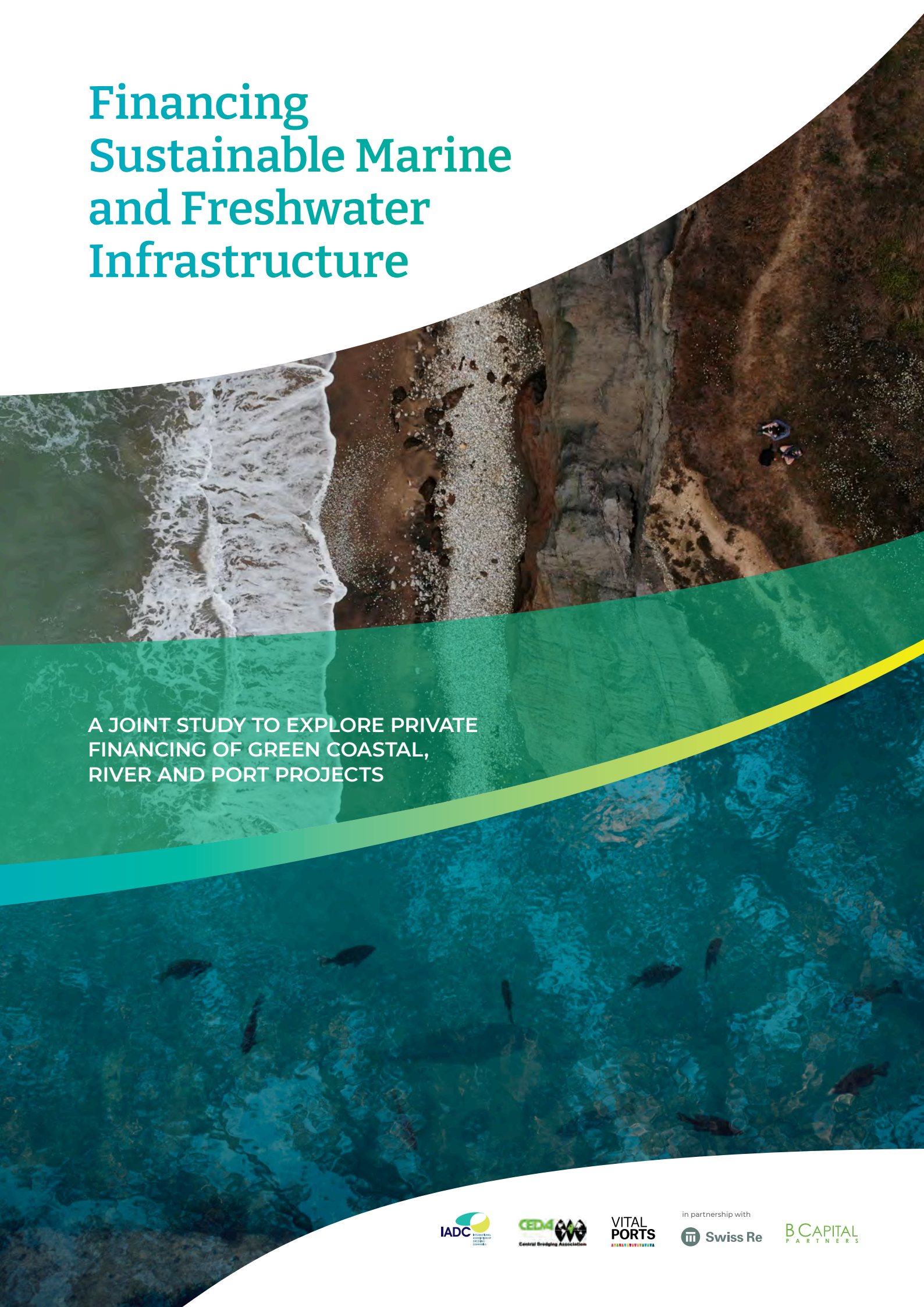
Financing Sustainable Marine and Freshwater Infrastructure



A JOINT STUDY TO EXPLORE PRIVATE FINANCING OF GREEN COASTAL, RIVER AND PORT PROJECTS

IADC

CEDA Central Dredging Association

VITAL PORTS

in partnership with

Swiss Re

B CAPITAL PARTNERS

Financing Sustainable Marine and Freshwater Infrastructure

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September 2021

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ABOUT THIS REPORT

Recent years have seen an increase in publications and forums discussing the financing of ‘nature-based solutions’ and investments in nature, led by various organisations such as the International Union for Conservation of Nature, World Wide Fund for Nature, Organisation for Economic Co-operation and Development, European Investment Bank and EcoShape. In this high-level study, representatives of the dredging sector, Swiss Re and B Capital Partners build on these publications in a joint exploration to identify, and clarify, the role of private finance in sustainable Marine and Freshwater Infrastructure. The purpose of this exploration is twofold: to raise awareness of sustainable dredging solutions within the financial community, and to start building a bridge between the worlds of sustainable dredging and private finance. This report is one of the first steps of this shared journey and serves as a starting point for inspiration and further discussion on potential financing mechanisms for projects.

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All photographs have been provided by IADC members unless otherwise indicated.

ABOUT THE ORGANISATIONS

VITAL PORTS

Vital Ports helps port authorities to create healthy systems. Through smart governance arrangements, the rules are changed from ‘sustainability as a cost’ to ‘sustainability as a source of revenue’. In this way, Vital Ports enables the uptake of sustainable solutions to the mutual benefit of the port authority, its investors and the local community.

CEDA Central Dredging Association

The Central Dredging Association (CEDA) is an established authority and the leading independent forum for the professional dredging community and associated industries in Europe, Africa and the Middle East. It represents dredging professionals and organisations, from government, academia and business, in the region. CEDA fosters and promotes the understanding and advancement of dredging to the wider community.

IADC INTERNATIONAL ASSOCIATION OF DREDGING COMPANIES

The International Association of Dredging Companies (IADC) is the global umbrella organisation for contractors in the private dredging industry. As such, the IADC is dedicated to promoting not only the skills, integrity and reliability of its members, but also that of the dredging industry in general. The information presented here is part of an ongoing effort to communicate with clients, stakeholders and other concerned parties about the fundamental importance of dredging and maritime construction.

Swiss Re

The Swiss Re Group is one of the world’s leading providers of reinsurance, insurance and other forms of insurance-based risk transfer, working to make the world more resilient. The aim of Swiss Re is to enable society to thrive and progress, creating new opportunities and solutions for its clients. Swiss Re insures, invests, operates and shares its knowledge, in a way that tackles sustainability challenges and creates long-term value.

B CAPITAL PARTNERS

B Capital Partners is an independent investment house established in 2003 in Zurich. B Capital Partners invests exclusively in sustainable infrastructure with a clear focus on the wider energy transition. It has deployed and advised on over EUR 2.6 billion worth of transactions since 2015, with and for institutional investors and large family offices, often in close co-operation with developers.

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LIST OF ACRONYMS, ABBREVIATIONS AND DEFINITIONS

Acronym/ Abbreviation	Expansion
CEDA	Central Dredging Association
DFI	Development Finance Institution
ESG	Environmental Social and Governance
GCD	Global Centre for Dialogue – Swiss Re, Rueschlikon
IADC	International Association of Dredging Companies
IFI	International Financial Institution
IUCN	International Union for Conservation of Nature
NbS	Nature-based solutions
OECD	Organisation for Economic Co-operation and Development
PPP	Public-private partnership
SDG	Sustainable Development Goal
SFDR	Sustainable Finance Disclosure Regulation
UNPRI	United Nations Principles for Responsible Investment

Term	Definition
Bankable	A project is bankable if it is in a position to attract commercial finance, by broadly meeting three criteria for financiers: 1) the underlying business case is viable with predictable cashflows; 2) the risk-adjusted rate of return is acceptable; and 3) the project's legal structure is solid.
Blue carbon	Blue carbon is the carbon sequestered and stored in coastal ecosystems, such as mangrove forests, seagrass meadows and saltmarshes.
Ecosystems services	Ecosystem services are the many and varied benefits gifted to humans by the natural environment and from healthy ecosystems. Such ecosystems include agro-ecosystems and forest, grassland and aquatic ecosystems.
Funding, finance and investment	Funding, finance and investment are often used interchangeably as is the case in this report. In literature and practice, there are however different definitions and interpretations of their meaning. Basically, 'funding' of a project refers to the capital deployed. The funding, or capital, can be sourced in various forms: via grants (non-recoverable), and on a private or commercial basis (recoverable with reward). In the latter, the terms 'finance' and 'investment' are relevant. The difference between a financier and an investor relates to matters such as risk-reward requirements, ownership and the priority in the payment order (e.g. interest payments in the case of financing, versus dividends in the case of investments). Further elaboration on this matter goes beyond the purpose of this report.
Green project	Projects with only 'nature-based' elements. Artificial elements (e.g. concrete and steel) are avoided and natural processes are used as much as possible.
Grey project	Projects with conventional engineering design. These projects often use hard, artificial elements (e.g. concrete and steel) and aim to solve a specific issue at minimum cost within regulatory boundaries.
Grey-green hybrid project	Projects which combine conventional (grey) and natural (green) infrastructure elements. As such, hybrid projects contribute to and/or expand healthy habitats beyond basic mitigation and compensation requirements.
Nature-based solutions	Nature-based solutions (NbS) are defined by the EU Commission as: 'Solutions that are inspired and supported by nature, which are cost-effective*, simultaneously provide environmental, social and economic benefits, and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions.' *The authors view that cost-effectiveness is an encouraged but not necessary component of NbS.
Sustainable development	Sustainable development, as defined by the UN, is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Broadly, it calls for concerted efforts towards building an inclusive, sustainable and resilient future for people and the planet. In this report, both 'sustainable' and 'green' are used interchangeably with the same meaning. This is common in the infrastructure sector.

EXECUTIVE SUMMARY

Context

In past decades, sustainable development has become an important theme in Marine and Freshwater Infrastructure. This is the collection of works at coastlines, rivers, canals and in port areas, to enable or provide flood protection, urban and port development, navigation and upgrade or protection of nature. Conventional engineering solutions typically contrast with the dynamic landscapes they occupy. In response, a variety of sustainable solutions have been developed by the actors in this field. Sustainable variants, designed to deliver on project needs, range from hybrid to fully green (nature-based) solutions.

Against a background of substantial future infrastructure investment needs, particularly evident in coastal protection, there is a widespread ambition to scale up private finance. Meeting these investment needs cannot be done through public resources alone. There is a critical complementary and supporting role that private capital can play to bridge the investment gap. This also fits closely with the desire to re-orient financial flows toward a low-carbon economy. However, barriers for the financial sector include the lack of an investment track record and of bankable projects. The latter is largely due to a lack of viable business cases and strong institutional and legal frameworks, and inadequate standards and instruments to assess Environmental, Social and Governance (ESG) indicators. Also, risk-adversity due to a general unfamiliarity with the concepts and sector plays a role.

Table 0.1 Examples of conventional and sustainable Marine and Freshwater Infrastructure applications.

Conventional Marine and Freshwater Infrastructure applications	Sustainable Marine and Freshwater Infrastructure applications
Land reclamation	Hybrid land reclamation, including habitat improvement and expansion
Riverbank protection	Beneficial use of dredged material for sustainable applications
Flood barriers (e.g. dams, dykes, dunes)	Wetland restoration
Beach nourishment	Mangrove forestry and restoration
Integrated coastal zone management	Coral reef restoration
Dredging of navigable waterways	Circular use of materials, use of local materials
Port development and maintenance	Eco-friendly breakwaters and river protection
Breakwater construction	Integrated river system development

Marine and Freshwater Infrastructure presents a promising financing opportunity. The recent developments in sustainable concepts could be an attractive avenue for private investors seeking to invest in sustainable infrastructure. This study aims to provide content for further dialogue that will:

- foster the uptake of green marine and freshwater concepts by private investors;
- explore the potential role of this sector; and
- identify needs related to private finance.

Categorising projects from a financial perspective

Broadly two groups of projects can be distinguished, based on the origin of the cashflows with which the financing of investment costs can be serviced (as opposed to traditional government funding):

- Public service projects (e.g. coastal protection): The government, as project client, pays periodically after completion, where the payments may be based on performance or availability criteria.
- Commercial projects (e.g. port development): The users or beneficiaries pay for the project's results or services. Cashflow is generated based on the project's business model.

Green or sustainable solutions, such as natural breakwaters, coastal mangrove belts, habitat protection and beneficial use of sediments, may be integrated into the above categories. However, public service or commercial projects could fall short in terms of financial viability, perhaps because the government institution has limited credit capacity (notably low-income economies) or the project's business model is insufficient to carry the financing obligations. In such cases, opportunities exist to use concessional funding sources (blended finance) or additional revenue streams generated by sustainable elements (e.g. from green markets, such as carbon trading markets).

