Making a (business) case for Building with Nature

Guidance and lessons from the Interreg North Sea Region project

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Building with Nature Business Guidance Report

Deliverable 2 of Work Package 5 - Upscaling: business case development and opportunity mapping, part of the INTERREG Building with Nature project.

http://www.northsearegion.eu/building-with-nature/

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INTERREG Building with Nature project

The INTERREG Building with Nature (BwN) project demonstrates BwN solutions that utilize natural processes to deliver flood risk and coastal erosion management whilst enhancing ecosystem services. The overall objective of the INTERREG BwN project is to make coasts, estuaries and catchments of the North Sea Region more adaptable and resilient to the effects of climate change through the use of BwN measures. INTERREG BwN creates joint transnational monitoring programmes, uses state-of-the-art analysis methods, develops improved designs and business cases for BwN solutions.

This report is a deliverable of Work Package 5 'Upscaling: business case development and opportunity mapping'. The objective of WP 5 is to: 1) show available methodologies for business case development and valuation; 2) provide guidance for BwN concepts to approach business case development; and 3) to demonstrate opportunities of BwN by giving good examples of business cases for BwN. This report is the final deliverable with lessons from quick scans and elaborated business cases of the INTERREG BwN Living Laboratories.

Project website: https://northsearegion.eu/building-with-nature/

Introduction

Goal and Target group

This document is meant for policy makers and practitioners who work with, or are interested in BwN, such as the BwN INTERREG project partners and the EcoShape consortium. The document offers guidance on various steps in the process of building the business case for a BwN approach. BwN solutions are typically designed based on locally specific characteristics: the lessons, methodologies and products discussed highlight generic challenges illustrated with local examples.

Acknowledgements

This document has been developed as part of the Interreg North Sea region – Building with Nature project. The guideline includes lessons and illustrations from various case studies in the North Sea region. Underlying reports and more background on these cases are available on the project website: https://northsearegion.eu/building-with-nature/output-library/

What is Building with Nature?

BwN is applicable worldwide in a wide variety of settings but still needs to be recognized as a viable strategy that adds value through co-benefits to 'conventional' concepts. An evidence base is needed to illustrate and enhance the (societal) value of BwN projects and to show how these (co-)benefits can be quantified.

The BwN approach is often associated with uncertainties regarding (long term) performance. The evidence base of BwN is small compared to conventional approaches, and ecological solutions are sometimes less predictable than man-made structures. Therefore, dealing with and reducing these (perceived) uncertainties is just as important as valuating the co-benefits to stimulate up-scaling of BwN.

Even though BwN has many forms and applications, the INTERREG BwN project and this document focus on BwN for flood risk reduction in coastal, estuarine and fluvial environments in the North Sea region.

Definition of business case

There are many definitions of a business case, but most entail an economic justification to provide a decision maker of a proposed project or undertaking, with economic information generally based on expected financial benefit. For public sectors, however, it makes sense to select and evaluate BwN measures on their impact on welfare from (co-) benefits, instead of financial benefits. In this report, we define a business case as follows:

> *A business case is a decision support framework that gives insight in the answers to these two questions: 1. Does the project provide increased welfare for society? 2. Can we identify sources and mechanisms for financing?*

A business case is an important tool to stimulate upscaling of the BwN approach. It contributes to the export of existing BwN concepts to new locations; the recognition and adoption of the BwN benefits by policy makers and their effort to stimulate BwN implementation; and using BwN solutions for multiple issues (such as flood risk, recreation, food production and climate change adaptation).

How to read this report

This guideline is structured along 5 key steps in developing a business case for BwN: the scoping step (1), system analysis (2), evaluation and selection of a project design (3), optimization of project design (4) and implementation (5). Each chapter presents an overview of useful methodologies and products to execute this step, as well as lessons learned in the Interreg BwN living laboratories (case studies).

Table 1 Five steps and their objectives that form the core of this guidance report.

	Step	Objective
Stakeholder involvement ↕	1. Scope	Identify key societal challenges for which BwN could pose a solution.
	2. System analysis	Analyse the physical, socio-economic and institutional system to identify potential BwN solutions (to address the societal challenges identified in Step 1).
	3. Selection of preferred alternative	Select the preferred BwN alternative based on cost-effectiveness and value of the (co-)benefits.
	4. Optimize design	Optimize the detailed design, to increase the expected delivery of (co-) benefits and reduce uncertainty.
	5. Implementation	Explore financial and contractual arrangements to enable implementation.

Iterative process

The steps to develop a business case for BwN should not be viewed as a linear process but rather an iterative process in increasing level of detail (Figure 1). In the first phase a workshop or number of workshops can generate initial project ideas. In the second phase these are substantiated in a ‘quick scan’, based on available or easily collected information. In the final design phase an elaborated business case is developed which is substantiated/ supported by in-depth and locally specifically analyses.

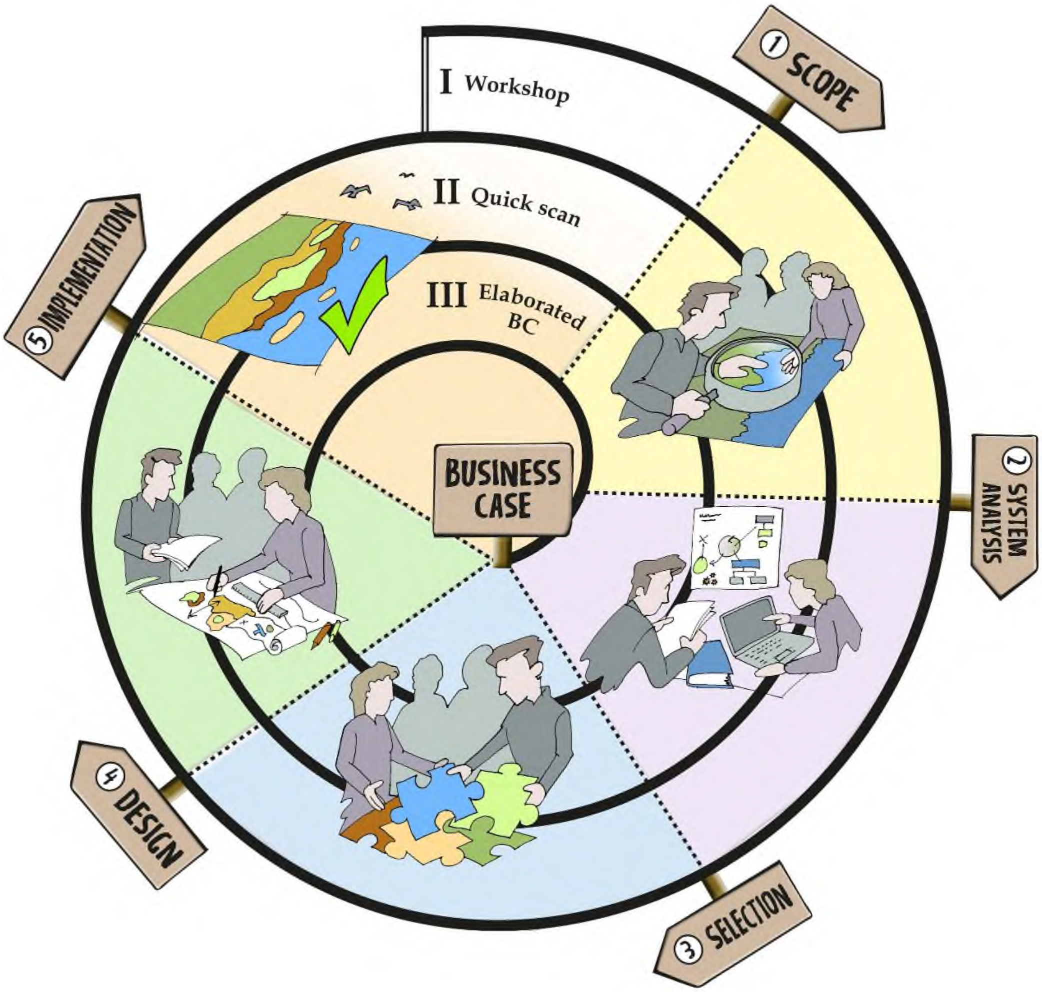

Figure 1 Five steps presented in a circle, showing the iterative process and their mutual dependencies

Step 1. Scope

Objective	Identify key societal challenges for which BwN could pose a solution
Actions	• For a location/region of interest, select the problems and issues perceived by decision-makers and stakeholders. • Identify the main challenges and their interlinkages.
Output	List of relevant challenges and the spatial scale (boundaries) of these challenges

Introduction

The objective of the scoping process is to identify key societal challenges for which BwN could pose a solution. The result can be a combination of global, regional and local challenges (Figure). The case studies in this report have in common that they deal with flood risk reduction, but also contribute to other challenges. This is nothing new: decision makers often operate on all levels at once. For example when global challenges of climate change or food security need to be implemented in local projects. This chapter presents the scope as societal challenges of different levels and how to assess these challenges as a decision-maker.

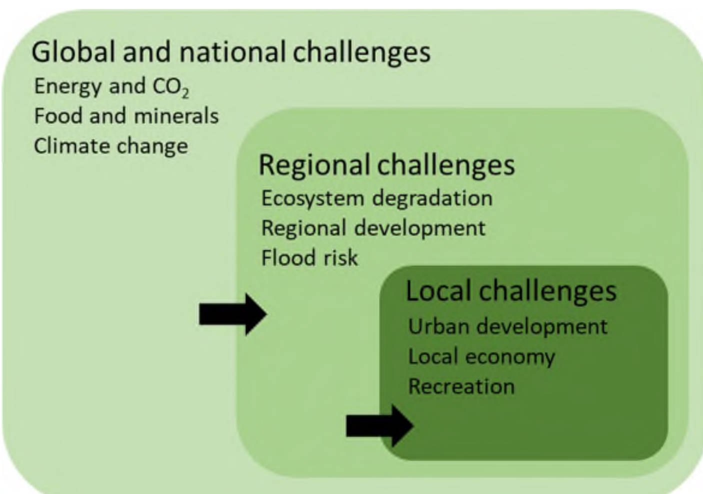

Figure 2 Three levels of societal challenges, that can be input for the scope of a BwN solution.

Global and National Challenges

At this moment, climate change and all consequences play a major role in coastal and river management. Adaptation of the physical system in order to deal with extreme situations is one of the needs at present. Another worldwide trend is the energy transition; governments and companies invest in sustainable energy in order to reduce the CO2 emission and to be independent of the political instable regions. This guidance helps policy makers and practitioners to use BwN concepts to contribute to these global and national challenges.

Regional Challenges

Many deltas and coastal regions face complex issues due to growing populations, sea level rise and increased flood risk. BwN offers a multi-functional solution and is thus an interesting option for these areas with a combination of societal issues and limited land availability.

Local Challenges

Local challenges can vary from a need for an impulse of the urban development and the local economy, to creating recreational spaces and improving the local infrastructure.

How to assess societal challenges

The societal challenges should refer to the problems and issues perceived by the decision-makers and stakeholders and be expressed in socio-economic and environmental impacts that are meaningful for decision-makers and stakeholders. Because often problems do not stand alone, define the main problems and their interlinkages. These should be agreed upon as the most urgent and important problems by the decision-makers and the stakeholders.

Thus, the scope varies between worldwide societal challenges and challenges related to the local community with all kind of interests. The product of the scoping phase is a list of the most relevant challenges and their spatial scale (boundaries). This list is input for Step 2 – BwN options and system analysis.

Lessons learned from cases

Lesson from Ameland (NL):
Knowledge development as part of the scope

A pilot sand nourisment is placed in the start of 2019 the outer delta of the Ameland Inlet. The pilot is part of Coastal Genesis 2.0, a research and knowledge development programme. The objective of the pilot is to experiment, generate knowledge and to create an evidence base for long term coastal management. The results will be used to give policy advice about Dutch coastal management in the future.

Lesson from North Sealand (DK):
Never waste a good disaster

This case concerns the 60 km long coast of Zeeland between Hundsted Port and Helsingør North Port. The north coast is exposed to severe erosion pressure. After storm Bodil in 2013, the damage was enormous. The storm event turned out to be a good opportunity to start the conversation about an integrated coastal zone management plan. The project ‘Future of the North coast’ started in 2014 and aims to make a coordinated large-scale coastal protection with sand nourishment as a key element.

