of programmes like PAGW and IRM.

Identifying the optimal governance structure to facilitate ISBAM is extremely important. Although this factor is outside the scope of this paper, we believe that a suitable governance structure could include a dedicated central organisation in charge of ISBAM, housing specific responsibilities in existing organisations or another form of collaboration involving different organisations. Regardless of the governance structure adopted, mainstreaming ISBAM depends crucially on investing time, budget and effort.

3.3 Time to act

ISBAM is an approach that could release the full potential of BwN and support the mainstreaming of NbS as key solutions for current and future water management challenges. The upcoming renovation and replacement of major water infrastructure, and the significant and pressing ambitions to establish a sustainable and resilient future underline how urgent action is [23].

The first concrete step should be the formulation of a clear vision of ISBAM. This vision should include: a system-based definition of ambitions, challenge and solutions; a description of how specific assets in the system (such as dikes or the coastline) relate and interconnect with other functions; plans for collaboration with stakeholders and for crossing the borders between sectors, budgets and disciplines.

As a second step, a demonstration programme should be set up focusing on a specific system. This could help to generate lessons learned and good practices. Ideally, ISBAM and this programme will link to, and leverage on, existing initiatives, networks and experiences.
Large programmes that already focus on integration and that are defining or redefining scope are good candidates for the introduction of this approach, examples being VenR[18] (the Rijkswaterstaat replacement and renovation programme), IRM and HWBP programmes.
A last step on the road to definitively embedding ISBAM in Dutch institutions for water management should be a decision about where, in which organization and how to locate the responsibility for embedding ISBAM throughout the country.

16 https://dezandmotor.nl/; https://www.ecoshape.org/en/pilots/the-delfland-sand-engine-4/
17 https://www.ecoshape.org/en/pilots/mud-motor-6/
18 https://www.rijkswaterstaat.nl/nieuws/2020/05/make-over-voor-bruggen-sluizen-tunnels-en-viaducten-op-leeftijd.aspx

Marconi project

The Marconi Buitendijks pilot project studies the best way to restore salt marshes by re-using dredged material and sand. These salt marshes contribute to biodiversity, water quality, ecology, coastal safety and the attractiveness of the coast. A cost-benefit analysis was used to decide whether to adopt a dike reinforcement design with or without a salt-marsh foreshore. The project had three main financiers: the local municipality (which was interested in improving the appeal of the city), a regional development fund (the Wadden Fund, which was interested in promoting ecological quality in the area and salt marsh knowledge development) and EcoShape (knowledge development).

This pilot project was also an integral part of the larger Marconi waterfront redevelopment project, the aim of which was to reconnect the city of Delfzijl to the Eems-Dollard estuary while generating a wide range of socio-economic and nature-development benefits.

4. Concluding remarks

Lessons learned from more than a decade of EcoShape and from interaction with key stakeholders evidence that Nature-based Solutions provide added value for people, planet and prosperity. BwN, an approach to implementing those solutions in water infrastructures, is the answer to many current water-related challenges. With the upcoming renovation and replacement of major water infrastructure, and the significant and pressing ambitions to create a sustainable and resilient future, it is now time to act and to mainstream BwN throughout the Dutch water management sector.

The broader benefits generated with NbS generally result in a stronger socio-economic rationale. In other words, they contribute to multiple system functions with value for a wide range of beneficiaries. A broader range of beneficiaries opens up the possibility of wider and diverse sources of funding.

NbS are dynamic, and this implies the necessity for adaptive monitoring, maintenance, contracting and a financing approach which can cope with and exploit uncertainties. However, the mainstreaming of NbS is still a long way from achieving its full potential. A key barrier that prevents definitive mainstreaming of NbS consists of inadequate collaboration between different depart-ments and organisations of Dutch water management

Exploiting the full potential of BwN requires completing the transition from object-based asset management to integrated, system-based asset management (ISBAM). In particular, it requires breaking through the current silos in the water management infrastructure. This entails more structural cooperation with multiple stake-holders from an early stage, including the exploration of the business case and co-funding options. It also requires a different approach to the cost, benefit and risk profile to improve financier confidence. Finally, capacity building in the respective organisations will be needed to achieve the definitive embedding of ISBAM in the relevant institutions.

Exploiting the full potential of BwN requires completing the transition from object-based asset management to integrated, system-based asset management (ISBAM).

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