Reflections from the financial sector

In this report, (re-)insurance company and investor Swiss Re and infrastructure investment house B Capital Partners reflect on the role that private infrastructure investors can play in sustainable Marine and Freshwater Infrastructure projects. From a societal perspective, it is generally recognised that there is no alternative to green infrastructure, if we are serious about tackling challenges such as climate change and biodiversity decline. Apart from ESG considerations, and solely from a financial perspective, institutional investors and infrastructure funds are increasingly conscious of, and concerned about, the predictability of the future value of their assets. The residual value of an infrastructure asset is, in the long run, fundamentally linked to the asset's resilience to external shocks. Green projects, if designed and developed properly, are well positioned to deliver on their future value.

Sustainable Marine and Freshwater Infrastructure could be an attractive avenue for private investors seeking ESG impact.

If we want to tackle the variety of global challenges ahead, including climate change and biodiversity decline, there is no alternative to green infrastructure.

As shown in this report, green infrastructure solutions are available, have been tested and are economically viable. Private capital could help to accelerate the uptake of such solutions, but, as described by Swiss Re and B Capital Partners, the following elements are recommended and emphasised:

1. **Joint screening by sponsors and private capital suppliers** is strongly encouraged to improve the availability of private capital for this segment. Early collaboration may avoid following leads which look attractive construction-wise, but are not viable for investors in terms of the economics or sustainability. A joint holistic selection effort can focus scarce resources on the most promising opportunities, with a snowball effect on the private funding of projects.
2. The EU Commission requires all financial parties to comply with a stringent investment process. This is stipulated in the Sustainable Finance Disclosure Regulation (SFDR). Transparent reporting is also required with respect to the Sustainable Development Goals (SDGs) and the sustainability impact of investments. These requirements urge financial actors, of all kinds, to adopt an investment ESG risk management and controlling system. **Certification of green projects** is instrumental in this regard to move forward.
3. **Standard legal frameworks** that allow private capital to enter the sustainable Marine and Freshwater Infrastructure market. This would include updating concession-type legal frameworks relating to, for example, public-private partnerships (PPPs).
4. **Reporting tools and harmonised methodologies** must be built to capture the associated ESG benefits which are often overlooked, particularly in relation to future savings, as they are difficult to quantify.
5. **The insurance industry as a 'de-risker'** can facilitate in establishing a longer-term investment framework. New types of insurance offerings could support standardisation of green solutions, make cashflow more predictable and make sustainable infrastructure, as an asset class, more attractive to investors – thus unlocking financing.
6. Green solutions need **policy incentives**, favouring projects with green features, that increase their uptake and allow the rerouting, or unlocking, of funds to support them.

Given the size and attractiveness of the sustainable marine and freshwater market, and the growing appetite for associated projects, it is expected that more avenues will open to enable the pursuit of such projects and more private capital will become available.

Suggestions to support private investment

Building on this report, we would like to propose a number of suggestions to support the viability of sustainable infrastructure for private funding. This includes reaching out to, and co-operating with, a wider and more diverse group of stakeholders than were involved in this first phase. Stakeholder groups would ideally include:

- development and commercial banks, funds and institutions;
- institutional and impact investors;
- insurance institutions;
- project certifiers;
- (public) project developers/sponsors (e.g. port authorities);
- global development networks (e.g. EU, OECD, UN);
- the dredging community; and
- related advisory firms.

Examples of engagements and desired outcomes could be defined as shown in the table opposite.

As a starting point, this report will be launched at upcoming forums and will target stakeholder groups working on, or interested in, financing sustainable projects. We warmly invite others to join us in the dialogue to finance promising green marine and freshwater project opportunities.

Table 0.2 Examples of engagements and desired outcomes.

Engage with...	Desired outcomes
Funds, banks and investors	Joint early-stage project screening to stimulate collaboration on (blended) financial structure developments. Jointly defining and developing pre-requisites (e.g. project certification, reporting tools, policy incentives) to enable upscaling of green project financing.
Green project certifiers	Identifying potential to develop and implement a project certification, or rating methodology, on sustainability, complementing technical and ESG frameworks applied by financiers.
(Re-)Insurance institutions	Joint early-stage project screening and regular communication to support future collaboration on project developments. Collaborating on knowledge sharing on sector and project-specific risks and potential mitigants relevant for financing sustainable Marine and Freshwater Infrastructure.
Project developers/ sponsors (e.g. port authorities)	Jointly identifying opportunities for developing sustainable infrastructure and increasing the role of private capital.
Global development networks (e.g. EU, OECD, UN)	Joint early-stage project screening to stimulate collaboration on (blended) financial structure developments. Jointly defining and developing pre-requisites (e.g. project certification such as the Blue Dot Initiative, reporting tools, policy incentives) to enable upscaling of green project financing. Embedding particulars of the dredging sector into the frameworks, standards respectively classification methods for financing sustainable development (e.g. EU Taxonomy for Sustainable Activities and OECD-UNDP Impact Standards for Financing Sustainable Development).

As shown in this report, green infrastructure solutions are available, have been tested and are economically viable.

(Vital Ports, p.12)

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INTRODUCTION

1 INTRODUCTION

1.1 Context

In past decades, sustainable development has become an important theme in Marine and Freshwater Infrastructure. This is the collection of works at coastlines, rivers and canals, and ports, which support navigation, flood protection and development. Conventional engineering solutions typically contrast with the dynamic landscapes they occupy (Van Eekelen and Bouw, 2020). In response, actors in this field (e.g. port authorities, governments, engineering firms and the dredging industry) have developed a variety of sustainable solutions to fit current and future needs. These concepts have been tested in pilot studies and, increasingly, they are being adopted by various clients in projects all over the world. The results of these projects have been well received by the responsible authorities, and there seems to be ample opportunity for widescale application of these solutions.

In many cases, these projects provide a public service and are therefore initiated and funded through public funds. Particularly in the developing world, loans and technical support are provided by International Financial Institutions (IFIs). Investment needs for Marine and Freshwater Infrastructure are set to increase with climate change and growing urbanisation in coastal areas. Budget constraints mean that public funds, from governments and IFIs, cannot meet the increasing infrastructure needs and that leaves a significant investment gap in Marine and Freshwater Infrastructure (also see Section 2). As a result, there is a widespread ambition to scale up blended finance, by using development finance to mobilise additional private finance towards sustainable development. There is also a willingness and drive in the private sector to shift investments towards more sustainable assets, supported by, for example, the development of the EU Taxonomy for Sustainable Activities (European Commission, 2020).

Unfortunately, despite proven track records of implemented sustainable solutions, such applications in port development, river management and coastal protection are still undercapitalised. Current investments continue to be largely conventional, as institutional incentives in governments and IFIs remain geared towards conventional infrastructure. Also, authorities lack the awareness and knowledge of more sustainable and innovative solutions. At the same time, efforts in attracting private investment in sustainable Marine and Freshwater Infrastructure have remained limited so far. This is not only the case for Marine and Freshwater Infrastructure, in general, the role of private capital in sustainable infrastructure is limited with only 1% of total asset allocations of institutional investors flowing into low-carbon, climate-resilient infrastructure (Meltzer, 2018).

1.2 Background and aims

In order to explore the potential role and needs related to private investment in more detail, a workshop was held at the Swiss Re Global Centre for Dialogue (GCD) in February 2020. Representatives of the financial sector (B Capital Partners and Swiss Re) and the dredging community (engineering firms and dredging companies) discussed needs and the potential to scale up private investment in green coastal and river projects. The purpose of this workshop was to build a mutual understanding of the different perspectives: to help members from the dredging community understand how institutional investors and fund managers work and how they address sustainability in their capital allocations. Similarly, the financial representatives were able to gain a better understanding of the potential for sustainable investment in Marine and Freshwater Infrastructure.

One main conclusion of the workshop was that, in order for investors to orient towards sustainable Marine and Freshwater Infrastructure projects – and to support development of this sector towards a mainstream investment asset class – sustainable concepts and associated financial structures would need to be clarified. This study is a result of this quest and aims to provide content for further dialogue that supports the uptake of green marine and freshwater concepts by private capital suppliers.

There is a drive in the private sector to shift investments towards more sustainable assets. However, investments in port development, river management and coastal protection remain largely geared towards conventional solutions.

1.3 Sustainable Marine and Freshwater Infrastructure

Marine and Freshwater Infrastructure is the collection of works at coastlines, estuaries, rivers and canals, and in port areas. In general, such works enable or provide flood protection, urban and port development, navigable waterways and the upgrade or protection of nature and/or recreational areas.

Sustainable variants of these assets range from the more conventional infrastructure asset (e.g. breakwater) to fully nature-based solutions (NbS) that deliver project needs. In general, the sustainable concepts are not only technically different, but they typically require early and extensive stakeholder involvement and aim to minimise negative and maximise positive ecological impact when implemented.

Table 1.1 Examples of conventional and sustainable Marine and Freshwater Infrastructure applications.

Conventional Marine and Freshwater Infrastructure applications	Sustainable Marine and Freshwater Infrastructure applications
Land reclamation	Hybrid land reclamation, including habitat improvement and expansion
Riverbank protection	Beneficial use of dredged material for sustainable applications
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In the Annex of this report, there are examples of sustainable infrastructure concepts that have been applied, or are planned, in real-world situations. In many cases, subsequent monitoring and evaluation demonstrated the effectiveness of both the services provided and the ecological quality achieved.

The sustainable solutions[1] in Marine and Freshwater Infrastructure most commonly contribute to the following sustainable development goals (SDGs) (Figure 1.1): SDG 3 (Good health and well-being), SDG 8 (Decent work and economic growth), SDG 9 (Industry, innovation, infrastructure), SDG 11 (Sustainable cities and communities), SDG 13 (Climate action), SDG 14 (Life below water) and SDG 15 (Life on land).

1.4 Potential role of private investors

Against a backdrop of climate change, sea level rise and limited public budgets, the investment gap in Marine and Freshwater Infrastructure leaves a critical and supporting role for private capital to play in bridging the gap (OECD, 2020a). With regard to sustainability, in general, ample funds are available from financial institutions and investors looking for ESG impact. To bridge the investment gap, as noted in Section 1.3, it is imperative that private institutions embrace coastal and marine infrastructure to ease the pressure on public budgets. Private investment in this sector can also offer various benefits in terms of budgeting, risk sharing and the delivery of efficiency gains (Meltzer, 2018).

The major question is: How can those funds be put to work? Answering this question is not simple. Some known barriers for private investors are the lack of an investment track record and bankable projects. The latter is largely due to the lack of viable business cases, inadequate risk-return profiles, missing characterisation as an asset class, lack of standards and instruments to assess ESG indicators or sustainable projects, and risk adversity due to general unfamiliarity with the concepts and sector (WBCSD, 2017; TNC, ICLEI and Ecologic, 2020; Thiele et al., 2020; WWF, 2020). The lack of a strong institutional and legal environment presents another obstacle for private co-investment.