Further reading

Table 2 Further reading for global and European challenges

Source	Title	Content	Link
UN	Sustainable Development Goals (SDGs)	International goals for sustainable development, based on global challenges and adopted as a blueprint for national and regional policy objectives.	https://www.un.org/sustainabledevelopment/
EU	Horizon2020	European funding programme based on key challenges and sustainable development objectives in Europe.	https://ec.europa.eu/programmes/horizon2020/en

Step 2. System analysis

Objective	Analyse the natural, socio-economic and institutional system to identify potential BwN solutions
Actions	• Analyse natural system, including geology, geomorphology, hydrology, ecosystems and ecosystem services • Analyse socio-economic system, including land use and vulnerability maps • Analyse institutional system, including relevant laws and regulations and enabling institutional conditions for implementation
Output	Integrated system assessment report of the intervention area, describing the natural, socio-economic and institutional system and their interlinkages.

Introduction

To identify potential BwN solutions, an analysis of the system provides essential insight in the physical, the socio-economic and the institutional system (addressed to the societal challenges identified in Step 1) and results in an integrated system assessment report. It will provide insight in which elements are relevant and should be further considered. This outcome helps to select a preferred BwN measure and is therefore input for Step 3.

Analyse the natural system

It is important to understand the natural system of an area and which ecosystem services the area provides. The natural system will determine which type of BwN can be implemented as flood risk reduction measure. A possible BwN location is unique in each area, and the natural system is characterized by its geology, geomorphology, hydrology, its ecosystem and its climate. Thereupon, it is needed to understand which additional services the ecosystem provides for humans. These ecosystem services can determine the additional benefits BwN can provide in addition to the primary function (flood risk). Below, these indicators and their influences are described and should be considered when assessing the natural system.

The geology and the geomorphology determine the sediment availability, its source and the potential sediment transport within an area. The type of BwN solution that is applicable, depends on the sediment type and sediment availability. Hydrodynamics such as (large and smaller scale) riverine and coastal processes can shape a landscape and affect the design and effectiveness of a BwN measure. Flood risk can be driven by hydrodynamic factors such as extreme local rainfall, high river discharge, or coastal storm surges. Ecosystems consist of a community of living organisms and their interaction with the environment. When considering a BwN solution the ecology and how these species interact with the natural system should be considered, so the BwN solution fits the natural ecosystem. Last, climate is an important factor, since it affects the hydrodynamics (precipitation, sea level rise), and the type of ecosystems that occurs (temperature). Overall, the natural system is the result of interaction between sediment, hydrodynamics, ecosystems and climate.

Analyse the socio-economic system

Analysing the socio-economic system of an area where a BwN solution is considered is highly recommended. BwN measures for flood risk solutions are less common than traditional measures and the implementation in the local socio-economic system can be a challenge. Therefore, it is essential to understand the (local) socio-economic system and understand which socio-economic benefits can be incorporated in a BwN measure. For example, what is the current land-use, and how can BwN be applied to improve this land-use?

Ecosystem services are the benefits to humans by the natural environment through a healthy ecosystem. Ecosystem services are defined on a European level for example by BISE[1] as the direct and indirect contributions of ecosystems to human well-being. They support directly or indirectly our survival and quality of life. Examples of ecosystem services that interact with BwN approaches are flood risk, climate regulation, food production, water purification, soil biodiversity and cultural services (standard classification of ecosystem services is described by CICES[2]). Ecosystem health can be measured by indicators such as species diversity, abundance and biomass.

Analyse the institutional system

Each country or area is unique and has its own governmental institute, laws and regulations, and responsible parties for flood protection measures. When considering a BwN solution, one should understand existing national and regional plans or strategies. This involves knowing who is responsible for flood reduction measures, to involve and/or inform the right parties or stakeholders at the right time (see also: Stakeholder involvement). For example: Are flood risk measures organized by a governmental institute or are local stakeholders responsible? Which parties are financially involved to reduce flood risk? And who is responsible in monitoring the flood risk in the area? For the selection of a flood risk (BwN) measure the laws and the (local) regulations are relevant. For example, considering the mandate for permits, the regulations for working in vulnerable ecological systems and the decision-making procedures.

BwN options for different natural systems

Depending on the environment, a variety of BwN options might be possible (Figure). The web-based Building With Nature Guideline (note: the BwN Guideline will be replaced by an update of the EcoShape website from October 2020 www.ecoshape.org) gives an overview of options and technical background and guidance for development/ design.

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[1] https://biodiversity.europa.eu/
[2] https://cices.eu/

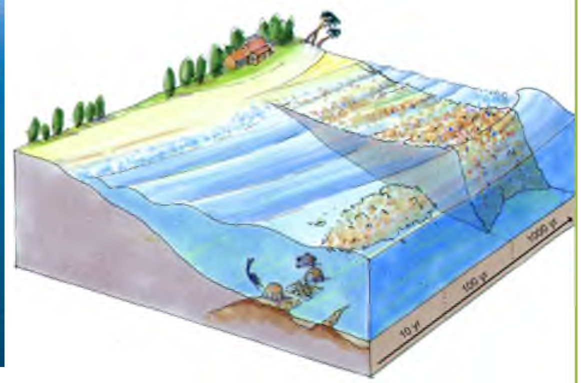
Sand Nourishment, feeder beaches	Shellfish and coral reefs
 *The SandMotor:* ***www.zandmotor.nl***	
Feeder beaches like the Sand motor can be used along sandy coastlines: they provide sediment to the coastline, develop new habitats and offer opportunities for tourism and recreation.	Development of shellfish reefs and coral reefs can be another combination of BwN measures (protection against coastal erosion and flooding) and ecosystem services like the strengthening of habitats, spawning grounds for fish (important source of nourishment in large parts of the world) and (eco) tourism

Figure 3 Examples of BwN concepts in different ecosystems

Lessons learned from cases

Lesson from Twin Dike (NL):
A detailed business case can narrow the project scope

For the twin dike a detailed saline agriculture business case was developed for the area between two dikes based on input from saline agricultural entrepreneurs in an early stage of the project. Evaluation with stakeholders concluded that such a detailed approach at an early stage had advantages and disadvantages. The saline agriculture business case was tangible through the amount of details, so key decision makers were easier persuaded of the feasibility. However, this did make it more difficult throughout the process to keep a broad scope for the area of interest and made it harder to incorporate new opportunities or insights for the area.

Lesson from Sylt (DE):
System analysis enables identification of multi-effect strategy

The objective of this project was to reduce beach nourishment and dike reinforcement efforts on the southern side of the island Sylt, whilst minimizing impact on the natural system. System analysis (such as sediment transport and habitat impact modelling) enabled the identification of shoreface nourishment as a multi-effect strategy. This strategy reduces costs for beach replenishment (tourism & coastal protection) and dike reinforcement (coastal protection).

Lesson from Eddleston (UK)

Nearly all natural flood management (NFM) solutions influence existing land use, directly or indirectly, via hydrology or by land use conversion. Large-scale application of NFM therefore has a major impact on the landscape and its potential for recreation and agriculture. Because of this direct relation, interaction with the farmers and an assessment of the effects of NFM on farmers' business models is as important as their effect on hydrology and ecology. Some NFM have a positive effect for landowners, for example if the NFM reduces erosion of river banks and agricultural land. Measures that have been taken as part of the Eddleston pilot, are based on voluntary participation and hence mostly have a limited impact on the farm. It is for this reason that measures such as (re)forestation have not been considered in grassland farming locations.

Further reading

Table 3 Further reading for system analysis

Source	Title	Content	Link
EEA	European Environment Agency: Biodiversity – Ecosystems	The EEA is a source of guidelines, data and current policy on biodiversity and ecosystems in Europe.	https://www.eea.europa.eu/themes/biodiversity
BISE	Biodiversity Information System for Europe	BISE is a single entry point for data and information on biodiversity in Europe.	https://biodiversity.europa.eu/
CICES	Common International Classification of Ecosystem Services	Standardized method of classifying ecosystem services, developed by the European Environmental Agency (EEA).	https://cices.eu/
EcoShape	Building with Nature Guideline	Website with technical information about BwN options in various landscapes/ contexts Note: the BwN Guideline will be replaced by an update of the EcoShape website from October 2020	Building With Nature Guideline www.ecoshape.org

Step 3. Selection of preferred BwN measure

Objective	Identify and select the preferred (BwN) project alternative based on cost-effectiveness and value of the (co-)benefits.
Actions	• Develop comprehensive project strategies (which may consist of various building blocks or solutions) based on a long-list of options, e.g. using cost effectiveness analysis • Assess the economic rationale of project strategies using LCC multi-criteria analysis and/or a cost-benefit analysis • Select the preferred solution
Output	Substantiated economic rationale of alternatives as input for selection of the preferred solution

Introduction

Step 1 and 2 have guided us through the process of determining the scope, context and possibilities for BwN flood protection measures. The result is a longlist of possible measures to achieve the desired level of flood or erosion protection. Unless there is already an explicit policy in place that prescribes BwN measures, this longlist of options can consist of conventional solutions and BwN solutions or a combination of both. This chapter focusses on the economic analyses and tools that can be used in the process of selecting the preferred solution from the initial longlist of possible solutions.

In this selection process, the (relative) attractiveness of the different solutions needs to be evaluated. To do this, two questions should be considered and answered:

i. What are the costs of the identified alternatives?
ii. Does the BwN option provide sufficient additional benefits making it more attractive from a (socio) economic point of view?

At the end of this chapter the reader will have gained insight in available economic tools for (BwN) project assessment and under what conditions best to use them to answer the two questions above.

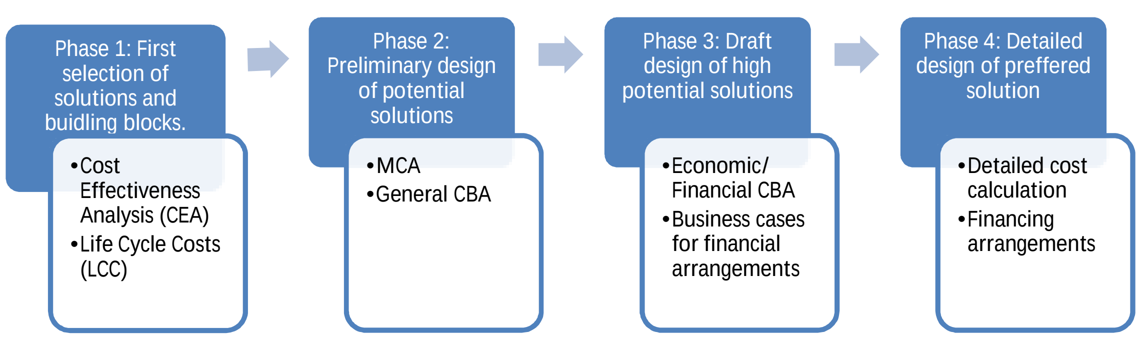


Figure 4: Overview of the economic tools useable in the different phases of the design phase

Chapter structure

The structure of this chapter is as follows; first we discuss the variety of different economic tools available in relation to the phase of the design process (Figure). Second, we discuss issues of importance we come across when estimating costs and (co-) benefits specifically for BwN solutions. Thirdly we discuss different methods that can be used to include uncertainty in the assessment of alternatives. Lastly, we will provide the reader with an overview of further reading.

The selection process and the economic tools

The selection process refers to the process of moving from a longlist of possible project designs and building blocks to the final design of the preferred solution. As shown in **Error! Reference source not found.**, this is in an iterative process. It may begin with a series of workshops, then with a quick-scan analysis and preliminary design of alternatives, finally resulting in final design and official level social, environmental and economic assessment studies. Depending on how far this process is along, different economic tools can be used evaluate the solutions relative to each other and relative to the project goals.

Figure shows a variety of available economic tools for the different phases of the design process. These are discussed below.

Phase 1: First selection of solutions and building blocks.

In phase 1 quick-scan assessment of the cost-effectiveness of alternatives defined in Step 2 in relation to the policy objectives can be used as first selection criterion. Furthermore, we would like to identify possible co-benefits, provide a first indication of expected costs and the identification of relevant stakeholders. In this phase there is no actual design of solutions yet, and the list may include both BwN solutions as conventional ones.

What approach is used for the initial selection depends on the decision criteria of the responsible entity/ primary investor: what is the general policy on decision criteria? Is the general policy to decide based on cost minimization or cost effectiveness? Do other criteria such as social and environmental aspects also come into play? It is important that such questions are discussed amongst key stakeholders and decision makers in an early stage of the project. The answers to such questions form the selection criteria in the screening process and also determine which screening method(s) are most applicable.