1.5 Methodology

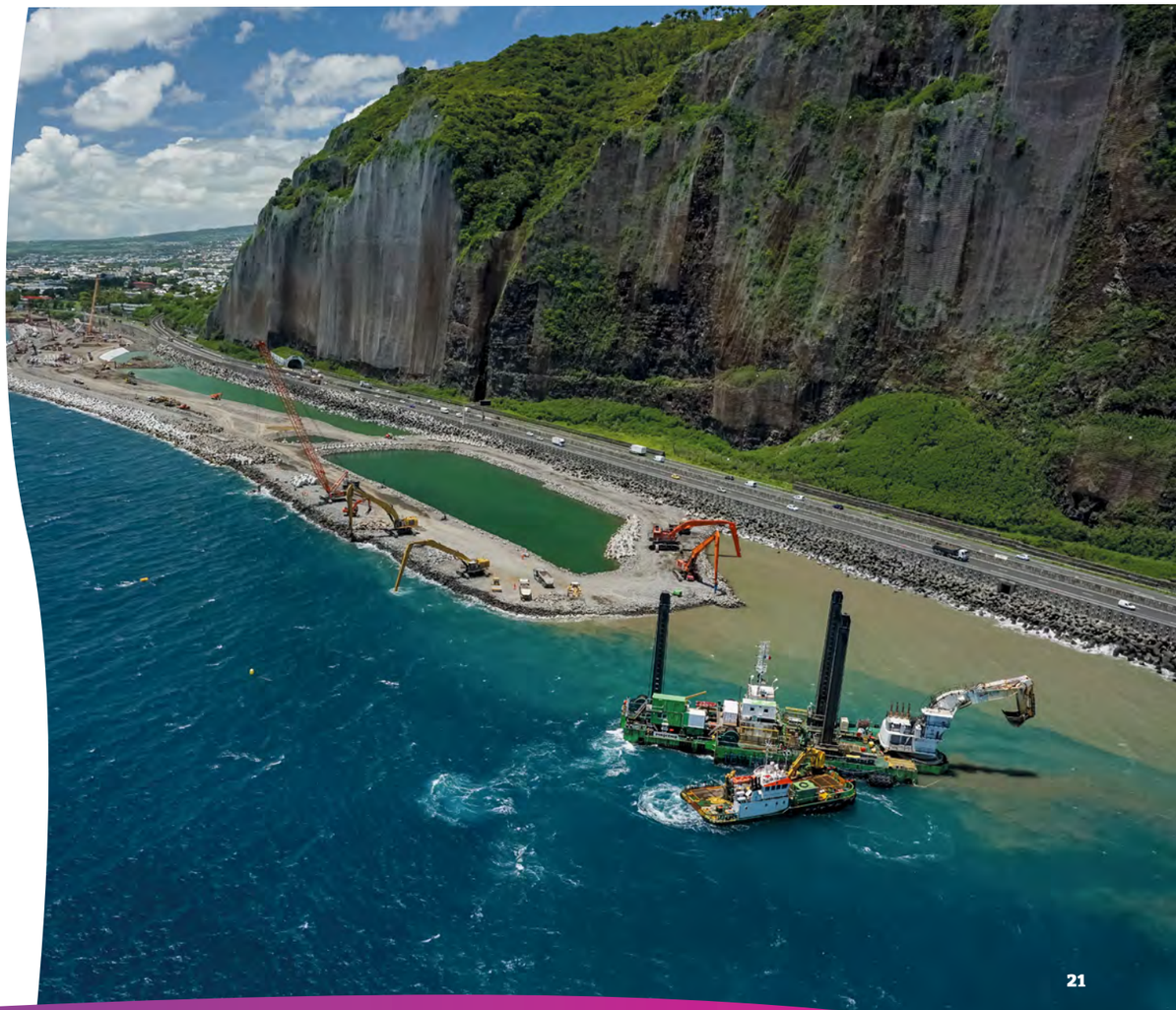
This study aims to provide a basis for further dialogue between the Marine and Freshwater Infrastructure sector and the financial sector. A project team, consisting of representatives from the dredging community worked on compiling cases covering the width of the sector. These cases were used to identify a characterisation of projects. Swiss Re and B Capital Partners contributed to this report by reflecting on the cases and initial characterisations of projects.

The main report outlines the market size of Marine and Freshwater Infrastructure (Section 2) and presents a characterisation of projects (Section 3) which are illustrated by real-life examples in the Annex. Section 4 includes key findings and a reflection on the report by Swiss Re and B Capital Partners. Section 5 presents suggestions for next steps.

1. Underlying concepts are further elaborated in this section and in Section 3.1.

Figure 1.1 Sustainable development goals.

The content of this publication has not been approved by the United Nations and does not reflect the views of the United Nations or its officials or Member States. https://www.un.org/sustainabledevelopment



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MARKET SIZE AND GREEN POTENTIAL

2 MARKET SIZE AND GREEN POTENTIAL

Tracking global investments and investment needs in Marine and Freshwater Infrastructure is notoriously complicated due to differences in reporting and definitions, and a general lack of data (Pauw, 2017). To give an idea of the market size, this section outlines some insights from sub-sectors where statistics and projections are available, and major trends driving market developments.

2.1 Market size

There is no comprehensive study on the full extent of investments (needed) in Marine and Freshwater Infrastructure.

2.1.1 Current market size

The following studies give a good idea of the order of magnitude involved in such investments.

- In nine flood-prone economies in Asia, in 2015, USD 33.6 billion was invested in fluvial and coastal flood protection (Ishiwatari and Daisuke, 2020).
- The ecosystem 'restoration economy' has a turnover of USD 25 billion, in the US alone, which provides a significant 220,000 jobs. Approximately USD 9 billion of this work relates to the restoration and management of aquatic, riparian and wetland environments (Bendor et al., 2015).
- Between 2000 and 2010, approximately USD 38 billion was invested globally by private investors in 195 projects in port development. Most investment included greenfield projects in the seaport sectors. For example, USD 20 billion was spent on 78 greenfield projects in Asia, the Pacific, Latin America and the Caribbean, in this period. Concession deals included USD 15.5 billion on 97 projects, whilst 11 ventures received USD 305 million in management and lease projects (Holman Fenwick Willan LLP, 2011).
- Analysis of global investment in climate adaptation provides a comprehensive estimate, but only reports on additional costs related to climate change, compared to a general development baseline. With many countries having an investment gap on flood protection/ coastal infrastructure, additional expenditure on climate change is still quite limited. USD 0.3 billion per year was spent during 2017 and 2018 (Buchner et al., 2019).

2.1.2 Investment needs

With increasing urbanisation, coastal development, sea level rise and extreme weather events, across the globe, the economic rationale to invest in coastal and fluvial flood risk protection is high and increasing. Environmental degradation and growing flood protection needs lead to stronger demand for restoration of natural ecosystems such as reefs and mangroves. The expansion and revitalisation of ports also opens up potential for further investment along coasts and rivers. The following gives a rough idea of the order of magnitude of future investment needs in Marine and Freshwater Infrastructure:

- For coastal protection alone, global investment needs for new infrastructure and maintenance of existing infrastructure are estimated at USD 10 billion per year, in the short term. By 2100, that is expected to be in the region of USD 103-215 billion per year (Nicholls et al., 2019). Investment needs for fluvial flood protection (along rivers) are unknown.
- Analysis of future coastal and fluvial flood risk in nine flood-prone economies in Asia shows that annual demand for flood protection infrastructure will be USD 94.5 billion per year between 2016-2030, and USD 98.4 billion if climate change is included[1]. (Ishiwatari and Daisuke, 2020).
- By 2030, the economically optimal investment[2] in flood protection for low- and middle-income economies is expected to be between 0.05% and 0.5% of their annual GDP (Rozenberg and Fay, 2019).
- In 2011, the estimated investment needs for ports up to 2030, including connected investments in port infrastructure, roads, rail, energy and water, amounted to USD 830 billion (Holman Fenwick Willan LLP, 2011). In 2019, the OECD Transport Outlook estimated that scheduled investment in port capacity should be enough to meet demand until 2030, except in South Asia (ITF 2019).

2.1.3 The infrastructure investment gap

When comparing the picture that arises from the two previous sections (investment needs and current investment levels), it is clear that there is a significant investment gap in Marine and Freshwater Infrastructure, particularly in coastal protection infrastructure. Figure 2.1 illustrates a total gap of approximately USD 65 billion per year in flood protection in Asia, based on the study of Ishiwatari and Daisuke (2020). Public capital alone will be insufficient to meet the investment needs particularly in lower- and middle-income economies.

2.2 The role and market size of the dredging industry

As most projects in Marine and Freshwater Infrastructure require the removal, recovery and/or transportation of minerals, the dredging industry has an active role in these projects. As such, the dredging market can help to shed some extra light on characteristics of the market.

The International Association of Dredging Companies (IADC), the global umbrella organisation for the private dredging industry, compiles market overviews. According to IADC, about half of the projects in the entire market take place in open markets and half in closed markets such as China, USA and Japan. In the open market, the total turnover of the dredging industry was relatively stable at EUR 5.2 billion in 2019 (IADC, 2019). Projects are related to coastal protection, urban development, energy development (e.g. offshore wind), tourism and trade (e.g. port and waterway development).

Figure 2.2 shows the general characteristics of the market in 2019, as seen through the lens of the dredging industry. Capital infrastructure projects constituted 43% of turnover, with a majority of works realised in Europe, followed by the Middle East and Africa.

Figure 2.1 Investment gap in flood protection in Asia

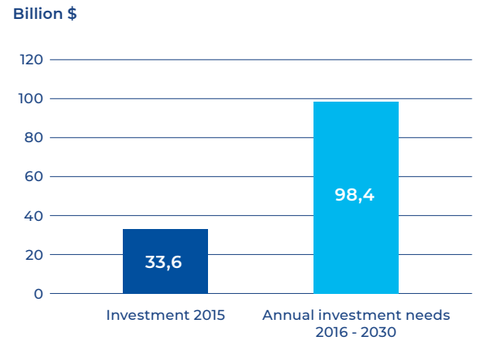
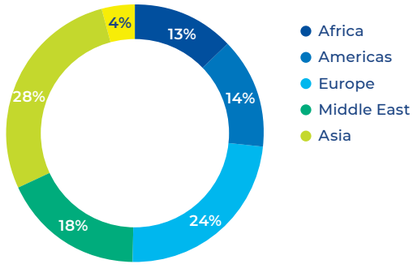
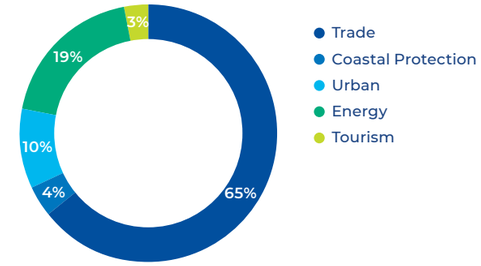


Figure 2.2 Market characteristics for the dredging sector in 2019

Open markets by area



Open markets by segment



1. **In the longer term, the pressure of climate change on these investment needs are expected to increase.**

2. **'Economically optimal' means that the societal benefits (e.g. a reduction in expected damage from flooding and land loss) are higher than the investment costs. In terms of cost-benefit analysis, this means that projects would have a benefit-cost ratio of larger than 1.**

2.3 Trends and opportunities for sustainable projects

The potential to develop sustainable projects builds on the general characteristics of the existing Marine and Freshwater Infrastructure market. Almost without exception, projects can be developed in a 'grey', 'hybrid' or 'green' way (see also section 3.1). As projects tend to take place in a natural environment (e.g. marine waters, coasts, estuaries, rivers, lakes and shores), conventional 'grey' engineering practices can lead to environmental damage.

Hybrid or green alternative solutions are developed more in line with natural processes. They can mitigate and, in some cases, entirely avoid environmental damage. They can also improve and restore the quality of local ecological habitats and provide additional ecosystem services, such as CO_2 sequestration. At the same time, these solutions can provide flood protection (e.g. mangroves, coral reefs), limit damaging erosion processes (e.g. natural green embankments) and reduce the need for navigation channel maintenance dredging (e.g. seagrass fields, coral reefs, mangroves).

As most of the projects provide public goods and are ordered by public authorities, greening the current infrastructure planning processes presents a big opportunity to create more sustainable projects. In this process, cost-benefit analysis is critical to demonstrate to decision-makers why the greening of infrastructure should be done (e.g. because it is more cost-effective or generates higher social and environmental values).

Aside from greening the current Marine and Freshwater Infrastructure market, developments and rising markets that bring further potential for sustainable projects include:

- Climate adaptation: with rising sea levels and changing weather patterns, the demand for investment in flood protection is expected to increase significantly during the 21st century.
- Ecosystem restoration: 2021-2030 is the 'UN Decade of Ecosystem Restoration'. A global call for action to protect and restore ecosystems, including in freshwater and marine environments is supported by 70 countries (FAO and UNEP, 2020).
- Carbon trading markets – blue carbon: the market for capturing carbon from the atmosphere and storing it permanently (e.g. in nature-based solutions such as mangrove and seagrass solutions) (Ullman, Bilbao-Bastida and Grimsditch, 2013) is expected to grow to the size of today's oil and gas industry by 2050 (Burmeier, Schneider and Brahin, 2015).
- Biodiversity offsets markets: with the biodiversity crisis top-of-mind and increasingly embedded in financial markets (UNPRI, 2020), the coming decades may see a rise in biodiversity related offset markets (also see Section 3.4).

3

CHARACTERISING SUSTAINABLE MARINE AND FRESHWATER INFRASTRUCTURE PROJECTS

3 CHARACTERISING SUSTAINABLE MARINE AND FRESHWATER INFRASTRUCTURE PROJECTS

3.1 Grey, hybrid and green projects

Sustainable development is generally defined as development that meets the needs of the present, without compromising the ability of future generations to meet their own needs. In the context of Marine and Freshwater Infrastructure, it is common to distinguish between the different 'shades of green' in a project. In most cases, a project can be developed either in a conventional 'grey' way, a hybrid 'grey-green' way, which integrates both conventional and nature-based elements, or as fully 'green' with primarily nature-based elements (Sutton-Grier, Wowk and Bamford, 2015). The winning desirable and feasible configuration will depend on local circumstances, such as desired coastal protection levels, physical characteristics and available space. Hybrid and green infrastructure projects typically require a more integrated design approach, and high stakeholder engagement, in order to achieve both the primary objective and sustainable ambitions. We define these groups as shown in Table 3.1.

The three project groups also have an increasing potential to deliver on a variety of SDGs as they move from 'grey' to 'green' (see Section 1.3).

Table 3.2 provides an overview of typical projects and development concepts according to these three categories.

Table 3.1 Definitions of grey, hybrid and green projects.