Phase 2: Preliminary design of potential solutions

In this phase, preliminary project alternatives or strategies are designed by combining different building blocks and solutions. A general cost-benefit analysis (CBA) may be conducted based on general benefits and transfer principles (e.g. not considering specific local context like actual demand or local market prices). Alternatively, a qualitative multi-criteria analysis (MCA) may be done, which is particularly valuable in increasing stakeholder engagement and support. The procedure for selecting the preferred alternative differs per country, spatial scale and purpose of the project.

Most countries specify which analyses are required to secure grants from a (coastal) flood risk infrastructure investment program: this often includes an environmental impact assessment and a CBA.

Phase 3: Draft Design

The analyses done in the previous 2 phases select solutions that meet the policy objectives and that show varying levels of co-benefits and cost effectiveness. In phase 3 a more location-specific CBA (financial/economical) is often required, based on location specific data and detailed cost calculation. Alternatively, in case of private (co) -investors, a business case analysis identifying cash flows can be made. Based on the previous analyses at the end of this phase a preferred alternative is selected.

Phase 4: Detailed design

In phase 4 the preferred alternative is developed into a detailed design. This is the alternative that will be used to implement in the project. Detailed cost calculations and financial arrangements can be made. Normally no further economic assessment will take place. These activities are discussed more elaborately in Step 4 and Step 5.

Table 4 Economic tools for assessment of project alternatives

Economic tools	Description	Best applicable when:	Advantages/ disadvantages
Cost-Effectiveness Analysis (CEA)	All options are compared in effectiveness – to what extent do they contribute to one specific (flood-risk related) goal? 1. The investment/ O&M costs of each measure are estimated (quick scan: order of magnitude, based on data/ expert judgement). 2. For each measure a ratio is given for the amount of effect you get for one unit of money: *e.g. how much flood risk protection is delivered for €1?*	1. If there is one **single, clear-defined goal** for the project and it is of interest to find the most attractive alternative from a **financial** point of view. 2. As a first screening of measures	A risk of using CEA is that the method does not take into account any additional benefits a measure might have.
Life Cycle Costing (LCC)	In an LCC all costs for the asset over its entire lifetime, operation and maintenance and if relevant breakdown costs are compared over a fixed (long) time horizon, for example 100 years and discounted.	You want to have an idea of the costs of a solution	

Multi-Criteria Analysis (MCA)	A MCA is a semi-quantitative analysis in which the performance of measures is scored on multiple criteria based on expert/ stakeholders opinions (e.g. natural habitat creation; contribution to flood risk reduction; costs; cultural heritage preserved).	There are **multiple criteria or effects** to take into consideration **Increase stakeholder engagement and support**.	+Very good for engaging stakeholders (and using their local knowledge) and increasing support for project - MCA is a qualitative but relatively subjective approach
Cost-benefit analysis General/Economic/Financacial - CBA	The costs of the project are compared to the welfare effects/ benefits. These are determined in relation to a reference situation that includes autonomous development. If possible, all effects are expressed in monetary terms to ensure comparability. In a quick scan, standard numbers from other studies in similar contexts, can give a first insight of the value of certain investments. A full CBA includes more detailed analysis to include local context, is executed for a limited number of spatially explicit designs and includes sensitivity analysis of results.	More objective than MCA: all effects from viewpoint of impact on welfare (increased comparability, more objective)	+ Quantified, more objective overview of costs and benefits; comparable. + there are quite a number of other advantages - False sense of security through quantitative results

Estimating costs and (co-)benefits for BwN

In the tools discussed above, costs and benefits feature in varying degrees of detail. Below we highlight some approaches and examples on how to evaluate BwN designs with respect to:

1. Cost estimates of conventional and BwN solutions
2. Estimating the flood risk benefit
3. Assessment of co-benefits: ecosystem services approach

Cost estimates of conventional and BwN solutions

In most countries there are set costing procedures and standard cost estimates for engineering projects. This is even more so when projects are financed by public funding. These procedures and cost databases are traditionally geared towards conventional, 'hard', measures: the smaller experience base and adaptive character of BwN projects makes costing them more complicated and uncertain.

When comparing the cost estimates of different solutions, both BwN and conventional, a lifecycle cost (LCC) approach should be used. In an LCC all costs of the asset over its entire lifetime, including operation and maintenance and if relevant breakdown costs, are compared over a fixed (long) time horizon, for example 100 years and discounted. Other elements of interest when comparing costs of BwN with conventional approaches is how uncertainty, adaptability and flexibility of design are taken into account in the costing process.

Estimating the flood risk benefits

Reducing flood risk is often the primary objective there for the achieved flood risk protection is the main benefit. All other benefits additional to the goal of the project are co-benefits. Quantifying the benefit of flood risk protection is important. The most common way to do this is by estimating the baseline

$$(current) flood\ risk = (probability\ of\ flooding * economic\ damage) /\ loss\ of\ life$$

and then estimating, depending on the resources at hand e.g. expert judgement or a modelling study, the reduction achieved by a particular design.

If there is a pre-defined safety norm and a clear (conventional) alternative, a least-cost analysis compares alternatives based on costs – and possibly some additional criteria, such as robustness. All solutions have to meet the pre-set flood risk standard. However, if there is no pre-defined flood risk goal for the project, the flood risk reduction achieved by each design is estimated, and a cost-effectiveness analysis is done.

Compared to conventional infrastructure, the small evidence base of BwN leads to a disadvantage. First, the direct impact on flood risk reduction is different: where flood risk impact of conventional approaches is often well known (there are design requirements and standards) there is much less known about the flood risk impact BwN, though the evidence base is increasing (Narayan et al., 2016). The uncertainty may translate in conservative assumptions on the flood risk reduction. Second, the small evidence base on BwN may lead to i) conservative assumptions when estimating the costs, ii) a higher risk premium (over dimensioning) in design.

Assessment of co-benefits: ecosystem services approach

Valuing co-benefits of the BwN using ecosystem services approach is key in demonstrating the added value of BwN over conventional approaches. Depending on the physical setting and other characteristics of the project area, a wide array of ecosystem services may be relevant: there are various guidelines and tools that can be used to valuate these benefits (see further reading). Some examples include the nature points index used in the Netherlands and the INVEST toolset.

In addition to economic valuation of co-benefits it is valuable to identify each benefits' beneficiaries. This can lead to the identification of a broad(er) group of stakeholders. This exercise links to the screening phase previously discussed: interests and concerns of the different stakeholders should be identified included in this process. Subsequently, linking co-benefits to stakeholders can be a valuable input in the process of finding (co)finance sources. Related to the latter, a 'Strenghts, Weaknesses, Opportunities, Threats' analysis (SWOT) can be useful to increase understanding of possible (dis)incentives of various stakeholders to co-invest. Below is an example of a part of a SWOT analysis for the Eddleston water scoping study where the analysis is used to identify the different groups of stakeholders.

Assessing performance under uncertainty

The future is uncertain. What if sea level rise turns out much faster than expected? What if global economic changes shrink or expand the local economy – and with it the value at risk? In light of this uncertainty, choosing the 'optimal' design level of a measure can be complex. To some extent this uncertainty is addressed in common CBA practice, but some additional tools are available as well. Typical uncertainties related to conventional and BwN projects are uncertainty of technical performance and performance under climate change/ future scenarios.

Uncertainty of technical performance BwN

Uncertainty of technical performance translates in a higher risk premium of project insurance or overdimensioning of measures. There are standardized procedures to address this risk in conventional engineering (e.g. fixed risk premiums). The high uncertainties in performance of BwN lead to high risk premiums in design, and a conservative assessment of the flood risk benefit: this may lead to a more negative outcome of the CBA. Although uncertainty of assumptions on technical performance and co-benefits is often addressed in CBA through a sensitivity analysis, special attention for this issue – and using available, up-to-date performance evidence (see further reading)- might be valid.

Performance under climate change/ future scenarios.

The future brings more uncertainty about the development of climatic and economic factors that influence the optimal risk reduction level of measures. Conventional approaches are typically less flexible (i.e. ability to change with environmental conditions) than BwN: they cannot be implemented in phases and it may become increasingly difficult to switch to a different approach (lock-in). By phasing BwN (e.g. increase sand nourishment volume over time) the optimum investment level is determined over time instead of up-front, as the future unveils itself. Furthermore, climate change may render specific solutions less robust (i.e. sufficient performance under various climate change scenarios) in the long term, for example, a dike cannot be increased indefinitely, and is difficult to relocate.

In CBA uncertainty of performance under future scenarios is addressed using scenario analysis: the outcome of the analysis is presented under various scenarios in economic and demographic growth and climate change. Additionally, there are other, more sophisticated approaches such as real options analysis (ROA) and adaptation pathways that specifically address flexibility and robustness of adaptation strategies or alternatives (Table 5). In ROA, uncertainty and flexibility are taken into account (whereas CBA assumes a deterministic future with no room for changes): valuing flexibility using decision trees and Monte Carlo analysis.

Adaptation pathways are a planning tool depicting possible future pathways in adaptation solutions, including 'tipping points' when a solution is no longer viable and a switch to another strategy should be made.

Table 5 Methods to assess performance under uncertainty

Methods	Description	Best applicable when:
Scenario analysis in CBA	The results of the CBA are calculated under various future scenarios, i.e. regarding climate change, demographic or economic developments	In CBA, when it is reasonable to expect significant differences. Commonly used scenarios are SSP (shared socio-economic pathways) and climate scenarios by the IPCC – many countries have defined own scenarios.
Sensitivity analysis	Investigates sensitivity of parameter values and assumptions used in cost-benefit estimation. Common element of CBA	Some uses of sensitivity analysis: makes results stronger/ more credible by testing robustness, increase understanding of system, further development of values and assumptions.
Real options analysis	Quantifies investment risk under an uncertain future – used to value flexibility of projects. Flexible and reversible options handle deep uncertainty by leaving room for new insights.	Comparing a flexible BwN with inflexible conventional solutions
Adaptation pathways	Conceptual and analytical approach where flexible adaptation strategies are build based on decision triggers that signal a next phase or path of adaptation strategy.	Create insight in path dependency, potential lock-ins of various adaptation strategies - how to they perform under various future scenarios?

Lessons learned from cases

Lesson from Eddleston (UK):
A SWOT analysis can give valuable insight of how stakeholders value alternatives

The Eddleston Water, a north bank tributary of the River Tweed in the Scottish borders has been classed as 'poor' under the EC water framework directive. Potential measures of natural flood management (source control and slowing the flow) have been listed. A SWOT analysis of the combination of measures was conducted. By identifying the strengths, weaknesses, opportunities and threats of the alternatives the different possible groups of stakeholders are identified.

Lesson from Lodbjerg (DK):
Use monitoring to evaluate the effectiveness of BwN

For many years, groins were used against erosion in Lodbjerg. Monitoring showed that coastal retreat still occurred, however. In the '70 the Danish government started an experiment with sand nourishment, with positive effects. In the '90 they designed a strategy to conserve the sediment coastal profile with nourishment. Monitoring showed the (lack of) effectiveness of common practice, and pilots and international knowledge exchange were used to test the effectiveness of alternative (better) solutions before large scale implementation.

Lesson from Danish West Coast
Select evaluation approach based on institutional setting

Key criteria to evaluate an BwN alternative against grey alternatives depend on the institutional setting. Along the Danish coast, local landowners and municipalities are often responsible for coastal protection, and cost minimization and proven effectiveness on the relatively short-term weigh heavily. In other locations the national government has a mandate and enters a joint agreement with local municipalities: here a wider welfare perspective – supported e.g. through cost-benefit analysis - is taken into consideration.

Further reading

Table 6 Further reading for assessment guidelines and projects per country/region

Country	Targeted at/ Scope	Title (hyperlink)
EU	General CBA principles: EU investments in Transport; Environment; Energy; Broadband; R&D	Guide to cost-benefit analysis of investment projects
EU (project)	(proposed) EU transnational cooperation streamlining use of CBA in context of flood risk infrastructure standards development	Integrating CBA in the Development of Standards for Flood Protection & Safety
EU (project)	The NAIAD project aims to operationalise the insurance value of ecosystems for water-related risk mitigation, by developing and testing concepts, tools and applications on 9 demo sites across Europe, under the common concept of Nature-Based Solutions (NBS).	Nature Insurance Value: assessment and demonstration
UK	Mandatory guidance manual for project appraisal in publicly funded projects.	Flood and Coastal Erosion Risk Management appraisal Guidance (FCERM-AG)
UK (project)	The Natural Capital Assessment Gateway brings together information on the growing number of projects in the UK concerned with mapping and assessing natural capital and ecosystem service delivery at the local, regional or national level.	Natural Capital Assessment Gateway
Netherlands	Review of the development of CBA approaches/ guidelines used in flood risk management in the future and its impact on society.	Cost-benefit analysis for flood risk management and water governance in the Netherlands: An overview of one century (CBP, 2017)

Table 7 Further reading for methods of cost-estimation, flood risk (FR) impact, cost-effectiveness assessment (CEA), cost-benefit analysis (CBA) and dealing with uncertainty.

	Source	Method	Title (hyperlink)	Content
Cost	NOAA (2013)	Cost estimation	What will adaptation cost? An economic framework for coastal community infrastructure	Chapter 2 discusses how to analyse the adaptation strategies' impact on flood risk, including a number of case studies; chapter 3 on monetizing this impact.
Cost	TU Delft (2010)	Cost estimaton	Coastal defence cost estimates – Case study of the Netherlands, New Orleans and Vietnam	Cost estimates at project and system level for low-lying deltaic coastal areas: unit cost estimates for both conventional and BwN approaches.
	NAIAD2020	Life cycle Cost approach NBS	Costs of Infrastructures: Elements of method for their estimation	Outlines how the LCC methodology can be tailored to NBS, including an overview and references to available cost figures and empirical data.
FR Impact	NOAA	Flood-risk + ecosystem services	A guide to assessing green infrastructure costs and benefits for flood reduction	Guide for assessing flood risk and co-benefits of green infrastructures (stormwater drainage) to prevent riverine/ rainfall flooding
FR Impact	Greeninfrastructureenw.co.uk (2010)	Flood risk impact + ecosystem services	Building natural value for sustainable economic development. The green infrastructure valuation toolkit user guide	Calculation toolkit for estimating the benefits of green infrastructure, including impact on flood risk: relevant for riverine/ estuary flood risk.
CEA	Paper; PLOSone (2016)	Costs-effectiveness (quick-scan)	The effectiveness, costs and coastal protection benefits of natural and nature-based defences.	Evidence-based analysis of cost-effectiveness of coastal building with nature projects
CEA	World Bank	Cost-effectiveness; cost-benefit	Implementing nature-based flood protection – principles and implementation guidance	Principle 3 on performance evaluation (needed for CEA); Step 5 on estimation of effectiveness, costs and benefits.
CBA	COASTADAPT (2016)	Cost-benefit analysis	Information manual – Assessing costs and benefits of adaptation	Clear description, explanation and links to other sources on cost-benefit analysis and other approaches in coastal adaptation context.
CBA	Renaud et al (2017)	Cost-benefit analysis	Ecosystem-based disaster risk reduction and adaptation in practice. Part I: Economic approaches and Tools for Eco-DRR/CCA	Number of book chapters discussing valuation of BwN strategies – best practices, existing studies and various case studies.
CBA	WUR (2014)	CBA: valuing ecosystem services	Economic viewpoints on ecosystem services	General introduction into ecosystem services valuation and tools – not specific for coastal infrastructure/ ecosystems.
CBA	GIZ (2017)	Cost, benefits & FR impacts	Valuing the benefits, costs and impacts of ecosystem-based adaptation measures – a sourcebook of methods for decision-making	Elaborate guideline on valuing BwN benefits, including case studies, and an overview of tools.
CBA	EcoShape (Origin:	Nature index	This tool outlines a methodology to include	Tool description, guideline, practical applications.

	Netherlands environmental agency Sijtsma et al., 2009)		nature qualities in planning processes by defining a quantitative nature index	
	TEEB	Database for ecosystem service valuation	Ecosystem Service Valuation Database	Database of monetary values of ecosystem services based on 300 case studies, including in coastal/ wetland/ watershed biome types.
Dealing with uncertainty	CoastAdapt	Real options analysis	Real options for coastal adaptation	Guideline on applying real options analysis to coastal adaptation.
	Coastadapt	Sensitivity analysis + scenario analysis	Information manual – assessing costs and benefits of adaptation	Chapter 5 discusses uses of sensitivity analysis and further links to guidelines on how to do so.
	Coastadapt	Adaptation pathways	Information manual – assessing costs and benefits of adaptation	Chapter 8 introduces adaptation pathways and links to various guidelines/ approaches and examples.

Step 4. Optimizing design of BwN measure

Objective	Optimize the detailed design, to increase the expected delivery of (co-)benefits and reduce uncertainty
Actions	Optimize the design regarding: • technical feasibility of the design • the use of natural/ecological processes and minimize negative environmental impact • within relevant laws and regulations • increasing economical benefits, within market conditions • social acceptance and stakeholder involvement • financial possibilities • adaptability to handle uncertainties
Output	Detailed and optimized design of the selected solution

Introduction

After selection of one or more preferred alternatives based on the societal challenges (Step 1), system analysis (Step 2), cost effectiveness and benefits (Step 3), it is possible to improve an initial design of the BwN alternative. A good design will match the potential of the physical environment with the needs and ambitions of society, within the policy objectives and financial boundaries. The design should be informed by the risk reduction target, the required integration of the measure in the existing environment and by identified ecosystem management and restoration methods.

BwN approach	Traditional approach
Optimize design to achieve multiple benefits, making use of the ecosystem services and aiming for win-win solutions.	Optimize design to meet one objective (e.g. flood risk reduction), while minimizing or mitigating detrimental effects on the environment.

Optimizing BwN design

In this chapter we distinguish six dimensions that play a role in optimizing the design of BwN measures. These dimensions are functionally related and should therefore be handled as one coordinated network (Figure). Whether it would be logical to steer the design into a specific direction will depend upon the expected added value, whether it will bring additional finance, public or private acceptance, and the expected costs for implementation and maintenance.

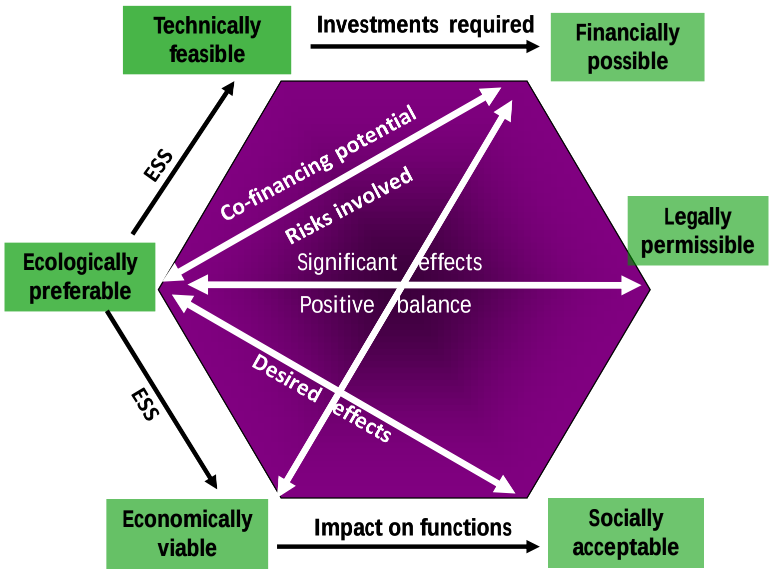


Figure 5 Network of six factors that play a role in optimizing BwN design, and their mutual relationships

Technical feasibility

Technical feasibility of BwN design is largely determined by the local physical conditions, together with the level of required knowledge and skills. Important physical parameters are bed slope, hydrodynamic energy, and salinity. With flat slopes, so called 'soft solutions' are possible that are completely sediment-based. High energy systems (sandy coasts) demand larger volumes of sediment and have a low vegetation cover (the sand engine), while low energy systems (lakeshores) allow soft solutions of a smaller area and typically have a dense vegetation cover (sandy vegetated foreshores).

Ecological optimization

Ecological optimization is about improving environmental conditions and ecological processes. Integrate the required physical conditions for potential benefits (ecosystem services) into the design process. Habitat requirements of the desired species are part of the physical conditions for the design.

Nature development is often difficult to predict. It is key to make use of existing ecosystems, native species, and comply with basic principles of ecological restoration and conservation. Ecosystems that have a higher biodiversity are also more productive and more resilient to disturbances. Sometimes it can be beneficial not to be too specific in the habitat description in the project objectives. If, after construction/restoration the natural development is slightly different than envisioned in the project plan, it might be better to adjust the goals to what spontaneously is developed than to interfere with the habitat for high costs.

Legal and policy requirements

In many projects formal safety standards or nature legislation (e.g. Natura2000) play an important or even decisive role in the design process and the choice for a specific alternative.

For example, if a project site is designed as a protected area for birds, the project may be executed as long as it has no effects on the protected bird populations. It becomes more difficult when the area is designated as a protected habitat area. In this case the possibilities for intervention are very limited. In addition to European legislation, national legislation and policy requirements can set tight conditions that have a large impact on the design possibilities. For example, deadlines for project results can be very demanding and decisive for the selection of the final solution. Ideally deadlines are adjusted to the natural building capacity of natural processes, under the condition that safety or other functions are not compromised in the short term.

Economic viability and market conditions

It is important to know how the design affects the economic impacts and opportunities for different stakeholders of the project. An increase in economic benefits from BwN measures will more likely lead to project support from the stakeholders. Economic benefits are for example a higher job availability due to recreational opportunities and improved agricultural production. A project is economically viable when the economic benefits meet the costs (also taking into account changes in the future benefits and costs). However, in some countries different discounting rates apply and there, the project needs to have a larger positive rate of return. A project needs a benefit/cost ratio of at least 2.2 to 5 depending on socio-economic “status” of the impacted population.

Social acceptance and stakeholder involvement

To ensure social acceptance of the BwN measure after construction, stakeholders should be involved in all phases of the project. In the design phase, they can help to select between different design alternatives. The stakeholders can for example contribute to the criteria that the final design should meet.

Projects consist of a physical design and a societal design. The societal design are the arrangements, contracts, licences and more that determine compensation, use and access, tasks and responsibilities in implementation and maintenance and financial contribution of different stakeholders. In spite of the fact that the physical design can be challenging, because of uncertainties in its future development, the societal design is often decisive. It can also be even more challenging, since it has to reconcile the many often competing ambitions and interests of various stakeholder groups as well as their often very different perceptions of the uncertainties and opportunities the physical design is offering.

Financial possibilities

Co-financing opportunities can be integrated into the design, by optimizing the design in such a way that co-benefits for potential investors are included. The most creative solutions are often developed when there are financial constraints, since this triggers the search for additional functions, beneficiaries and added value as well as ways to cost-optimize the design. It is easier to find finance for a BwN measure if the costs are lower than a conventional (non-BwN) design. The construction costs depend on e.g. the type of material, the duration of the construction and the construction technique. All these factors are determined in the design phase. But the design will also impact the maintenance costs on the longer term. So a maintenance plan should already be drafted in the design phase.

Handling uncertainties by optimizing design

As discussed in Step 3, the performance of BwN (especially on the longer term) may hold uncertainties. The level of uncertainty may depend on past experiences in reference situations, in morphological and hydrological models and whether the proposed solution is very sensitive to unknown variables (e.g. a migrating tidal channel close to a sandy primary flood defence), or assumptions (e.g. what is the chance that a new heavy rain event happens, at the time natural buffer areas are still full). Besides incomplete knowledge and unpredictability, also multiple interpretations of the situation or problem (so-called 'knowledge frames') can be a source of uncertainty.

Methods for dealing with uncertainties

In general uncertainties can be met in the design phase by one of the following ways:

- Many BwN measures are innovative and work needs to be done to improve the **evidence base**, how well does it perform, what added values are created. Sometimes there is time do to dedicated pilot research prior to the final design stage.
- **Robust design,** so there it becomes more certain that the design fulfils its objectives, albeit often at larger costs.
- **Adaptable design and development,** changing and altering depending upon its prior uncertain development. This can be viable option as long as it does not comprise vital goals. Can often be used to steer management or future use but also the incremental development of a project.
- **Flexible project goals and contractual requirements,** flexibility in project objectives can be introduced (e.g. by extending a deadline or being less specific about when and where certain habitats will be developed). Flexible goals are best combined with adaptive management and development, as well as with contractual arrangements, that give ample scope to the contractor in case the implementation of a project may offer win-win opportunities.

Flexibility and adaptability to deal with uncertain circumstances

Flexibility and robustness are often cited as major attributes of BwN solutions. Especially in situations where there is uncertainty regarding the development of environmental conditions such as sea level rise, required standards (in most cases safety standards become stricter and are never reduced) and socio-economic ambitions and development potential. In these situations, flexibility and robustness of the design are a pre-condition. Adaptive management is a way to monitor the effect of the BwN measure. It gives space to adapt the measure when the circumstances change, or when the performance is different than expected.