Project type	Project characteristics
Grey project	Projects with conventional engineering design. Often using hard, artificial elements (e.g. concrete and steel). Aims to solve a specific issue at minimum cost within regulatory constraints.
Grey-green hybrid project	Projects which combine conventional (grey) and natural (green) infrastructure elements. As such, hybrid projects contribute to and/or expand healthy habitats beyond basic mitigation and compensation requirements.
Green project	Projects with only 'nature-based' elements. Artificial elements (e.g. concrete and steel) are avoided and natural processes are used as much as possible.

Table 3.2 Grey, hybrid grey-green and green elements in typical Marine and Freshwater Infrastructure projects.

Example solutions at various sustainability levels			
Project	**Grey**	**Hybrid grey-green**	**Green**
Land reclamation	Straightforward new land for desired purpose	Reclaiming land including habitat improvements or enlargements	
		Creation of polders using less material	
		Combine land reclamation with protecting vulnerable low laying areas/ecosystems	
		Use locally sourced materials and apply soil improvement	
Port development	Purpose built port infrastructure	Biodiverse breakwaters fostering marine life	Natural harbour-ports
	Smooth, closed concrete and steel surfaces	Open structure revetments and quay walls	Sheltered waters through ecosystem restoration
Coastal protection	Concrete smooth levees and dykes, dams	Beach nourishments and/or sand dunes	
		Protecting estuaries by movable open barriers	Mangrove forestry
	Closing off estuaries by closed dams	Open structure revetments	Wetland/Marshes restoration
		Habitat improvements and enlargements	Coral reef restoration
	Seawalls	Green embankments	Seagrass beds fixating sediments
			Restoring natural flood plains
Riverine flood risk reduction	Artificial levees, dykes, walls	Open structure revetments	Restoring natural flood plains
	Straightening and deepening rivers	Habitat improvements and enlargements	
		Green embankments	Wetland/Marshes restoration
Navigational dredging	Dredging and disposal of dredged materials	Dredging and disposal of sediments where beneficial for ecosystems	
		Use of dredged sediments for habitat improvement or enlargement (e.g. wetlands, bird islands)	
		Circular use of materials, dredged materials for construction purposes	
Shore/ bed protection	Concrete slabs	Open structure revetments	Mangrove forestry
	Asphalt embankment and bed lining	Green embankments	
	Steel sheetpiling	Biodiverse breakwaters fostering marine life	Use of local natural materials
Nature development			Ecosystem restoration
			Wetlands, bird islands
			Habitat improvements, enlargement

3.2 Characterisation in terms of cashflow sources

The classification of projects, as shown in Section 3.1, is instrumental in assessing development options in technical terms, but does not relate to the characteristics of the financial regime.

The majority of Marine and Freshwater Infrastructure projects are traditionally funded by the public sector (with taxpayers' money), without involving financing. In projects where private financing of investments is considered, a distinguishing parameter is the source of the cashflow for interest payments and repayments of the loan. Broadly two categories can be distinguished based on the origin of those cashflows:

- Public service projects (e.g. coastal protection): The government, as project client, pays periodically after completion, where the payments may be based on performance or availability criteria (Figure 3.1).
- Commercial projects (e.g. private port development): The users or beneficiaries pay for the project's results or services. Cashflow is generated based on the project's business model (Figure 3.2).

Green or sustainable solutions may be integrated into the above categories, such as natural breakwaters, coastal mangrove belts, habitat protection and beneficial use of sediments. As governments increasingly propagate nature-based solutions, and international (development) financial institutions stimulate and impose sustainable practices[1], projects are increasingly likely to have sustainable conditions.

However, public service or commercial projects could fall short in terms of financial viability, for example because the government institution has limited credit capacity (notably low-income economies) or the project's business model is insufficient to carry the financing obligation. In such cases, opportunities exist to make use of additional funding resources or additional income streams generated by sustainable elements (see Section 3.4.1 on blended finance and green markets).

3.2.1 Public service projects

Public service projects are projects where the initial, or partial, purpose is to provide a public good, or otherwise serve the public domain. As such, they fall under the government's mandate. Typical examples are coastal and flood protection measures to prevent economic and social damage, shore protection to safeguard water quality and prevent erosion over time, and dredging to provide and maintain navigation routes.

For governments, incorporating private financing in these projects (e.g. through public-private partnerships or PPPs) is an attractive option in case of constraints on public resources to realise critical infrastructure. However, there are more profound reasons to look to the private sector for financing. It aims to create incentives to optimise projects in terms of planning and costs, and to provide value for money by allocating risks to the parties that are best positioned to manage them. On the other hand, there is a cost attached to financing and banks tend towards proven technology.

The Pevensey Bay project, UK (Annex, Case 7) is a typical public service project on the basis of a PPP structure for the sponsors to design, construct, privately finance and maintain the shingle bank beach protection and deliver on agreed performances, for a period of 25 years. On the contrary, the Sigma Plan, Belgium (Annex, Case 9) and Prins Hendrik Zanddijk, the Netherlands (Annex, Case 8) are traditional publicly funded projects for flood protection respectively coastal protection. It is worth considering if there would have been benefits to be gained from integrating private finance into these projects.

3.2.2 Commercial projects

Commercial projects obtain income from users or beneficiaries ('off-takers'). In assessing the bankability of such projects, a major criterion is the cashflow-generating capacity of the project as a source to repay funds. Descriptions of the following commercial project examples can be found in the Annex:

- Beira Master Plan, Mozambique (Annex, Case 1) and Hulhumalé Land Reclamation, the Maldives (Annex, Case 3): Land reclamation to accommodate urbanisation whilst providing climate adaptation benefits, where revenues accrue from housing and/or industrial development.
- Maasvlakte 2, the Netherlands (Annex, Case 4): Port development where the main revenue stream accrues from handling fees and land leases charged to shipping liners and port operators.

Developing and implementing Marine and Freshwater Infrastructure projects is often far from straightforward. This is due to the many variables relating to the stakeholder environment, institutional and legal structure, and applied technologies, to name a few. In commercial projects, the market factor (the demand and price risk for the project's results) adds to the complexity, since the project has to earn sufficient income to pay for its operating and funding costs and must produce an adequate return for capital providers. Ideally, the market risk (volume and price) can be mitigated for the project via agreements with the off-takers whereby the project's output is sold on a pre-agreed basis.

3.3 Case studies

In the previous sections we characterised sustainable Marine and Freshwater Infrastructure projects based on technical (physical) features and cashflow sources. In practice, projects tend to be highly tailor-made to both the physical context and the institutional setting. To illustrate how real-life projects can be viewed through these lenses, we developed a series of case studies (Table 3.3). See the Annex for a more detailed description of the cases.

Figure 3.1

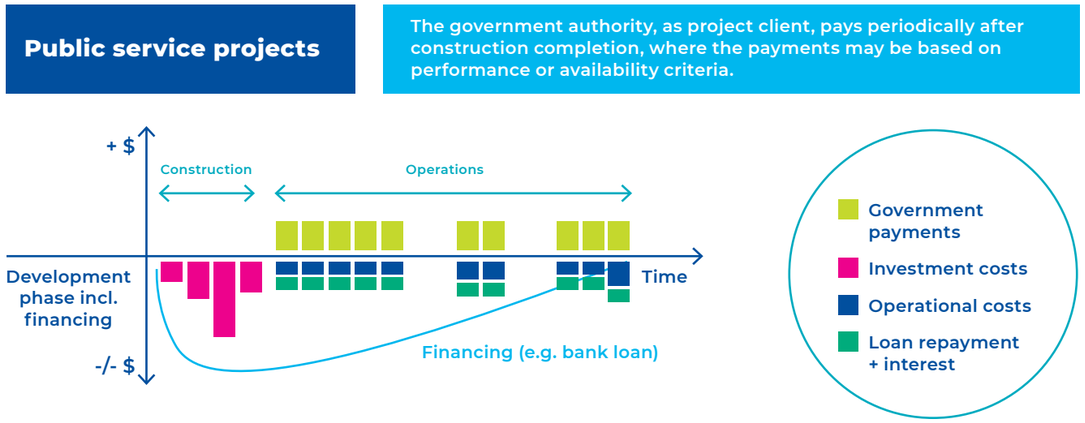
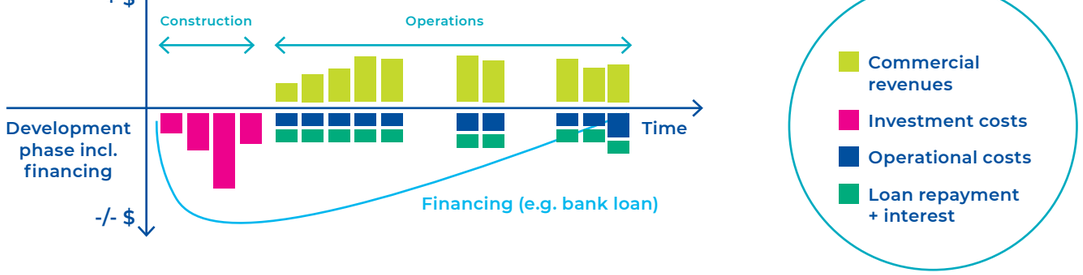


Figure 3.2



1. For an example of the latter, see the European Commission's Taxonomy and Sustainable Finance Disclosure Regulation, which came into effect in 2021.

Table 3.3. Real-life case studies that illustrate the type of projects in sustainable Marine and Freshwater Infrastructure. The examples cover public service projects, commercial projects and traditional publicly funded projects.

Case 1: Beira Master Plan, Mozambique

Type of project	'Hybrid' integrating urban resilient water system and improving social conditions.
Goal of project	A Masterplan 2035, developed and approved in 2014, sets out an integrated vision for the city, describing how it can respond to the future challenges. These challenges include co-existing with the environment and flood prevention, improving transport and poor living conditions.
Cashflow	Still pending - Mixed traditional public funding, public service and/or commercial project.
Green profile	Social and environmental improvement and enhanced climate resilience.

Case 2: Grensmaas, the Netherlands

Type of project	'Green' riverine project including: • implementation of sustainable flood protection measures (e.g. widening the channel and lowering flood plains) instead of raising the dykes; • large-scale nature development and ecological restoration of the river system; and • intensive community and stakeholder participation and involvement.
Goal of project	River flood protection, nature development, ecological restoration, and gravel and sand excavation (which funds the flood protection and nature development).
Cashflow	Commercial project.
Green profile	Improve climate adaptiveness, increase natural values and minimise negative impact for surrounding communities.

Case 3: Hulhumalé Land Reclamation, Maldives

Type of project	'Grey' land reclamation with 'green' features.
Goal of project	Various land reclamation initiatives will eventually provide 7 km^2 of urban land by 2040. Hulhumalé is expected to be home to more than 150,000 people by 2050. Climate change considerations and 'green' urban planning and sustainability play a key role in the design of the urban fabric. Project corals were translocated where needed.
Cashflow	Phase I: Traditional public funding. Phase II: Commercial project.
Green profile	Improve climate resilience and minimise negative impact by translocating corals.

Case 4: Maasvlakte 2, the Netherlands

Type of project	'Grey' port development with 'green' features.
Goal of project	Land reclamation for port development with an aim to minimise coastal impact and contribute to various other sustainable goals. The project includes: mitigation and compensation measures, development of new coastal habitat, doubling of recreational beaches in the area, and a sustainable signature of economic activities for the new land.
Cashflow	Commercial project.
Green profile	Minimise impact and expand coastal habitat.

Case 5: Mangrove Restoration

Type of project	'Green' coastal defence, habitat enlargement and carbon capture.
Goal of project	A stylised case where a project aims to create positive socio-environmental returns, leading to positive biodiversity impacts and climate change mitigation and adaptation. A strong fit for financiers and development finance institutions (DFIs) pursuing environmental, social and governance (ESG) impact rather than purely financial returns.
Cashflow	Potentially public service and/or commercial project.
Green profile	Social and environmental improvement and enhanced climate resilience.

Case 6: Odaw River Drainage Basin Project, Ghana

Type of project	'Hybrid' integrating urban resilient water system and improving social conditions.
Goal of project	The overall goal of the programme is to achieve clean, resilient, inclusive and integrated urban/coastal development, in the Greater Accra Region. It follows a multi-phase programmatic approach, potentially with 3 phases spanning 15 years.
Cashflow	Mixed public service and commercial project.
Green profile	Clean up of waterways and climate resilience.

Table 3.3. Real-life case studies that illustrate the type of projects in sustainable Marine and Freshwater Infrastructure. The examples cover public service projects, commercial projects and traditional publicly funded projects.