Lessons learned from cases

Lesson from Domburg (NL): Use monitoring results to optimize the BwN design
Domburg is a location along the Dutch coast with high erosion rates, so frequent beach nourishments are necessary. Monitoring results are used to optimize the nourishment design. Based on results of earlier nourishments we learned that nourishments should not be placed too high on the beach, that will cause small cliffs on the beach. Also, we know that it is not useful to make the nourishments much bigger, because then it will erode quickly.

Further reading

Table 8 Further reading for optimizing BwN design

Source	Title	Content	Link
EcoShape	Building with Nature Guideline – Ecosystem engineers	Section of the BwN guideline that provides information on habitat requirements of shellfish, mangroves, corals, seagrass and salt marshes. Can be used as input for ecological optimization of a BwN design. Note: the BwN Guideline will be replaced by an update of the EcoShape website from October 2020	https://publicwiki.deltares.nl/display/BTG/Ecosystem+engineers www.ecoshape.org
EcoShape	Building with Nature Guideline – Smart handling of fine sediments	When building in a muddy environment, turbidity can have negative ecological effects. Smart handling of fine sediments can help to reduce negative effects and instead make use of the sediment characteristics. Note: the BwN Guideline will be replaced by an update of the EcoShape website from October 2020	https://publicwiki.deltares.nl/display/BTG/Smart+handling+of+fine+sediments www.ecoshape.org
EcoShape	Building with Nature Guideline – Governance assessment and scoping	Section of the BwN guideline with information about scanning relevant regulations, assessing the knowledge context and how to arrange realisation. Note: the BwN Guideline will be replaced by an update of the EcoShape website from October 2020	https://publicwiki.deltares.nl/display/BTG/Governance+assessment+and+scoping www.ecoshape.org
CEDA 2015	Integrating Adaptive Environmental Management into Dredging Projects.	Position paper on adaptive environmental management. It presents a framework for decision-making.	https://dredging.org/media/ceda/org/documents/resources/cedaonline/2015-01-ceda_positionpaper-integrating_adaptive_environmental_management_into_dredging_projects.pdf
Brugnach et al. 2008	Toward a relational concept of uncertainty: About knowing too little, knowing too differently, and accepting not to know.	Paper that shows how multiple interpretations of the situation or problem (so-called 'knowledge frames') can be a source of uncertainty.	

Step 5. Implementation: Financial arrangements and contracting

Objective	Explore financial and contractual arrangements to enable implementation
Actions	• Identify funding sources and develop a financing strategy • Identify options for contracting and select the best contract type for implementation
Output	Funding for the project and a draft contract

Introduction

This chapter describes potential ways of funding a BwN project, mainly by translating benefits through ecosystem services into co-financing by stakeholders as well as by exploiting the various funds that are earmarked for habitat and ecosystem restoration. It also describes various modes of contracting the construction, maintenance and potential further development of a BwN project and organisational arrangements needed to contract, finance, use and maintain such a project.

Where and how to get the necessary finance?

It is not easy to finance green

It's the motto of Kermit the frog:" it is not easy to be green". It is however neither easy to finance green, for a number of reasons. Green projects often fail to deliver concrete marketable assets and products since its value depends on more general effects, such as regulating services or a beautiful landscape that are not easily converted into finance. Furthermore the benefits are often long-term, uncertain and do not fall under existing ways of taxing and financing. It has often been hinted that the design of a nature based project is the least of our worries, financing is the greater challenge, especially if a nature based alternative proves to be a more costly solution than a conventional one.

Because of this there have been some recent studies that looked into innovative financing mechanisms for nature based project. The CBD (Convention on Biological Diversity) indicated several potential private financing schemes that merit further exploration. These include e.g. business-biodiversity partnerships, biodiversity off-set mechanisms and payment for ecosystem services (PES).

Funding by principle or on the basis of economic benefits

The possibilities for funding differ per country and situation. Cases and countries within the Intereg project show the following bandwidth:

- In the **UK** as in **Scotland**, national public funds for flood protection need to be justified on the basis of a minimum benefit-cost ratio. Benefits include capitalized avoided damages to properties, infrastructure and the economy.
- In **the Netherlands**, coastal flood protection is backed up by national funds. Till recently investments in coastal protection as well as beach nourishments were paid for by the State. The water boards are responsible for maintenance of dikes and dunes, which is paid for by water fees, generated within the water board. At the moment the water boards contribute also partly to initial investments in coastal protection. The investments in regional flood protection infrastructure and its maintenance are also paid for by water fees. The water boards are large entities and raising the necessary money does constitute only a limited claim on the budget of local households or land owners.
- In countries like **Denmark**, large parts of the coast are privately owned. Coastal protection is paid for by land owners. There is often no cooperation between land owners, so coastal protection has a piece meal character and may not be the most cost-effective. Many private properties are mainly larger estates and villas and the costs of coastal protection can often be easily paid for by the owners.

So there is a large difference in funding situations. In the Netherlands, money for flood protection is available but a BC approach can be instrumental in creating design with more added values, in terms of nature development, WFD objectives, recreation amenities but co-funding by users and beneficiaries is not a requirement. In Scotland, a BC approach is also instrumental in identifying benefits that add up in the benefit-cost assessment and in finding co-financing opportunities. For Denmark a BC approach may help to identify coastal protection alternatives that are less costly and provide additional benefits to the local landowners.

Also **the financial mechanisms** that are available to authorities are different in different countries. In some countries, municipalities can impose local taxes, such as a property tax, a sales tax or tourist tax or even a flood protection fee. In other countries investments in flood protection come from national budget lines, so there the link between the finance for a local project and local benefits is weaker.

There is also a difference in the way different countries look upon **the responsibility of public authorities** (proving flood protection) and the responsibility of private firms and individuals to get proper insurance, flood proofing or pay for local flood protection. In areas where there are comparatively few households directly affected, the costs of protected are comparatively high and can often not be paid for by individual households. So in these situation flood protection depends very much on solidarity principles. Since nature areas are considered as a public good, perhaps more so than local flood protection, BwN alternatives may offer more opportunities for financing also local flood protection schemes.

Sources for finance and integrating them into the design

This brings us to a natural sequence in looking for financial opportunities. BwN alternatives that are more cost-effective than conventional solutions are the most simple to finance because this will be done out of the earmarked budgets for flood protection or coastal management. The essence is to have sufficient knowledge and confidence in the proposed BwN alternative, that is will deliver the goods or performance required. This is often difficult, since empirical knowledge is often lacking and building the necessary evidence base takes time.

It becomes more complicated when a BwN alternative costs more or has uncertain costs or uncertain performance that cannot be handled by a more robust design that is still more cost-effective than the conventional alternative. One may have to look for additional finance. Examples of potential “easy money” are: avoided costs or earmarked budgets for functions or habitats that can be performed or provided by the BwN alternative. Examples are funds that are targeting specific habitats in need for restoration or compensation. If these habitats can be created as part of a BwN solution, co-financing may be possible.

If no additional finance can be found based on avoided costs or by targeting earmarked funds, one may need to look at direct economic benefits. Direct economic benefits can be related to the economic use of (parts) of the BwN alternative. A BwN alternative may create an opportunity for real estate development, with financial gains for the developer. If these opportunities are provided by the BwN alternative and not by the conventional alternative, there is a possibility of co-financing. This needs to be identified early in the process, and the design may have to be optimized in order to make the desired use possible.

In addition to direct economic benefits one should also target more general societal benefits, such as stimulating the local economy or enhancing the living environment. It are the regional and local authorities that are willing to co- invest when the BwN alternatives offers more societal benefits.

A BwN project may be a pilot which generates knowledge that may lead to further cost-savings or more societal benefits in the future and for which a dedicated fund is available.

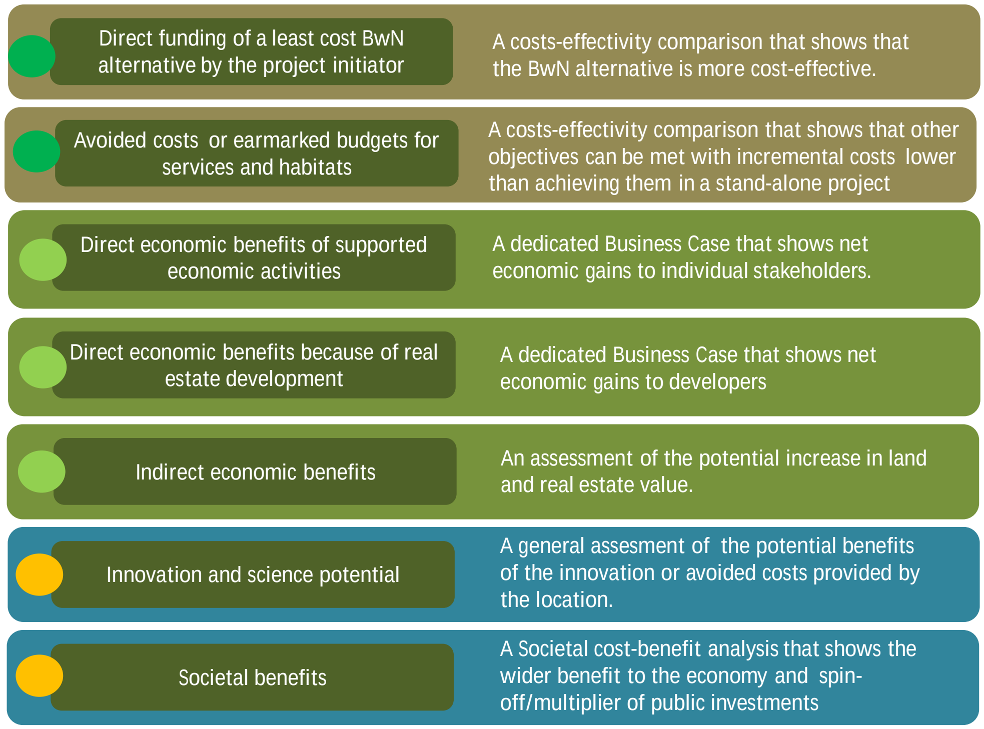


Figure 6 Possible ways of (co-) financing and required assessments needed to convince potential co-investors.

The co-funding landscape

It is important to know how economic values and revenue streams operate in the present situation. Three dimensions of the co-funding landscape merit attention:

Private revenue stream that support public funds. Private individuals already contribute to public funding, that are either linked to land and real estate values (e.g. sewer fees, land taxes) or economic activities (e.g. income taxes, sales taxes) or directed at specific user groups (e.g. tourist taxes, entrance fees). It is good to have some idea about the existing financial fluxes and potentials. This helps to see how benefits of a BwN alternative accrue to revenue streams for example to local authorities, which may help convincing them that co-financing is appropriate. It also gives an overview of existing financing mechanisms that may be used.

Public funding landscape. This encompasses earmarked funds for flood protection, habitat restoration, water framework directive funds. These are the first to look into, but there are many others that may be of interest, especially if there are opportunities to develop a more multifunctional BwN projects. There are for example funds for (regional) economic development, infrastructure development for innovation and research, for furthering sports, public green spaces and more. The landscape differs depending on country, region and municipality and location.

Real estate value. The major aim of flood protection is to save human lives and to prevent damages to buildings, infrastructure and the economy. It is good to have some idea of the geographical overview of real estate values and potential damages. Often a map with flood risks is already available**.**

Financing mechanism and cost-and benefit allocation

The previous section discussed potential sources for funding. The most direct financial mechanism is direct funding or a grant. There are a number of financial mechanisms that can be used by:

- A public authority in order to co-finance a BwN alternative with public money, such as local taxes based on real estate value.
- A private consortium to raise money for implementing and maintaining a BwN project.

The table gives an overview of different financing options that can in principle be available for financing. What to choose depends on the potential benefits and costs of a project. If there are potential revenues other options are logic than in the case that only a form of cost sharing is needed.

There are many different forms, but the essence is that costs and benefits are converted into contributions. This is not always easy. Grants are most cost-based, for example depending on the costs of creating a habitat or using a fixed price for specific benefits, such as a carbon credit or a subsidy for habitat management.

It becomes more difficult when there is for example a private investor that may see opportunities for developing an urban area, or to build a hotel. One may opt for cost sharing, in case additional costs have to be made in order to create the space needed to build a hotel. One may opt for revenue based contributions, for example a percentage of the value created, or of the turn-over or profits the hotel is making. If revenue streams are uncertain it would be better to look at cost-based sharing.

A municipality often has a local tax in place in order to pay for public services, such as waste collection. **Local property taxes** can be based on household size but also on the real estate value of a house. In the case a BwN project would lead to an increase in real estate prices, because of higher flood safety or a nicer landscape, this would automatically lead to a higher contribution in local taxes. The funding of the over 3 billion Euro flood protection project in Sacramento is based on an increase in property taxes. There are also examples of local sales taxes, often meant for managing streets and public spaces, sometimes also for flood protection, if national funding is absent. A BwN alternative may offer a much more attractive local flood protection alternative that also enhances the quality and recreational use of the landscape. So imposing or using such a tax for flood protection would become acceptable.

The use of local taxes for flood protection is common in countries like the US, where most flood protection works are financed by the municipalities. Often it are water authority that invest in flood protection, either with the help of national funds, or by raising **flood protection fees**. In The Netherlands all the water boards finance investments in regional flood infrastructure in this way. These water boards are democratic institutions and a raise in fees needs to be agreed upon in the regional assembly. There is sometimes discussion about the contribution of households, vis a vis land owners, and between those living in or outside flood prone areas.

From public, to public-private to private financing

Most BwN project that are directed at regional flood protection or coastal management is mainly financed by public funds. Even when there are economic benefits via recreational use or an increase in real estate prices, these normally constitute smaller co-funding opportunities often directed at providing some ease in maintenance costs or they provide additional investments for recreational facilities.

There are however exceptions, for example in the case there is no state authority that is fully responsible and the solution requires the cooperation and finance by a group of private land owners.

The simplest form of financing is based on single public, such as most nourishment schemes in the Netherlands. It already becomes more complex in the case of multiple public financing, such as the sand engine. The Twin dike is an example of a multiple public-private funding arrangement, albeit simplified by distinguished separate components.

Table 9 Overview of general and project-based co-financing funds and mechanisms

	Principle	Cost based sharing	Based on direct economic revenues	Based on benefits, not economic
General co-financing funds and mechanisms				
Taxes and fees	Those who benefit pay	Tourist taxes, local sales taxes, property taxes, flood protection fees, water management fees		
Public and private funds and grants for environmental objectives	Contribute to the specific objectives of funds that are available for general purposes	Grants (EU and national) and funds for habitat restoration (e.g. LIFE), National or local WFD-funding, private and public funds		Related to restoring specific habitats, CO2 sequestration, contribution to WFD objectives
General public funds for flood protection, infrastructure, utilities, regional development	Contribute to the objectives of funds that are available for general purposes	EU regional development funds, EU infrastructure funds.		
Project-based co-financing mechanisms				
User fees	People and enterprises pay for the use of the area.	Entrance fees in the case of recreational facilities. Long-term leases for hotels and restaurants.	Produce (e.g. fish, food, forest) based or income (e.g. increased turnover due to increase in	
User rights	Shares and licences that grant access and use	License costs for beach houses and restaurants. Shares coupled with user rights.		
Contributions of private developers	Private enterprises and (local) authorities co-finance because of development potential offered	Cost sharing of incremental costs because of specific design requirements.	Long-term leases. Profit sharing on initial investments.	
Direct contributions	Co-financing based on avoided costs	Contributions of utility companies, private enterprises, public authorities		
Revolving funds	Up front investments that are paid back and re-invested in further developments	Initial investments determine the amount put into the fund.	User fees and leases and local taxes are input to the fund.	
Crowd funding	Capital raised from a large number of people, with local or general interests	Can have the form of a grant.	Can have the form of a share	For restoration, preservation of landscape.

Tasks and roles in implementation

Reconsidering project requirements

In the first stages of the project it makes sense to reconsider deadlines and design requirements that have been imposed, often by the financing agency, constructing a framework within which the responsible authority has to deliver its project. However, these frameworks often limit the possible use of a BwN alterative from the onset of a project.

Allow time for a BwN alternative to be developed. Most flood protection works, whether on the coast or along rivers, have set deadlines. These deadlines define when the required flood safety standards must be achieved. Often these deadlines are part of legal frameworks or policy guidelines, and responsible water authorities need to work within these frameworks. However, often these deadlines are set having a conventional alternative in mind, for which the time needed for planning, procedures and implementation are known. A BwN alternative may require more time, the BwN alternative:

- is an innovative concept, so additional research and perhaps also pilot studies may be needed to underpin a final design. This costs more time.
- requires a more complex planning process, because it is multi-functional and addresses more objectives and stakeholders.
- may require also formal changes in policies and laws that define tasks and responsibilities, formal assessment procedures and more.
- may require more time for implementation because natural processes are used that have a specific but limited capacity, such as natural dune formation.

So allowing time creates more opportunities for the development, design and use of BwN alternatives. A pre-screening of the time needed that would enable the development of a BwN alterative needs to be made in the project initiation stage.

Define matching and logical requirements. Especially engineers that are used to designing dikes may extent similar requirements to BwN alternatives as well. However, a dike is a hard structure that is meant to last and perform during its entire functional and technical lifetime, as it was built initially. A BwN alternative is not hard, and over the years it may be developed gradually. With periodical nourishments, one can develop dunes and wider beaches over a longer time period, for example making use of navigation dredging material. Vegetation needs to time to grow as will its role in wave attenuation. So it makes no sense to define design requirements as would be needed 30 or 50 years from now. Due to sea level rise and climate change the required performance grows over time, as may be the delivered performance of a BwN alternative.

Types of contractual arrangements

There is a large number of different forms of contracts for building and maintaining projects. Typical examples are:

- **Design and build** is the most common form of builders contract for all kinds of hard infrastructure, such as dikes or dams. It can be based on a detailed design made by the Client organisation, but also on functional specifications that set building requirements and or performance requirements. This is a contract form that can be used when the basic design involves conventional engineering and maintenance is taken care of by the contracting organisation. Nourishment projects, and single purpose groynes and dikes, but also inundation areas can be contracted in this way. Also the sand engine was contracted in this way based on a detailed design based on (cross) profiles for the more stable parts and volumes for the more dynamic parts.
- **Design, build and maintain** is often a suitable contract form for BwN project, especially if there are strong relations between the design and its maintenance, which is often the case with projects in dynamic environments such as sandy coast lines. The Hondsbossche Pettenmer Seadike was contracted in this way. There was a tight set of functional specifications because the dune and beaches to be built are a primary defence structure with mainly degrees in freedom regarding the development of nature and recreation and especially regarding its maintenance. Maintenance could be achieved by nourishing an expected nourishment need for the coming 20 years as part of the initial construction, or it could rely on more frequent nourishments in this period.
- **The Design, Build, Finance, Maintain and Operate** is a contract form that covers all the bases and gives the contractor, or a consortium that may include a contractor and financing organisation, far reaching responsibilities and also opportunities. It is a suitable form when there is some degree of certainty regarding future income to maintain and operate. It is not a contract form that is very suitable for BwN projects, but there are some exceptions. Examples are certain types of by passing schemes (……)
- **Engineering and consult**, which gives the contractor much influence in the design process based on a first feasibility design. So detailed design and also supporting studies and getting the licenses are the responsibility of the contractor. This kind of contract can be used if the way the project can be built is uncertain or may strongly influence the design. It may also lead to an organisation that enables the joint development by contractor and client. The Markermeerdijken project is done in this way. The original budget for the project was determined based on detailed designs. However, since there was ample opportunity to further optimize the design in close consultation with stakeholders and the science community, this form was chosen.

It is important to note that the contract form strongly influences the design process and also the ultimate design. It contract form is preferably chosen early in the project cycle, but with due consideration of all its consequences.

Contractual logic

So there are very different forms in which a building contractor can be involved. Involvement can be done on the basis of a detailed design, or design and built, but it can also include maintenance after building or even co-financing its construction . The choice of a contract form, or the contractual logic, should depend on the kind of BwN project:

- In the case of a simple nourishment project, that is meant only to maintain the beach, only delivering a volume is needed and a simple contract suffices. There is no need to involve the contractor in the design.
- When however the design depends very much on the way it will be constructed it makes sense to involve contractors earlier in the design process. This implies that the contractor is contracted early in the project cycle on the basis of functional specifications, by putting forward a design and construction method that is the most cost-effective, environmentally benign or beneficial to stakeholders.
- In the case the financing of the project is also done by the contractor and may in part depend on long-term revenues, the contractor should be even involved at an earlier stage. In these cases the contractor can be selected on capabilities after which he may join a consortium together with the Client. This is a common arrangement for example for building infrastructure, such as bridges, in which there is a revenue stream (toll). BwN schemes or nourishment schemes may have this form, in which the revenue stream is based on annual nourishment needs. A beach upgrade may in part be financed based on revenues from tourist taxes or from the use of parking lots etc.

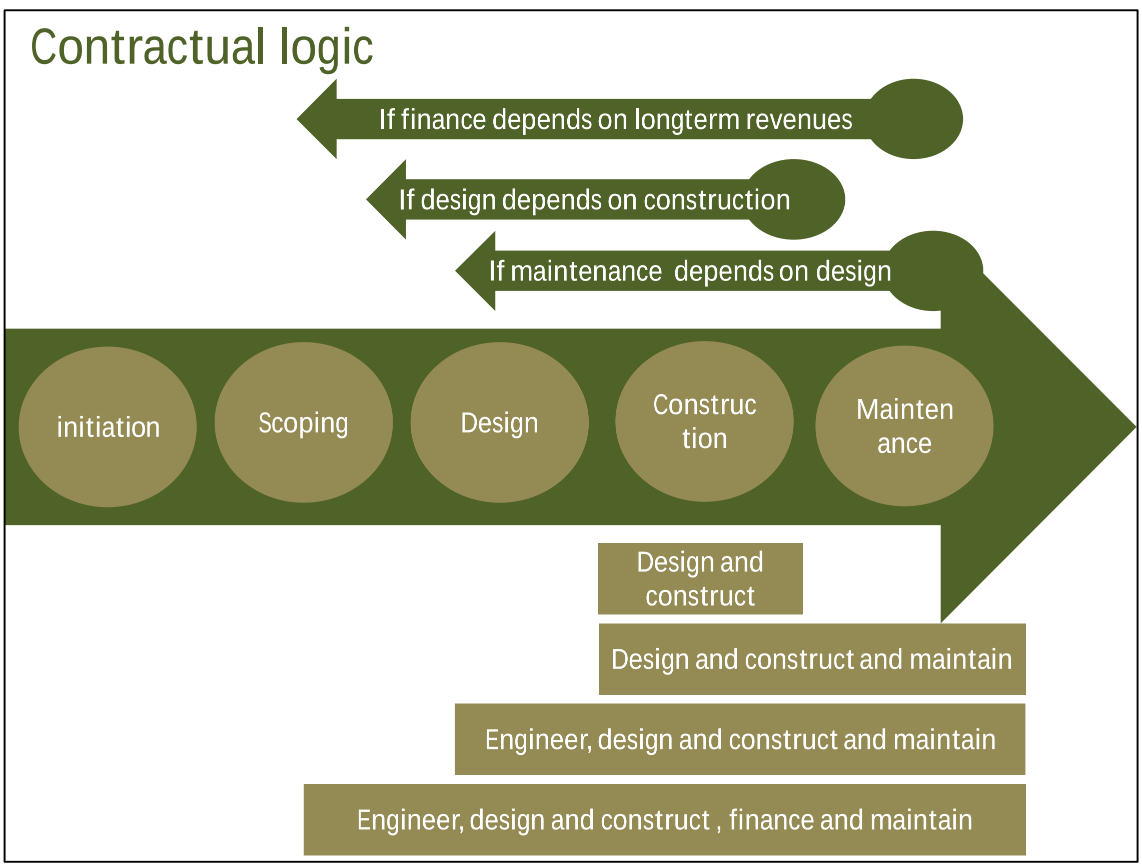


Figure 7 Phases of contracting

Using contractors creativity

Conventional projects can often be contracted within a design and built contract, since the building of dike is a known technology and there are no specific risks related to its performance or long term maintenance. BwN projects are different and often is makes sense to use a different kind of contract.

There is a number of different contract forms that can be used to implement, but also to involve the contractor and the managing organisation also in the design phase of project. The logic to use a specific kind of project strongly depends upon the type of project and often also on the philosophy of the contracting agency.

BwN projects that involve substantial capital dredging works and maintenance, are best contracted in a way that:

- Enables early involvement of the contracting firms. This is especially vital in the case of projects in which the way of building it, is strongly reflected in the design.
- Includes also long term maintenance. This comprises of projects in dynamics environments such as sandy shorelines. In this case the contractor can optimize between capital and maintenance dredging works.
- Uses win-wins with other projects, which may require extension of deadlines in order to optimize timing.