Case 7: Pevensey Bay Sea Defences PPP Project, UK	
Type of project	'Green' coastal protection.
Goal of project	To protect against flooding in Pevensey Bay, a soft sea defence was favoured. As storms have eroded beach material, and moved it east by longshore drift, it has either been recycled back, to rebuild narrowed defences, or replaced by annual beach nourishment. This is achieved by dredging similar sediments from the seabed and pumping them onto the beach.
Cashflow	Public service project.
Green profile	Flood defence based on natural dynamics and features.

Case 8: Prins Hendrik Zanddijk, the Netherlands	
Type of project	Coastal protection project.
Goal of project	Refurbishment of 14 kilometres of the dyke at the Waddensea island of Texel. Along a 3.2 kilometre-long section, in front of the Prins Hendrik Polder, the conditions were right to accommodate a soft coastal protection design.
Cashflow	Traditional public funding (no private finance).
Green profile	Upgrade of low-value natural habitats. A Natura 2000 bird and habitat directive and a UNESCO World Heritage site.

Case 9: Sigma Plan, Belgium	
Type of project	'Green' flood protection river/estuary system.
Goal of project	Cost-benefit analyses, by the Flemish government, concluded that the costs of building floodplains to decrease flood risk were substantially lower than other flood protection methods with typical large-scale 'grey' elements.
Cashflow	Traditional public funding (no private finance).
Green profile	Floodplains, enhancing natural dynamics and expansion of habitat.

The case studies illustrate that the scale and impact of these projects commonly cover a variety of issues and goals. Therefore, these integrated solutions also cover various elements of the characterisations in terms of how green they are (Table 3.2). Labelling a project as 'green' in its entirety might present challenges, however, it can be easier for specific elements of a project.

In terms of cashflows the cases show that projects could be labelled as 'public service' and/or 'commercial' project. Diving deeper into the specifics (see Annex), the financial structures and cashflow sources of projects reflect a high degree of dedicated tailor-made arrangements.

The case studies were chosen to show how considerations, in terms of green finance, might relate to real-life projects. Real-life projects provide tangible ideas on how things did or didn't work. However, it is also evident from the cases that finished projects, or projects currently in execution, have a long history of project development, which often exceeds a decade. This means that the current developments in the 'greening of the market' are not necessarily fully reflected in current projects.

3.4 Opportunities for the private sector: blended finance and green markets

To stimulate the mobilisation of private capital for sustainable infrastructure projects, a combination with public development and/or philanthropic funds can be created. This concept of blended finance is a means to fund projects that are justified in economic and societal terms but can only carry a limited amount of commercial funding. It helps enlarging the available private finance to developing countries, to achieve development impact. Furthermore, additional revenue streams can be created through green markets.

3.4.1 Blended Finance

In projects that are not yet attractive to private capital markets, development finance and philanthropic funds can be used strategically to mobilise private capital flows, in new and emerging markets, with positive results for both investors and communities. These blended finance structures help to reduce the risks for banks and investors that can co-fund projects on concessional (below-market) terms, thereby creating the necessary enabling environment for private sector financing. Examples of instruments used in blended finance include: risk transfer mechanisms (e.g. guarantees), first-loss provisions, subordinated loans and grants/subsidies. Development finance institutions (DFIs), such as the World Bank and European Bank for Reconstruction and Development, and other development organisations provide these instruments.

Labelling a project in its entirety presents challenges, it's about tailor-made arrangements.

Key initiatives in this area include:

- Green Climate Fund, Global Environment Facility and Adaptation Fund under the United Nations Framework Convention on Climate Change (See Annex, Case 6, Odaw River Drainage Basin Project, Ghana);
- OECD's Community of Practice on Private Finance for Sustainable Development, for mobilising more finance towards the SDGs through blended finance, and providing opportunities for public-private knowledge exchange and partnerships;
- Natural Capital Financing Facility, funded by the European Investment Bank, promoting biodiversity and nature-based adaptation;
- PROBLUE, administered by the World Bank, supporting the development of integrated, sustainable marine and coastal resources;
- Catalytic Green Finance Facility under the Association of Southeast Asian Nations (ASEAN) Infrastructure Fund, promoting green infrastructure projects in Southeast Asia;
- Blue Natural Capital Financing Facility, managed by the International Union for Conservation of Nature (IUCN). ; and
- Dutch Fund for Climate and Development (DFCD), enabling private sector investment in projects to increase resilience of communities and ecosystems most vulnerable to climate change.

3.4.2 Green markets

There are various trends and opportunities for new income streams from green markets, where sustainable coastal and marine infrastructure projects could tap into, making an attractive case for private financing.

Carbon market

To restrict the emission of greenhouse gases (e.g. CO_2) in the fight against global warming and associated sea level rise, carbon is priced through the implementation of carbon trading markets. Two types of markets are distinguished: the mandatory and voluntary market. The mandatory market is driven by emission ceilings set by governments as agreed in worldwide treaties (Kyoto Protocol, 2005 and Paris Agreement, 2015). The voluntary market is driven by the motivation of consumers and businesses (e.g. offsetting emissions of a flight). The mandatory market is substantially larger than the voluntary market.

The imposition of emission ceilings and establishment of mandatory (or cap-and-trade) markets for greenhouse gases has generated substantial investments in projects that capture and store carbon. From such projects, carbon credits can be created and traded (i.e. sold) and thus represent an investment value.

The mandatory carbon market is well established for terrestrial ecosystems like forestation and agriculture. Demand for carbon credits is growing strongly with increasing global ambitions to control the impact of climate change. This opens up the market for investments in blue carbon, being carbon sequestered and stored in coastal ecosystems such as mangroves, seagrass and saltmarshes (Sapkota and White, 2020) (see Annex, Case 5, Mangrove Restoration).

The mandatory market, such as the EU Emissions Trading Scheme, is most promising for blue carbon as this market is much larger in size and has generally higher carbon credit prices than the voluntary market. However, before blue carbon can be included, more research and effort is needed to promote it as a key policy (Ullman, Bilbao-Bastida and Grimsditch, 2013).

Biodiversity offset market

Similar markets could be developed in relation to biodiversity and habitat loss. Robust and comprehensive frameworks, and formal requirements regarding 'no net loss' of biodiversity and/or habitats, are a prerequisite for such markets (Conway et al., 2013). In essence, biodiversity offsets are economic instruments based on the polluter-pays principle, in which measurable conservation outcomes can be used to compensate for biodiversity loss from development projects. These are used only for residual biodiversity loss after steps have been taken to avoid, minimise and - where possible - restore this loss.

Governments play a key role in enforcing policies needed to develop these markets. They are also key in determining supply and demand of 'biodiversity units', supervising transactions and granting legitimacy to compensation sites (Koh, Hahn and Boonstra, 2019). In more than 100 countries, there are laws or policies in place that require or enable use of biodiversity offsets. The three approaches for biodiversity offsets are: one-off offsets (common under regulatory programmes and voluntary offsets), in lieu fees (where a developer is required to pay a fee to an offset provider) and biobanking (where offsets can be purchased directly from a public or private biobank, which is a repository of existing offset credits) (OECD, 2016) (Kok et al., 2021).

Conclusion

At present, the cashflow from these carbon and biodiversity offset markets is insufficient to achieve bankable project propositions due to limited scale (e.g. carbon volumes) and relatively low credit price levels. Also, further development of a track record is needed to gain broader acceptance among financiers. On the other hand, demand for carbon credits is growing strongly with tightening ESG policies as a main driver. As an example, sectors dependent on fossil fuels are increasingly engaged with acquiring offsets from coastal ecosystem projects.

Private capital requires standard, stable legal frameworks to ensure appropriate risk allocation and a safety net for proper business conduct.

(B Capital Partners, p.47)

4

KEY FINDINGS, REFLECTIONS AND NEXT STEPS

4 KEY FINDINGS, REFLECTIONS AND NEXT STEPS

The study yields various findings relevant to the uptake of sustainable solutions for coastal, river and port projects. These findings are based on analysis of the case studies and a series of seven online discussions by the expert group. In Section 4.1, key findings of this 'bottom-up perspective' of the project community are outlined. To put these findings into the context of the green infrastructure finance markets, they have been shared with financial and insurance specialists. These reflections are included in Section 4.2. In conclusion, Section 4.3 describes suggestions for steps forward.

4.1 Key findings

To structure the projects in a way that is relevant to the discussions on financing sustainable Marine and Freshwater Infrastructure, we distinguish three key elements:

- sustainability aspects at the project level;
- financial structure; and
- development of the sustainable Marine and Freshwater Infrastructure market.

4.1.1 Sustainable infrastructure aspects

Sustainable marine and freshwater projects typically cover river, coastal and port projects, and as a result they usually take place in, or have an influence on, aquatic ecosystems. These ecosystems can be sensitive to disturbance, but the human need for flood protection, shore stabilisation or port facilities often takes precedent. The study shows that for most of these needs, 'hybrid' or 'green' project variants can be developed that look after both socio-economic and environmental values. Some key findings with respect to these sustainable options are that:

- All projects can be delivered in a 'grey' or a 'hybrid grey-green' manner. In some cases, it is possible to select a fully 'green', nature-based approach.
- The 'grey' variants limit sustainable elements to the primary objective of the project and mandatory requirements regarding sustainability. In the 'hybrid' variant, conventional 'grey' infrastructure concepts are blended with more 'green' concepts to support sustainable development goals beyond legal requirements. In 'green' variants, sustainable design principles based on natural processes take centre stage whilst still delivering on primary objectives.
- 'Green' variants usually require extensive stakeholder participation and early-stage planning, which lead to more inclusive design processes and better social outcomes.
- 'Green' variants often have the advantage of long-term performance, growing and adapting on the basis of natural processes, as opposed to conventional 'hard' solutions. Sustainable projects deliver broader value to society than their 'grey' counterparts, and deliver a wide range of ecosystem services. By capturing the value of these ecosystem services, additional revenue streams could be generated to strengthen the business case.
- The case studies show that Marine and Freshwater Infrastructure projects typically tend to be integrated, cover a vast geographic area and include a range of goals. Such an integrated approach is desirable in terms of providing dedicated solutions for a specific context, but also makes it difficult to label a project as 'green', 'hybrid' or 'grey' in its entirety. The case studies illustrate that this integrated nature can be seen as a configuration of 'grey', 'hybrid' and 'green' elements, which helps to characterise projects in terms of green performance.

Projects require customisation. Not only in terms of physical concept, design and local circumstances, but also in terms of the financial structuring.

4.1.2 Financial structure

An obvious observation is that all projects require customisation. Not only in terms of physical concept, design and local circumstances, but also in terms of the financial structuring. There are some common features which allow projects to be categorised. Building on the case studies and for financing purposes, it was possible to distinguish broadly two groups, based on the origin of the cashflows with which the financing of investment costs can be serviced:

- Public service projects (e.g. coastal protection): The government, as project client, pays periodically after completion, where the payments may be based on performance or availability criteria.
- Commercial projects (e.g. private port development): The users or beneficiaries pay for the project's results or services. Cashflow is generated based on the project business model.

Private capital can play a role in both types of projects. The bankability or viability of co-investing could be enhanced in two ways:

- Blended finance: In projects that are on a risk-return basis less attractive to capital markets, development finance and/or philanthropic funds (e.g. in the form of grants) can be used strategically to mobilise private capital with positive results for both investors and communities.
- Use of green markets: Projects can offer value and derive additional revenues from green markets like carbon trading and biodiversity offset markets.

4.1.3 Green infrastructure market development

As solutions for green infrastructure in the marine and freshwater environment are becoming increasingly available, the market for these kinds of projects is also growing. This study shows several elements which come into play when considering green options. In further developing a green infrastructure market, the following key points should be considered:

- There is no standard financial approach for project solutions. A common language and understanding between the dredging and financial sector are needed to enable crowding-in private finance via 'public service' and 'commercial' models.
- The sustainable Marine and Freshwater Infrastructure market has a role to play in the growing carbon trade markets via its carbon sequestration capabilities and, as markets mature, an increasing role in biodiversity offset and habitat banking. They can bring commercial funding into Marine and Freshwater Infrastructures, and increase the potential for private investors to participate.
- Maritime construction companies, engineering firms and research institutes are well positioned to help implement green, climate adaptation measures along rivers, coastlines and waterfronts.

Linking these bottom-up insights to top-down views from financial actors could provide valuable insights into the steps needed to gear private capital towards sustainable Marine and Freshwater Infrastructure.

4.2 Reflections from the financial sector

This study looked at a series of project solutions in Marine and Freshwater Infrastructure. The early planning phases of the case studies took place at least 5 years ago and, in some cases, considerably earlier. As a result, funding packages for these projects may originate from several years ago. This does raise the question of how relevant the key findings and insights are to the current situation. If new projects were to be developed today, how would, or could, they perform in the changing financial landscape? To gain further insight, several financial organisations, with a key interest in infrastructure finance and insurance, were approached to provide their views. The following are the reflections of their specialists.