Using contractors creativity requires also that there are specific degrees of freedom that allow the contracting party to optimize the design depending upon the way he can use the equipment he has available in the most efficient way.

Lessons learned from cases

Lesson from Twin Dike:
To create willingness for BwN solutions, it is important that the financial risk of a business case is low

Thinking ahead where budget can be arranged is a priority, and it is complex because of the different aspects of interests. To create willingness for BwN solutions, it is important that the financial risk of a business case is low or that socio-economic part is of great importance to balance the financial risk. This would indicate that the risk distribution should be designed in such a way that every financier can adequately manage the risks and justify these aspects socially within their role.

Lesson from Raa (SE):
Clarity of future maintenance costs is needed to implement BwN

This programme proposes and executes various BwN projects in the catchment area of the Raa in Sweden to rehabilitate physical river processes, improve flood control and ecosystem services. In Sweden BwN is popular and up-front investment costs are usually covered successfully by a range of sources. However, in some cases certain types of NBS are avoided for fear and unclarity of future maintenance costs. As land owners have a large mandate in land use and responsibility in flood protection, the design of measures is strongly influenced by land owners. Thus, better information about (long term) maintenance costs towards the landowners could promote implementation of BwN.

Lesson from Munnikkenland (NL):
Co-funding from local stakeholders can help realize multi-functional BwN projects

Local residents and other stakeholders were involved in this flood plain widening project (executed 2013-2016). Although flood risk reduction was financed by a national fund, investments in landscape quality and recreation needed co-funding. So besides input from the local stakeholders in the design (in the form of a consultative group), local investments played an important role in making this project a success.

Further reading

Table 10 Further reading for financing and contracting

Source	Title	Content	Link
Walsh et al. 2015	Alternative business models for flood risk management infrastructures	Paper that discusses alternative business models, also relevant for BwN flood risk management.	https://eprint.ncl.ac.uk/file_store/production/232624/C014601C-B6ED-451B-94F1-D3B5830B6A52.pdf
EEA 2017	Green Infrastructure and Flood management	Report of the European Environmental Agency on promoting cost-efficient flood risk reduction via green infrastructure solutions.	https://www.eea.europa.eu/publications/green-infrastructure-and-flood-management
SEPA 2015	Natural Flood Management Handbook	Handbook for natural flood management in Scotland, including funding opportunities.	https://www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf
Deverell 2015	Who should be responsible for the provision and financing of flood defences in the UK?	Paper in Norwich Economic Papers that discusses differences in flood defences between the UK and the Netherlands.	https://www.uea.ac.uk/documents/953219/7433356/Edgar+Deverell.pdf/5732ade2-68f6-40a3-abb3-ccfbe9ac87b1

Stakeholder involvement: Who to involve and in what way?

Objective	Facilitate stakeholder engagement to ensure societal support
Actions	Identify the relevant stakeholders and group them according to their interest and influence on the project and make a strategy for stakeholder involvement
Output	Engaged stakeholders

Introduction

This chapter discusses the need to involve different stakeholder in the design process, how to identify potential relevant stakeholders and how these are best involved. Whether or not to involve them in co-creation or only to inform them is to a certain extent a matter of logic, but often also dependent upon political views regarding the need to involve local stakeholders in decision making.

A marriage of ambitions, knowledge, responsibilities and perceptions

Scoping, designing, implementing and the (adaptive) management of BwN projects should be the joint effort of all stakeholders that can contribute knowledge, experience and finance, those that are direct or indirect users or beneficiaries. Not all of these are actors, in the sense that they will directly influence the design and decision making process.

Working together depends on communication, of facts, data, alternatives, effects and more and that in the most appropriate form catering to the interests and level of expertise of relevant stakeholders. Communication with stakeholders, especially those outside of the project, is crucial for obtaining public and obtaining political acceptance.

It should be noted however that communication in the “kitchen” is as important. The communication between different disciplines and direct interest groups is difficult, but also crucial, since the kitchen determines the menu and the flavours of the dishes and how they are presented. This also involves many interim decisions, some taken within a project group, some taken explicit on the basis of consultation with the “outside world”.

The implementation of BwN is often more complex than that of conventional solution. For this reason the governance aspects of BwN projects are a major research theme in many research and innovation programmes. Notably the governance of green infrastructure and nature based solutions in cities has gained much momentum, mainly because urban environments are even more complex arenas.

How to identify possible stakeholders at the project level and how to involve them

A stakeholder analysis is the first step in identifying potential stakeholders. There are many groups:

- **Project initiators**, often water or coastal authorities with responsibilities for flood protection and coastal management. These often follow formal sectoral goals but may also tend towards conventional solutions.
- **Project financing organisation**, can be other regional or national authorities that set funding requirements, deadlines, design protocols that need to be fulfilled in order to be eligible for financing.
- **Public authorities** that have licensing powers, such as municipalities, water authorities and provinces regarding physical planning, flood infrastructure and nature laws. Especially requirements related to Nature 2000 may prove to be important in design and implementation.
- **Land owners and land users** of the project and adjacent areas. These often constitute the most important wider public that determines public acceptance but may also determine overall added values a BwN project can generate. It is however a very diverse groups, with different interests.
- **Project owners** of projects nearby and economic activities that may have functional links because they need ecosystem services, or may contribute resources and services. These could for example be operators of sand pits and hotel owners.
- **Public and private funds** that wield potential financial sources e.g. for bio-offsetting, habitat restoration perhaps also for maintenance of cultural inheritance. It is good to have an overview of potential habitats and funding criteria.
- **Private contractors** that will construct the project but may be involved in planning and design but may also be identified early in the project if this has major advantages. Often their experience and knowledge is valuable upfront and can sometimes be made available with contests or other forms.
- As may organisation that are eligible as **nature managing organisation** after construction; they may have specific requirements that enable and facilitate the necessary management.
- **Scientific community and experts**; this may be a group that is independent from the groups above which can be very important in terms of credibility of an innovative alternative, but also for attracting additional funds. EcoShape is such a group in the Netherlands that was instrumental in identifying pilots and in attracting also the necessary funds for conducting pilots.

Type of relation with the project *(actual and potential)*	License	Use	Owner	Know ledge	Con tractor	Funds
Are these related to the design *(consent, requirements, effects, innovation)*	●	●	●	●	●	●
Implementation and maintenance (requirements, timing, materials)	●	○	○	○	●	○
Can these lead to added values	○	○	○	○	○	○
that are substantial	○	●	○	○	○	○
that require specific designs	○	●	○	●	○	○
And to co-finance or cost-savings	○	○	○	○	○	○
by dedicated funding	○	○	○	○	○	●
by general taxation	○	○	○	○	○	○
by joint development	○	○	●	○	●	○
Best way to involve them						
by informing	○	○	○	○	○	●
In consultation	●	○	○	○	○	○
by joint designing	○	●	●	●	●	○
By joint implementation	○	○	○	○	●	○

Figure 8 scoping for potential relations and arguments for involvement.

So there are many potential stakeholders. How they should be involved depends upon their negotiation powers, their potential contribution to the project but also on formal procedures that stipulate stakeholder participation. What is important is that their potential to contribute or criticise the project should be recognized early in the project. That is also the main reason for conducting a stakeholder analysis. From a business case perspective important questions are:

- What are the **actual and potential relations to the project:** is it ownership, (economic) use, licensing powers, the opportunity of joint development, the contribution of essential knowledge, their responsibility for future management or can they contribute necessary funds. This relation may depend on the design or on its implementation.

- **Are these relations related to the design** and in what way? It could be by criteria posed by ear-marked funds for flood protection, requirements of specific users or owners.

- Can the involvement of specific stakeholders open **up new lines of added values**? Added values are not limited to financial or economic values. These values van be substantial but may also depend on specific components or characteristics of the design.

- May a stakeholder **potential contribute to the project financially or in other ways**? If yes, consider how financing requirements may be accommodated in the design and involve them in the design process. A stakeholder, such as a contractor, may bring in knowledge that would lead to **considerable cost savings or a more environmentally benign design?**

- Finally, consider what **would be the best way to involve them**. If a stakeholder may significantly contribute in a way that strongly depends on the design, it is best to involve them in the design process. Their involvement may be different in different project phases.

BwN projects require that new alliances are forged between stakeholders that so far had no business case together.

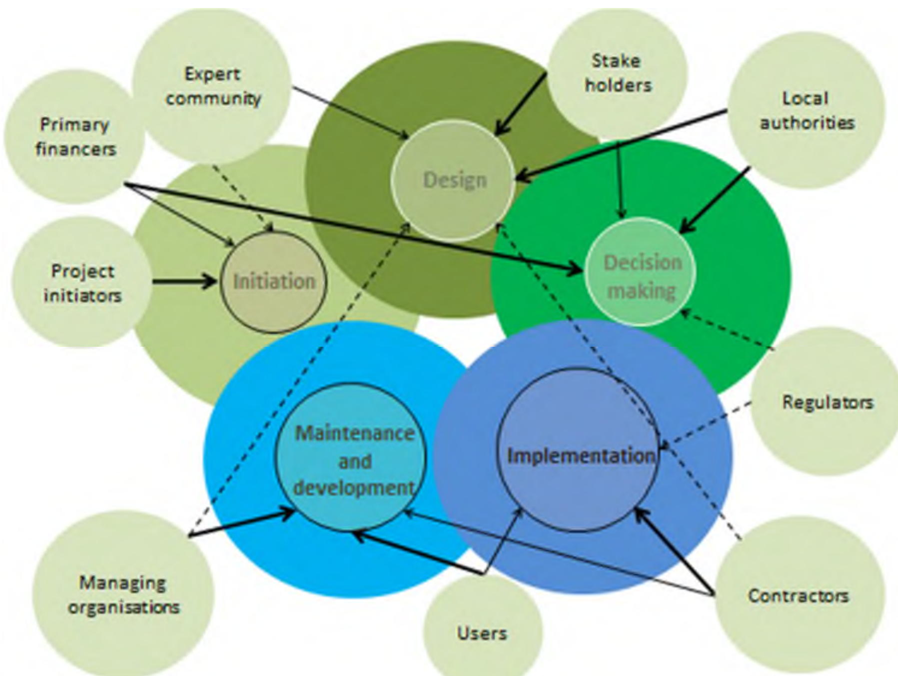


Figure 9 Various groups need to play their role in various project stages

Forming a dedicated project group

One of the first organisational decisions to be taken regards the building of a (building with nature) project organisation. This is not unlike in other projects.

The project organisation will at last consist of a project group, that prepares design (alternatives) and a steering group that makes interim and final decisions regarding the preferred alternative. For the project group is important that:

- **Relevant stakeholders are participating** or are represented with strong relation to the project, its implementation, use and maintenance.

- The **right mix of disciplines** is at the table, also the ones that can identify possible BwN alternatives. This will require the involvement of ecologists, environmental engineers and preferably also of environmental economists. In many BwN projects a representative of the scientific community can act as a catalyst for identifying BwN options. A landscape architect will add quality and synthesis.

The group needs a clear organisation structure that detailed tasks and responsibilities, specific mandates also vis a vis decision making procedures.

Wider embedding: policy making on behalf of BWN

Sometimes new policies are set based on the results of pilot projects. Pilot projects can be instrumental in this. However in order to facilitate BwN projects, organisational arrangements and policies are needed at a higher level that facilitates and advocates the use of BwN solutions. The chances for BwN projects become greater when:

There are **policy guidelines** that demand that BwN options should also be considered and not just standard engineering practise. These guidelines can be put into operation in for example SEA and EIA policy guidelines or can be made part of design protocols for specific type of projects such as flood protection works. Policy guidelines can be powerful advocates for using nature based solutions. They are more important than a guidance document.

There is a **policy broker**, someone who understands the right timing and circumstances to find a window of opportunity. This policy broker can very well be an experienced BwN expert, who understands the policy arena and is willing and able to 'sell' BwN solutions outside his or her natural 'habitat'.

Also the availability of **research funds for pilot projects** and increasing the evidence base is vital. Without appropriate research into especially the "engineering" capabilities of BwN alternatives, such as wave attenuation by salt marshes or peak flow reduction by natural inundation areas, it will be difficult to develop trust in nature based solutions and without this knowledge it is also difficult to develop a cost-effective design. A nature based community platform that exchanges knowledge and lessons learned will contribute to this.