4.2.1 B Capital Partners

B Capital Partners is an independent investment house established in 2003 in Zurich. B Capital Partners invests exclusively in sustainable infrastructure with a clear focus on the wider energy transition. It has deployed and advised on over EUR 2.6 billion worth of transactions since 2015, with and for institutional investors and large family offices, often in close co-operation with developers.

Reflections on the study

B Capital co-initiated the sustainable marine and freshwater initiative, by brainstorming about how to get capital and insurance groups interested in the sector. We were pleased to be able to contribute by sharing our financial knowledge, and sustainability based investment philosophy, with the members of the initiative. Specifically, we explained our approach to assessing and mitigating sustainability risks, where possible, to ensure ESG compliance and to contribute to a positive impact on the SDGs. We also helped the members of the initiative to understand what motivates institutional investors and fund managers, and how they address sustainability issues in their capital allocations.

As we were new to the marine works industry, and dredging as a particular sub-sector, we were impressed by the deeply rooted sustainability culture of the initiative's members, who represent the largest industry players in their field. These organisations clearly have a high regard for the preservation of coastal environments and marine life. This is evidenced, for instance through this study, by the fact that they introduce and propagate advanced construction technologies and financial engineering practices, which consider the environmental aspects. This is particularly relevant, not just for European economies, but also for fast-developing economies where the lack, or quality, of long-term sustainability assessments of infrastructure projects may have a negative impact on the wellbeing of local populations and their economies. This report, and other publications of the initiative's members, show real-life case studies of environmentally friendly projects, which are also concurrently improving local economies.

Historically, marine and freshwater works have been blamed for worsening the local natural equilibrium and economical impacts on local people. The long-term consequences of non-sustainable infrastructure can be damaging on many levels, whether environmental, financial or reputational for those who sponsor the projects. To address such risks, B Capital and Global Real Estate Sustainability Benchmark (GRESB) developed an open-source ESG due diligence tool for assessing and managing infrastructure investments. The tool has been improved to include the SDG impact. B Capital is also co-operating with research and industry-led organisations, which are defining the standards for sustainable and impact investing in the infrastructure space. B Capital is a signatory of United Nations Principles for Responsible Investment (UNPRI).

In our view, this report is important because it demonstrates that careful engineering, combined with sound financial structuring, can accelerate sustainable Marine and Freshwater Infrastructure projects. Due to the increasing need for coastal protection, as a response to climate change and rising sea levels, new projects need to be implemented globally. These projects are large-scale, with long economic lifecycles, and are therefore suitable for private capital contributions. Even if most of the capital expenditure for these projects is provided by lenders and development finance institutions, blended finance solutions, which include private equity, can be attracted to green Marine and Freshwater Infrastructures. We assume that around EUR 0.5 billion per year of marine infrastructure equity in OECD countries could be invested via private sources. The globally existing infrastructure funds, together with the large institutional investors who deploy large amounts of capital in single assets, have sufficient 'dry powder' which could be invested in sustainable and risk/return-adequate maritime projects outside the usual energy, social and transportation infrastructures.

To this end, this report addresses how PPP and concession-type marine and freshwater projects can ensure a commensurate private capital remuneration. Furthermore, it proves that industry specific concession-type legal frameworks, albeit still in development and not widely available yet, are coherent with usual infrastructure fund managers' and lenders' investment requirements. The report demonstrates innovative financial structures that are already being implemented but are less well known by the financial investors.

In a nutshell, the report shows that green marine, waterways and coastal projects, which return long-term cashflows, can be appealing for private capital. However, private capital deployment requires standard PPP or concession-type structures within stable legal systems. This is an overriding requirement to ensure proper risk mitigation, as well as control over the distribution of economic returns among the various project's stakeholders. A sound legal framework can speed up works completion, while providing project sponsors and authorities with a safety net with respect to proper business conduct during the life of the project/asset.

From our experience in more advanced PPP segments, we expect that financial structuring (including blended finance) by implying the co-ordinated contribution of various competences (e.g. engineering and construction, insurance, lending, investing) should attract significant funding for the realisation of marine and freshwater projects.

Recommendations for the future

Private finance, in terms of both equity and debt, can foster the change towards 'greener' coastal and freshwater infrastructures. It may also encourage a more disciplined approach to both ESG risk considerations and SDGs implications. In addition to a level of sustainability awareness amongst investors, who are increasingly putting capital into assets that have positive impacts on SDGs, there is a two-fold motivation which is more economic than ethical.

- First, institutional investors and infrastructure fund managers are increasingly conscious of, and concerned about, the predictability of the future value of their assets. The exit price, or residual value, of an infrastructure asset is, in the long run, fundamentally linked to the asset's resilience to external shocks. Anyone trying to sell a second-hand diesel-engine luxury car, in 2021, can appreciate the analogy. In the specific case of marine works, the residual value of an asset is usually not particularly volatile, since its terminal value is contractually defined (often zero at concession's end). However, private capital may refrain from embarking on projects with potentially negative economic, legal and reputational consequences for the natural and/or social environment caused by biotope reactions (e.g. coastal erosion, zeroing of plants or animal life and floods). Such adverse consequences may cause breach of debt covenants, default, or even a post-investment equity injection. 'Throwing good money after bad money' is one of the few things the private equity industry must not do.
- Second, since 2021, the European Commission requires institutional investors, financial intermediaries, lenders and asset managers, to comply with a stringent investment process and transparent reporting regarding the sustainability and SDG impact of their investments. See the Sustainable Finance Disclosure Regulation (SFDR). These mandatory requirements urge financial investors to adopt a pre- and post-investment ESG risk management and controlling system, and to record and steer both positive and negative sustainability impacts. This has an implication for the viability of private and development capital for projects with low-scoring due diligence results for sustainability.

In summary, marine and freshwater projects that are truly 'green' will be appealing to infrastructure investors. Embedding the sustainability criteria into the project development and the construction phase is mandatory to attract private risk capital.

It is worth stressing the need for standard frameworks that encourage private capital into natural marine infrastructure projects. Maritime and coastal works are usually delegated to port authorities, or ministry departments, who still use public tendering systems for construction works funded by the public budget (i.e. tax income). In many countries, the necessary upgrade of the legal framework, which would allow private financial investors to replace tax money, is lagging behind. But this is not the responsibility of the private sector. However, it is true to say that industry players, such as construction companies, are often neither used to, nor keen on, working with financial investment participations and hence, do not lobby for better legal frameworks. For the sake of the environment, this initiative will hopefully bring the long-needed public attention to the need for policy change.

Given the size and the attractiveness of the marine and freshwater works segment, we can expect access to more private capital in due course. To improve the availability of private capital, we strongly encourage joint screening by sponsors and private capital suppliers. Early collaborations may help to avoid following leads, which may be initially attractive, from a construction capital expenditure size, but turn out to be non-viable for investors in terms of economics or sustainability. A joint selection effort, based on sustainability and contractual solutions, can focus scarce resources on the most promising opportunities and have a positive effect on private funding for Marine and Freshwater Infrastructure projects.

Infrastructure funds, together with institutional investors, have sufficient 'dry powder' which could be invested in sustainable and risk/return-adequate maritime projects outside the usual energy, social and transportation sectors.

4.2.2 Swiss Re Group

The Swiss Re Group is one of the world's leading providers of reinsurance, insurance and other forms of insurance-based risk transfer, working to make the world more resilient. The aim of Swiss Re is to enable society to thrive and progress, creating new opportunities and solutions for its clients. Swiss Re insures, invests, operates and shares its knowledge, in a way that tackles sustainability challenges and creates long-term value. Headquartered in Zurich, Switzerland, where it was founded in 1863, the Swiss Re Group operates through a network of around 80 offices globally.

By 2040, it is estimated that the world will be spending USD 80 trillion on infrastructure to support the changing needs of our growing population. New transport links, housing, energy supplies and communications connectivity are all key to meeting the UN's SDGs. As we look to a post-pandemic recovery, there is also an expectation that we can build our way out of many of our economic woes.

However, nature has been paying the price of this development. Alarms are sounding over biodiversity loss and ecosystem damage, and the pressure is on to find new ways to unite the drivers for development with the health of the natural world. Decisions taken in 2021 and beyond will be crucial if we want to minimise further damage to our environment, society and economy. To make the year 2021 a turning point governments, financial institutions and the private sector all have to collaborate and work together to make it happen.

As investors and de-riskers, the re/insurance industry can be central to creating a more stable, long-term framework, for sustainable and resilient infrastructure projects with a positive impact on climate change, biodiversity and livelihood development.

Globally, the insurance sector has over USD 30 trillion assets under management and, as investors, re/insurers can take concrete actions to make investment decisions count.

Re/insurance as an investor

Globally, the insurance sector has over USD 30 trillion assets under management and as investors, re/insurers can take concrete actions to make these assets and investment decisions count. As an investor, the insurance industry needs to back assets that match the long duration of its liabilities, making infrastructure an ideal long-term investment asset class. By investing in sustainable projects, insurers help reduce financing costs and create incentives to build for resilience.

Sadly, this potential has not yet translated into significant movements of money. The current level of institutional investor activity in new infrastructure deals, for both debt and equity investments, is extremely low. For example, in emerging markets it is only 0.7% of total private participation in infrastructure investment. The demand-side factors leading to this extremely low level of participation from institutional investors stem from a broad range of perceived risks, which have been amplified by the economic effects of COVID-19.

A number of initiatives are helping, such as the G20 Finance Ministers and Central Bank Governors endorsing new G20 Principles for Quality Infrastructure Investment in June 2020. While this is a welcome development, it will only help close the infrastructure gap in developed countries, where traditional financing mechanics of public funding and project finance are already well established.

According to Swiss Re Institute forecasts, there could be USD 66 trillion of infrastructure investment opportunities over the next 20 years, with 66% of that coming from emerging markets (Swiss Re Institute and Global Infrastructure Facility, 2020.). Without more regulatory certainty, harmonisation and a standardised investment framework, making these projects a reality is very difficult.

Policy makers are aware of the need to bring in more multi-dimensionality and, as the market for more sustainable investments develops, the regulatory framework is changing. However, stronger policy incentives are needed to favour projects with certain features, for example, the EU Taxonomy leading to the recognition of a project's higher SDG impact and lower capital charges. Also, the current economic framework does not capture the entirety of the positive externalities green marine infrastructure projects could bring. To overcome this, there needs to be an integration of ESG and climate adaptation/resilience considerations at the earliest stages of project preparation, and enhanced associated disclosure, to demonstrate both the ESG and financial value of infrastructure investments.

Re/insurance as de-risker

The industry's position as a 'de-risker' can be transformational in establishing a longer-term investment framework. It can create new types of insurance offerings that make infrastructure projects more standardised, cashflows more predictable and infrastructure as an asset class more attractive to investors, thus unlocking financing. As a result, less sustainable infrastructure will become less insurable and the threat of losing access to insurance will incentivise a switch to projects that are better designed, better planned and truly consider the costs of climate change.

Constructing innovative sustainable Marine and Freshwater Infrastructure projects introduces a number of risks (i.e. liability or material damages, political, weather). Some are universal, others can be more specific to elements including the technology, the location and the financing model. By incorporating insurance cover throughout the lifecycle of the project, sustainable Marine and Freshwater Infrastructure project developers, funders and contractors, can proceed more confidently through the different stages of the project.

Additionally, insurance services embedded within insurance products, such as simulations and early warnings of extreme weather, contribute to resilience and sustainable development. Remote sensing, and other technology solutions, are used to assess the impacts of events and changes in the landscape. They can also be applied to monitoring and protecting nature-based solutions. Such technologies also lead to financial innovations such as 'parametric' index-based insurance that covers the probability of a pre-defined event. Redirecting existing insurance practices towards sustainable marine infrastructure would encourage more commercial practices and private investment.

To date, the role and value of sustainable infrastructure is still not well understood. Building sustainable green infrastructures is one of the most effective climate adaptation measures to reduce the impacts of weather-related disasters and natural catastrophes such as coastal flooding and erosion, river flooding and drought.

According to Barbier, ecosystem restoration (river diversion, marsh creation, accompanied by building of levees and other structures) along the coast of Louisiana, would lower annual expected flood costs by USD 5.3 billion, to USD 18 billion (Barbier, 2015).

There are many long-term benefits, including decreased risk levels. Globally, an annual investment of USD 5-10 billion into coastal wetlands protection could lower annual flood damage pay outs by USD 52 billion (Barbier, et al. The Conversation) (Swiss Re Institute, 2020).