Promoting **assessment procedures** that include a comprehensive assessment of all potential benefits of BwN solutions is also very important. The first step is to consider wider societal benefits and not only initial and recurrent costs. These assessments should look at short- and long term benefits, within appropriate time and geographical system boundaries. For coastal projects, this is the entire coastal cell, for flood protection projects it may need to include the entire catchment area. The quality of a wider Societal Cost Benefit Analysis depends upon in depth knowledge on the value of ecosystem services in different physical and societal situations. It is not possible to conduct in depth studies in every project, it is important to develop a database of key figures and a concise system of rules how these key figures can be used. Also this requires a programmatic effort.

Habitat banking and biodiversity offsetting is not an established practise in most countries. It can however contribute to the funding of BwN alternatives, since it offers a co-financing in case specific natural habitats are part of the design.

Many ecosystem services are for free. Enabling **payment for ecosystem services** may increase the potential for financing nature based solutions. Opening up new paying mechanisms is subject to political decision making and it may not be possible to redefine existing systems that easily. However, it should be noted that a potential revenue stream is not the only criterion. Many natural habitats are formally protected and their restoration and maintenance is therefore not directly related to the ecosystem services these habitats can provide.

Lessons learned

Lesson from North Jutland (DK): **When landowners are responsible for coastal erosion control, it is more difficult to implement BwN.**
In most parts of Denmark, landowners are responsible for coastal erosion control. As a result, it has proven to be more difficult to implement BwN. Because BwN (such as sand nourishment) only works when it is applied on a large scale and for a longer time frame. Therefore, landowners tend to choose for a ‘quick fix’ of their coastal section, such as stone revetments. Stakeholder processes led by the municipality can enable a change in this attitude, but that is not easily done and requires a long term approach.

Lesson from Twin Dike (NL): **An entrepreneur can act as a policy broker**
In the Northern part of the Netherlands a coastal defense challenge arose, due to frequent flooding with seawater. This brings in nutrients and salt and makes the soil inconvenient for traditional agriculture. The solution was an innovative approach of a double dike with a field-lab for brackish agriculture in between the two dikes. An entrepreneur in salty vegetables acted as policy broker, being partner in this project and willing to exploit the brackish area. This case shows that risks (of brackish-soil) can be changed in a chance for benefits.

Lessons from Eddleston (UK) **Voluntary implementation of natural flood management (NFM) is supported through sound financial analysis at farm-level**
In a context where solutions include activities on privately owned land, voluntary participation of land owners is required: this requires good communication and relevant information tailored to land owners, e.g. about true costs and benefits to individual farmers. Voluntary implementation can only be expected if NFM is attractive to the farmer. This also affects the financial architecture of a NFM scheme: often the focus lies on initial investment, where for the farmer and for the local economy, stable incomes over a longer period are critical.

Further reading

Table 11 Further reading for stakeholder involvement

Source	Title	Content	Link	Step
Naturvation 2017	The Governance and Politics of Nature-Based Solutions	Report of the NATURVATION project with evidence for successful governance, business, finance and public participation schemes for the implementation of nature-based solutions.	https://naturvation.eu/sites/default/files/news/files/naturvation_the_governance_and_politics_of_nature-based_solutions.pdf	5
Kabisch et al. 2017	Nature-based Solutions to Climate Change Adaptation in Urban Areas	Open access book that explores the linkages between science, policy and practice related to urban nature-based solutions.	https://link.springer.com/content/pdf/10.1007%2F978-3-319-56091-5.pdf	5
TUD, Deltares	Added value of joint action	A workshop method to help stakeholders understand the benefits of multifunctional approaches and cooperation.	https://www.deltares.nl/nl/projecten/added-value-of-joint-action-a-workshop-methodology/	5

Conclusion

This guidance report aims to introduce the typicalities of business cases for Building with Nature solutions. We outlined a practical and pragmatic five step approach that could be followed in developing a business case for Building with Nature solutions, independent of the phase the project is in. As such, the method is circular and iterative, retracing steps with increasing detail as the project progresses. We trust this also clarifies that there is no single set of tools that is the ultimate solution for developing the business case for Building with Nature.

As the definition of a business case in this report, we considered a definition that relates to both public and private context relevant to BwN in a water management context:
A business case is a decision support framework that gives insight in whether (1) the project provides increased welfare for society and (2) sources and mechanisms for funding and financing can be identified.
Additionally, we highlight that through iterative consideration of the business case in various phases of project development, the business case can also steer the design of the project to increase feasibility of implementation (improve the business case) later on.

Within the initial steps 'Scope' and 'System analysis' the possible interaction between the environment and society is presented. Focus is on the possible role of nature and natural processes in delivering "engineering services" such as flood attenuation and coastal protection. But attention is also paid to other ecosystem services that increase the welfare of society and/or meet local goals. In this way we also identify relevant stakeholders.

The next step 'Selection' shows the different options there are and how to choose the best BwN measures. The selection procedure takes into account several criteria such as: effectiveness, co-benefits, costs, acceptance among stakeholders, etc. After this, the step 'Optimization' allows for optimizing the chosen BwN measurement on the physical design on those elements, taking potential network relations and habitat requirements as a starting point. In this way, selection and optimization is not only directed at improving "engineering services", but also at enhancing nature and services that benefit society.

The final step 'Implementation and financial arrangements' highlights the necessity and various ways to confirm (formal) arrangements around contracting and financing, in order to make the necessary steps towards implementation and operation and maintenance. Fitting the right strategies with the right goals, scope and selected approach is key to make things happen.

In all five steps, stakeholder engagement and collaboration is needed. A special section on this topic highlights available methodologies and elaborates on the key item in any business case: integrating the perspectives of key stakeholders in order to provide a convincing argument for investment, and public support.

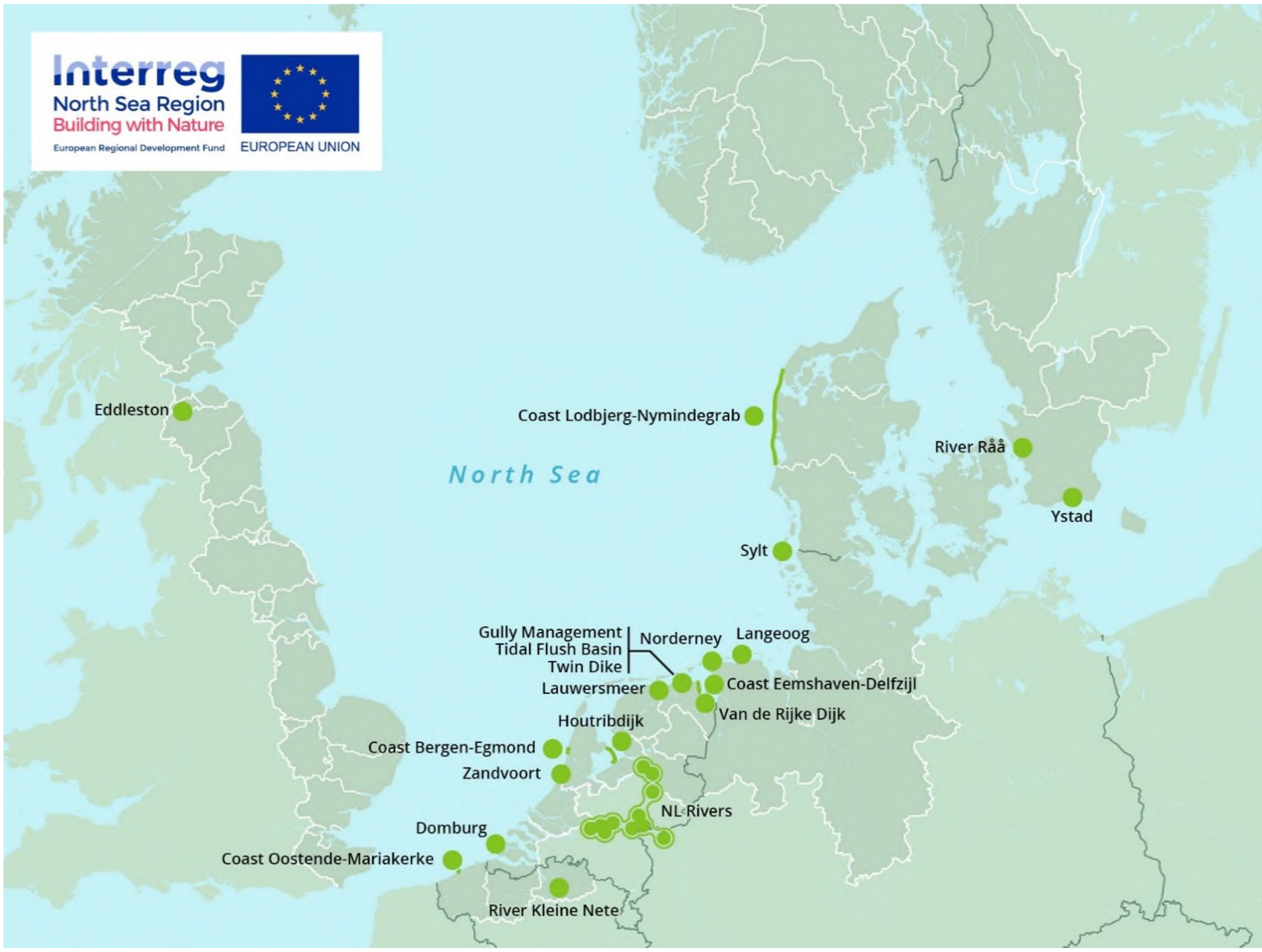
This report provides guidance in developing the business case of BwN: it presents a logical overview of steps to be considered, tools that can be applied and best management practices that are derived from experiences and lessons learned of many (BwN) projects and pilots. In this light, the guidance report does not include a detailed procedure with corresponding tools, but rather provides an (incomplete) list of relevant tools, approaches and lessons learned from real-life cases to be used as inspiration.

Appendix I Further reading (guidelines)

Table 12 Further reading for guidelines about BwN

Source	Title	Content	Link	Step
EcoShape	Building with Nature Guideline	The online BwN guideline contains knowledge gained through BwN pilots carried out by EcoShape partners. Learn about BwN concepts, ecosystems, the pilot projects and tools. Note: the BwN Guideline will be replaced by an update of the EcoShape website from October 2020	www.buildingwithnatureguidelines.org www.ecoshape.org	1-5
Deltares, World Bank, GFDRR, PROFOR	Natural Hazards – Nature-based Solutions	Case studies and guidance on implementing nature-based solutions to reduce the risk of natural hazards.	https://naturebasedsolutions.org/	1-5
ThinkNature 2019	Nature-based Solutions Handbook	Guideline on implementing nature-based solutions, from the EU ThinkNature project. The site also contains a platform, a serious game and webinars.	https://www.think-nature.eu/	1-5
Environment Agency 2017	Working with Natural Processes – Evidence Directory	The Evidence Directory summarises the effectiveness of Working with Natural Processes in the UK. It contains a literature review, guidance on project monitoring and 65 case studies.	https://www.gov.uk/government/publications/working-with-natural-processes-to-reduce-flood-risk	1-5
WBCSD	Natural infrastructure for business	A platform with resources about the business case of natural infrastructure, aimed for business leaders. Also contains tools and case studies.	https://www.naturalinfrastructureforbusiness.org/	1-5

Appendix II Living laboratories



Estuaries, rivers and lakes

- Eddleston Water Project (Scotland)
- Restoration of streams, Helsingborg, catchment area of Råå (Sweden)
- Flood prevention in Kleine Nete catchment (VMM) (Belgium)
- Room for the River (The Netherlands)

Coasts

- Dutch North Sea coast shoreface nourishment (The Netherlands)
- Danish North Sea coast between Lodbjerg and Nymindegrab (Denmark)
- Coastal protection strategy for two East Frisian Islands (Germany)
  On the islands of Langeoog and Norderney NLWKN wants to develop a better understanding of the natural processes in the shoreface and beach areas to optimize the coastal protection strategy using building with nature principles.
- Sylt beach and shoreface nourishment (Germany)
- Planned retreat and other solutions to prevent coastal erosion along the Swedish coast (Grannian, Sweden)
  In Ystad a pilot beach nourishment is currently being monitored and under research. Besides this sandy solution, along the Swedish coast several pilot projects will be executed which investigate the use of ecosystem (grasses) in order to prevent coastal erosion.

- Ameland tidal inlet monitoring and analysis (The Netherlands)
- Research program (Belgium)
  In Oostende - Mariakerke the coastal division of the Flemish government is currently performing a research program including the monitoring of a beach and shoreface nourishment pilot to understand the behaviour and effectiveness of both nourishments for coastal protection.
- Gully Management (The Netherlands)
- Twin Dike (The Netherlands)
- Tidal Flush Basin (The Netherlands)
- Benevolent (Rich) Dike coastal lab