Reflection and outlook

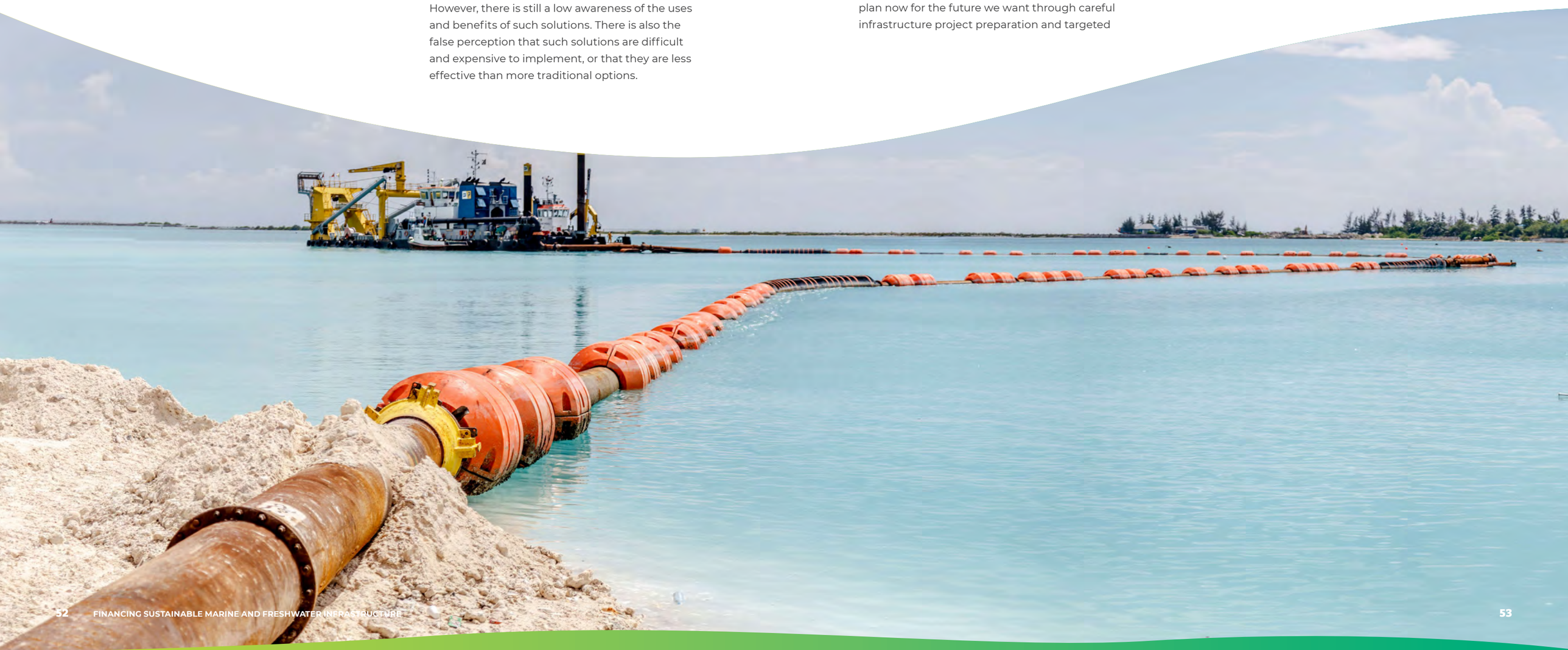
The solutions featured in this report send an important and positive message. Solutions exist, they have been tested, they offer wider benefits to the community, and when compared to more conventional ones, they can be cheaper (See Annex, Case 9, Sigma Plan).

However, there is still a low awareness of the uses and benefits of such solutions. There is also the false perception that such solutions are difficult and expensive to implement, or that they are less effective than more traditional options.

Reporting tools and harmonised methodologies still need to be built to capture some of the associated benefits which are often overlooked as they are difficult to quantify, particularly in relation to future savings. What is certain is that such solutions require a more holistic approach and greater coordination and cooperation. They will also need to be incentivised through policy frameworks that increase their uptake and allow the rerouting or unlocking of new funds to support them (OECD, 2020).

Closing the sustainable infrastructure investment gap is going to be a collective effort. Governments need to promote the development of quality and sustainable infrastructure; multilateral development banks need to leverage tools such as credit enhancements to create risk-adjusted investment opportunities; and the private sector needs to prioritise investments that adhere to environmental and social best practice. Times of crisis have the potential to create transformative change. We can plan now for the future we want through careful infrastructure project preparation and targeted investment. Together with our partners across the public and private sectors, we have the power to build back better with green, inclusive, sustainable infrastructure for long-term economic growth and resilience.

Building green infrastructure counts as being among the most effective climate adaptation measures to reduce the impacts of weather-related disasters and natural catastrophes such as flooding and erosion.



4.3 Steps forward

4.3.1 Outreach

In preceding sections, we have attempted to classify sustainable Marine and Freshwater Infrastructure projects on sustainability respectively financing aspects, in order to provide insights into the particulars of such projects.

Building on this report, we would like to propose a number of suggestions to support the viability of sustainable infrastructure for private funding. This includes reaching out to, and co-operating with, a wider and more diverse group of stakeholders than were involved in this first phase. Stakeholder groups would ideally include:

- development and commercial banks , funds and institutions;
- institutional and impact investors;
- insurance institutions;
- project certifiers;
- (public) project developers/sponsors (e.g. port authorities);
- global development networks (e.g. EU, OECD, UN);
- the dredging community; and
- related advisory firms.

Examples of engagements and desired outcomes could be defined as shown in Table 4.1.

Table 4.1 Outreach: Examples of engagements and desired outcomes.

Engage with...	Desired outcomes
Funds, banks and investors	Joint early-stage project screening to stimulate collaboration on blended finance structure developments. Jointly defining and developing pre-requisites (e.g. project certification, reporting tools, policy incentives) to enable upscaling of green project financing.
Green project certifiers	Identifying potential to develop and implement a project certification, or rating methodology, on sustainability, complementing technical and ESG frameworks applied by financiers.
Re-insurance institutions	Joint early-stage project screening and regular communication to support future collaboration on project developments. Collaborating on knowledge sharing sector and project-specific risks and potential mitigants relevant for financing sustainable Marine and Freshwater Infrastructure.
Project developers/sponsors (e.g. port authorities)	Jointly identifying opportunities for developing sustainable infrastructure and increasing the role of private capital.
Global development networks (e.g. EU, OECD, UN)	Joint early-stage project screening to stimulate collaboration on blended finance structure developments. Jointly defining and developing pre-requisites (e.g. project certification, reporting tools, policy incentives) to enable upscaling of green project financing. On certification, an initiative is the Blue Dot Network, launched in 2019 by the US, Australia and Japan to align existing global standards to certify sustainable infrastructure projects for attracting private capital. The OECD is engaged to provide guidance and technical input to operationalise the certification process. Embedding particulars of the dredging sector into the frameworks, standards respectively classification methods for financing sustainable development. Examples are the EU Taxonomy for Sustainable Activities and OECD-UNDP Impact Standards for Financing Sustainable Development.

Sedimentation behind permeable structures at Java, Indonesia. Photo: Kuswantoro.

4.3.2 Next steps

Aside from the outreach suggestions listed above, the authors of this report recommend that the initiating organisations consider taking the following next steps:

- Report exposure. Launching the report at upcoming forums, with accompanying press activity, to reach the stakeholders listed and potential partners.
- Stakeholder mapping. Addressing the stakeholder groups mentioned in the previous section. Identification and mapping of organisations currently working financing on sustainable applications in Marine and Freshwater Infrastructure. This will help to streamline and consolidate knowledge from the different groups and create further collaboration opportunities. Such organisations include e.g. EcoShape, OECD, G20 Initiative Quality Infrastructure and IUCN Blue Finance.
- Informal platform. Setting up a platform for early-stage dialogue on project leads and potential collaborations. This platform could involve members from the dredging community, as well as financiers, certifiers, insurers and other stakeholders (assessed through the mapping exercise).
- Joint project screening. Collaboration with private capital suppliers and sponsors to organise a joint screening process for early-stage prospects. The objective will be to identify promising opportunities and evaluate projects. Expectedly, this will generate gaps (relating to e.g. business case approach, risk mitigation, ESG assessments and legal structuring) which the partners would be able to start bridging with their experience and expertise.

5

REFERENCES

5 REFERENCES

Barbier, E.B. 2015. Hurricane Katrina's lessons for the World. Nature, 20 August 2015. Vol. 524, p. 285–287. (Barbier refers to the Coastal Protection and Restoration Authority of Louisiana: Louisiana's Comprehensive Master Plan for a Sustainable Coast. Office of Coastal Protection and Restoration 2012. The 2017 and 2023 plans are available online.)

Barbier, E.B., Burgess, J.C. and Dean, T.J. The Conversation. https://theconversation.com/why-companies-should-help-pay-for-the-biodiversity-thats-good-for-their-bottom-line-106298

Bendor, T., Lester, T.W., Livengood, A., Davis, A. and Yonavjak, L. 2015. Estimating the Size and Impact of the Ecological Restoration Economy. PLoS ONE 10 (6): 1–15. https://doi.org/10.1371/journal.pone.0128339

Buchner, B., Clark, A., Falconer, A., Macquarie, C., Tolentino, R. and Watherbee, C. 2019. Global Landscape of Climate Finance 2019. Climate Police Initiative. November: 15.

Conway, M., Rayment, M., White, A. and Berman, S. 2013. Exploring Potential Demand for and Supply of Habitat Banking in the EU and Approprate Design Elements for a Habitat Banking Scheme. https://ec.europa.eu/environment/enveco/taxation/pdf/Habitat_banking_Report.pdf

European Commission. 2020. EU Taxonomy for Sustainable Activities. www.Ec.Europa.Eu. 2020. https://ec.europa.eu/info/business-economy-euro banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en

FAO and UNEP. 2020. About the UN Decade. www.Decadeonrestoration.Org. 2020. https://www.decadeonrestoration.org/about-un-decade

Holman Fenwick Willan LLP. 2011. Global Investment in Ports & Terminals. Holman Fenwick Willan LLP. https://www.hfw.com/downloads/HFW Ports and Terminals Report %5BA4%5D February 2013.pdf

IADC. 2019. Dredging In Figures 2019. https://www.iadc-dredging.com/wp-content/uploads/2020/10/dredging-in-figures-2019.pdf

Ishiwatari, M. and Daisuke, S. 2020. Bridging the Gaps in Infrastructure Investment for Flood Protection in Asia. March. https://doi.org/10.13140/RG.2.2.24910.20800

ITF. 2019. ITF Transport Outlook 2019. OECD Publishing. https://www.oecd-ilibrary.org/transport/itf-transport-outlook-2019_transp_outlook-en-2019-en

Koh, N.S., Hahn, T. and Boonstra, W.J. 2019. How Much of a Market Is Involved in a Biodiversity Offset? A Typology of Biodiversity Offset Policies. Journal of Environmental Management 232 (July 2018): 679–91. https://doi.org/10.1016/j.jenvman.2018.11.080

Kok, S., Gleijm, A., De Kok, M., Van Eekelen, E., Gauderis, J. and Jansen, B. 2021. Paving the Way for Scaling up Investment in Nature-Based Solutions along Coasts and Rivers – How to Finance and Accelerate Implementation of Nature-Based Solutions. https://www.ecoshape.org/app/uploads/sites/2/2021/01/S20.0022-Whitepaper-paving-the-road-def.pdf

Meltzer, J.P. 2018. Blending Climate Funds to Finance Low-Carbon, Climate-Resilient Infrastructure. 120. Global Economy and Development. https://doi.org/10.2139/ssrn.3205293

Nicholls, R.J., Hinkel, J., Lincke, C. and Van der Pol, T. 2019. Global Investment Costs for Coastal Defence through the 21st Century. Washington, DC.

OECD. 2016. Biodiversity Offsets: Effective Design and Implementation: Policy Highlights. https://www.oecd-ilibrary.org/environment/biodiversity-offsets_9789264222519-en

OECD. 2020. Blended Finance – Unlocking Commercial Finance for the Sustainable Development Goals. https://www.oecd.org/development/financing-sustainable-development/blended-finance-principles/

OECD. 2020. Nature-based solutions for adapting to water-related climate risks. OECD Environment Policy Paper No. 21.

Pauw, W.P. 2017. From Public to Private Climate Change Adaptation. Universiteit Utrecht.

Rozenberg, J. and Fay, M. 2019. Beyond the Gap – How Countries Can Afford the Infrastructure They Need While Protecting the Planet. Edited by Julie Rozenberg and Marianne Fay. Washington: World Bank.

Sapkota, Y. and White, J.R. 2020. Carbon Offset Market Methodologies Applicable for Coastal Wetland Restoration and Conservation in the United States: A Review. Science of The Total Environment 701: 134497. https://doi.org/10.1016/j.scitotenv.2019.134497

Sutton-Grier, A.E., Wowk, K. and Bamford, H. 2015. Future of Our Coasts: The Potential for Natural and Hybrid Infrastructure to Enhance the Resilience of Our Coastal Communities, Economies and Ecosystems. Environmental Science and Policy 51: 137–48. https://doi.org/10.1016/j.envsci.2015.04.006

Swiss Re. 2015. Sonar Emerging Risks Insights. Burmeier, S., Schneider, R. and Brahin, P.

Swiss Re Institute. 2020. Biodiversity and Ecosystem Services: a business case for re/insurance. Retsa, A., Schelske, O., Wilke, B., Rutherford, G. and de Jong, R.

Swiss Re Institute and Global Infrastructure Facility. 2020. Closing the Infrastructure Gap. Mobilising Institutional Investment into Sustainable, Quality Infrastructure in Emerging Markets and Developing Economies. Saner, P., Gillespie, F., Kerr, L. and Lev, C. https://www.swissre.com/dam/jcr:3f5e2757-f08b-4fb2-8805-fdc479dd7c20/swiss-re-institute-publication-closing-the-infrastructure-gap-2021.pdf pg.6 (7 of 29)

Thiele, T., Alleng, G., Biermann, A., Corwin, E., Crooks, S., Fieldhouse, P., Herr, D. et al. 2020. Blue Infrastructure Finance : A New Approach, Integrating Nature-Based Solutions for Coastal Resilience.

TNC, ICLEI and Ecologic. 2020. Investing in Nature for European.

Ullman, R., Bilbao-Bastida, V. and Grimsditch, G. 2013. Including Blue Carbon in Climate Market Mechanisms. Ocean & Coastal Management 83: 15–18. https://doi.org/10.1016/j.ocecoaman.2012.02.009

UNPRI. 2020. Investor Action on Biodiversity: Discussion Paper. https://www.unpri.org/sustainability-issues/environmental-social-and-governance-issues/environmental-issues/biodiversity

Van Eekelen, E. and Bouw, M. 2020. Building with Nature – Creating, Implementing and Upscaling Nature-Based Solutions. Rotterdam: Marcel Witvoet.

WBCSD. 2017. Incentives for Natural Infrastructure. https://docs.wbcsd.org/2017/05/Incentives_for_Natural_Infrastructure.pdf

WWF. 2020. Bankable Nature Solutions – Blueprints for Bankable Nature Solutions from across the Globe to Adapt to and Mitigate Climate Change and to Help Our Living Planet Thrive.

Redirecting existing insurance practices towards sustainable marine infrastructure encourages more commercial practices and private investment.

(Swiss Re, p.52)

ANNEX – CASE STUDIES

CASE 1: BEIRA MASTERPLAN, MOZAMBIQUE

Beira's poor living conditions.

CHALLENGE

Beira, in Mozambique, faces three challenges:

- Make the most of the great economic potential of the city, and its hinterland, afforded by its strategic location on the Indian Ocean and at the end of an important transport corridor with a sea port;
- Improve the poor living conditions of many of its inhabitants, due to poor basic infrastructure and service coverage; and
- Adapt to climate change and sustainably coexist with its natural environment. Beira is in a delta and large parts of the built-up areas are prone to flooding.

Solution

To meet these challenges, an integrated and planned approach is necessary, plus a clear implementation and financing strategy. The Masterplan 2035 was developed and approved, in 2014, and sets out a vision for the city, which describes how it can respond to the challenges in the decades to come. An integrated approach, which links the challenges, also creates better opportunities for financing follow-up projects. The foremost intervention is capacity building of the municipality of Beira (Conselho Municipal da Beira (CMB)) and institutional strengthening, which is a precondition for the successful implementation of the masterplan and the follow-up projects.

The core strategic parameters have been integrated into one strategy for the spatial development and urban expansion of Beira. Part of the Beira Masterplan project is the development of a list of follow-up projects that meet the challenges which contribute to its implementation.

The project list

1 Capacity building and institutional strengthening
2 Optimisation study into dredging of the port access channel
3a Urban transport plan
3b Rehabilitation and paving of primary access roads
3c Rehabilitation and improvement of hinterland transport infrastructure
3d Feasibility study into the improvement and expansion of the urban public transport system
3e Design and realisation of a new port access road
3f Design and realisation of the extension of the railway to the port
3g Reconstruction of the EN6 main access road to Beira
4 Rehabilitation and expansion of drinking water treatment plant
5 Rehabilitation and expansion of drinking water distribution network
6 Rehabilitation and expansion of sewer network
7 Coastal protection projects to keep Beira safe from extreme storm events
8 Drainage projects to keep the land dry
9 Social housing projects to improve the living conditions
10 Development of structure plans and zoning plans
11 Land development company (LDC) to organise the projects and the financial mechanism
12 Solid waste management to improve the living conditions

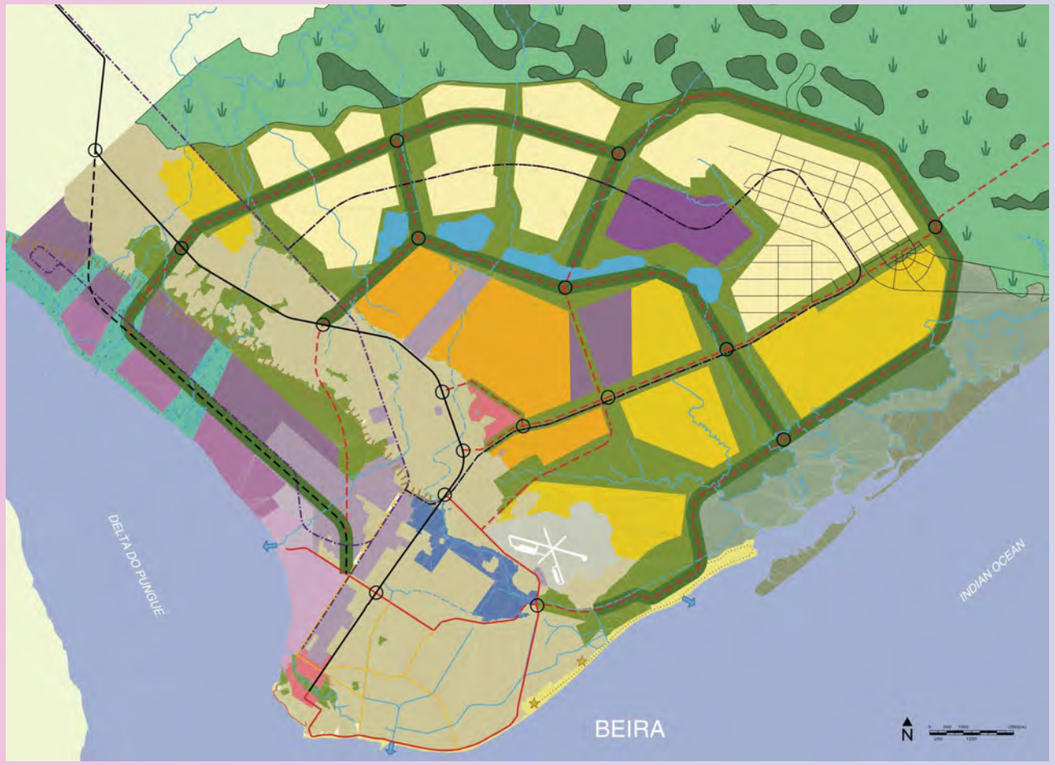


Figure 1.1: Beira Masterplan.

Type of finance

The making of the Beira Masterplan was funded by the Dutch Government. Some of the follow-up projects are, or will be, financed by International Financial Institutions (IFIs). The intention is to attract private investors and to have a Land Development Company (LDC) to facilitate it.

Payback/Revenue model

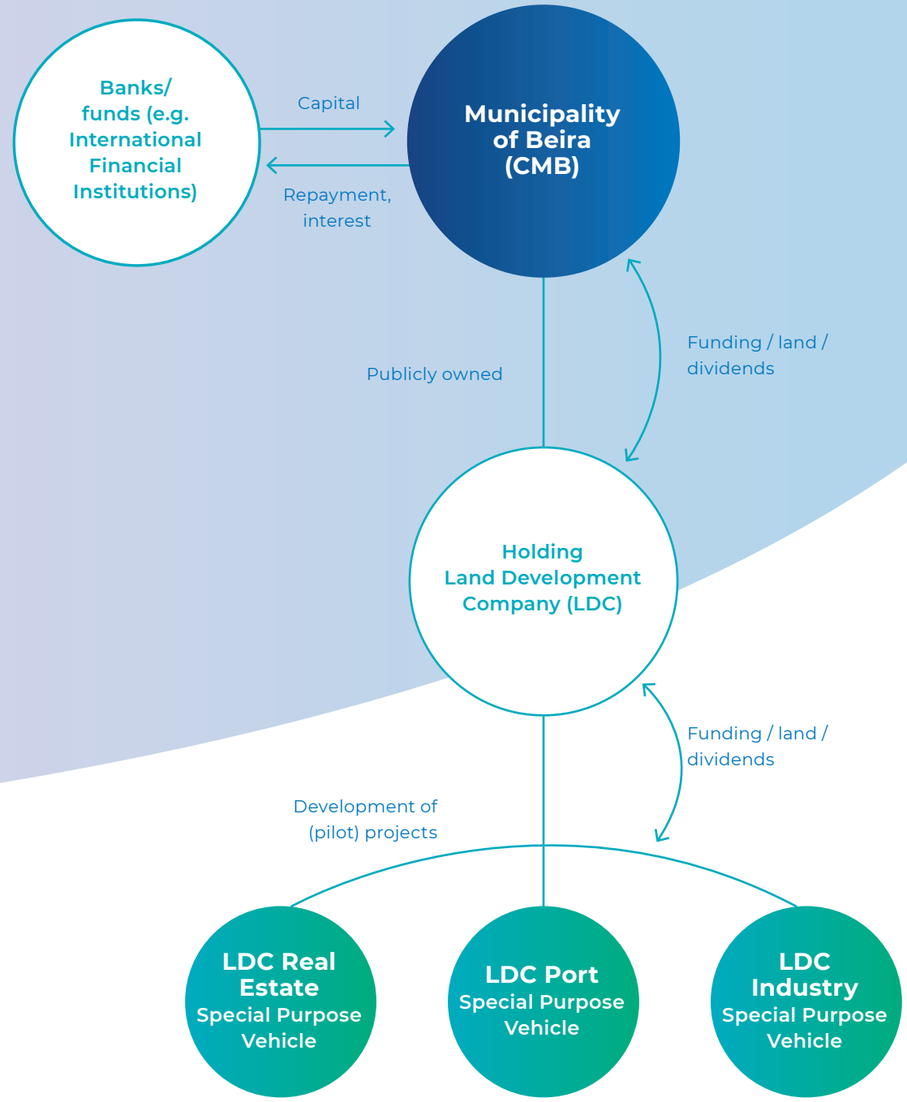
An LDC will be established with the following goals:

- Provide dry land and plots for residential and industrial purposes, which will be suitable for construction (i.e. heightening and levelling); and
- Facilitate adequate (good quality) housing at affordable prices, industrial plots and basic infrastructure (specifically drainage) and transport infrastructure.

The LDC could provide CMB with the initial means, and mechanisms, to better control urban development. This concept could also improve the financing capacity of CMB.

Capital and service flows

Schematic structure:



CASE 2: GRENSMAAS, THE NETHERLANDS

Widened floodplains, South Limburg. Photo: www.flying-eye.eu

CHALLENGE

The Netherlands is vulnerable to flooding from both the sea and rivers. The rivers often have to process lots of water. Due to climate change, there are increasingly frequent periods where more rain and meltwater cause the water levels in the rivers to rise. In the 1990s, large amounts of rain and meltwater caused extremely high levels in the Dutch rivers. In 1993, about 8% (18,000 ha) of the province of Limburg was flooded which resulted in substantial damages. The recent devastating river floodings in Germany, Belgium and the Netherlands, due to heavy rainfall in July 2021, make the importance of water management clearer than ever.

Solution

Since the early 2000s, 'giving room to the river' has become the working approach to address the issue of flooding rivers. In addition to dyke improvements, river widening is taken into account in national flood protection planning. This allows more river water to be stored, and discharged, and therefore makes the river system more adaptive to climate change.

The project Grensmaas, in the southern Dutch province of Limburg, covers the unnavigable part of the river Meuse. The project follows the concept of 'room for the river', started in 2008 and will run until 2027. It has a total cost of approximately € 700 million and has three main objectives:

- River flood protection by widening the channel and lowering flood plains;
- Large-scale nature development and ecological restoration of the river system, to create new river-bound nature covering more than 1,000 ha; and
- Gravel and sand excavation.

The project is run by Consortium Grensmaas. This is a collaboration of contractors (Van den Biggelaar, Van Oord and Boskalis), several gravel producers, and the Dutch Society for Nature Conservation (Natuurmonumenten), working closely with local, provincial and national authorities and partners.

Project Grensmaas has won several awards, including the Sustainable Development Award of the UEPG (Union Européenne des Producteurs de Granulats) for economic contribution and added value to society. The project gained support due to intensive local community engagement and broad collaboration with local, provincial and national partners.

Type of finance

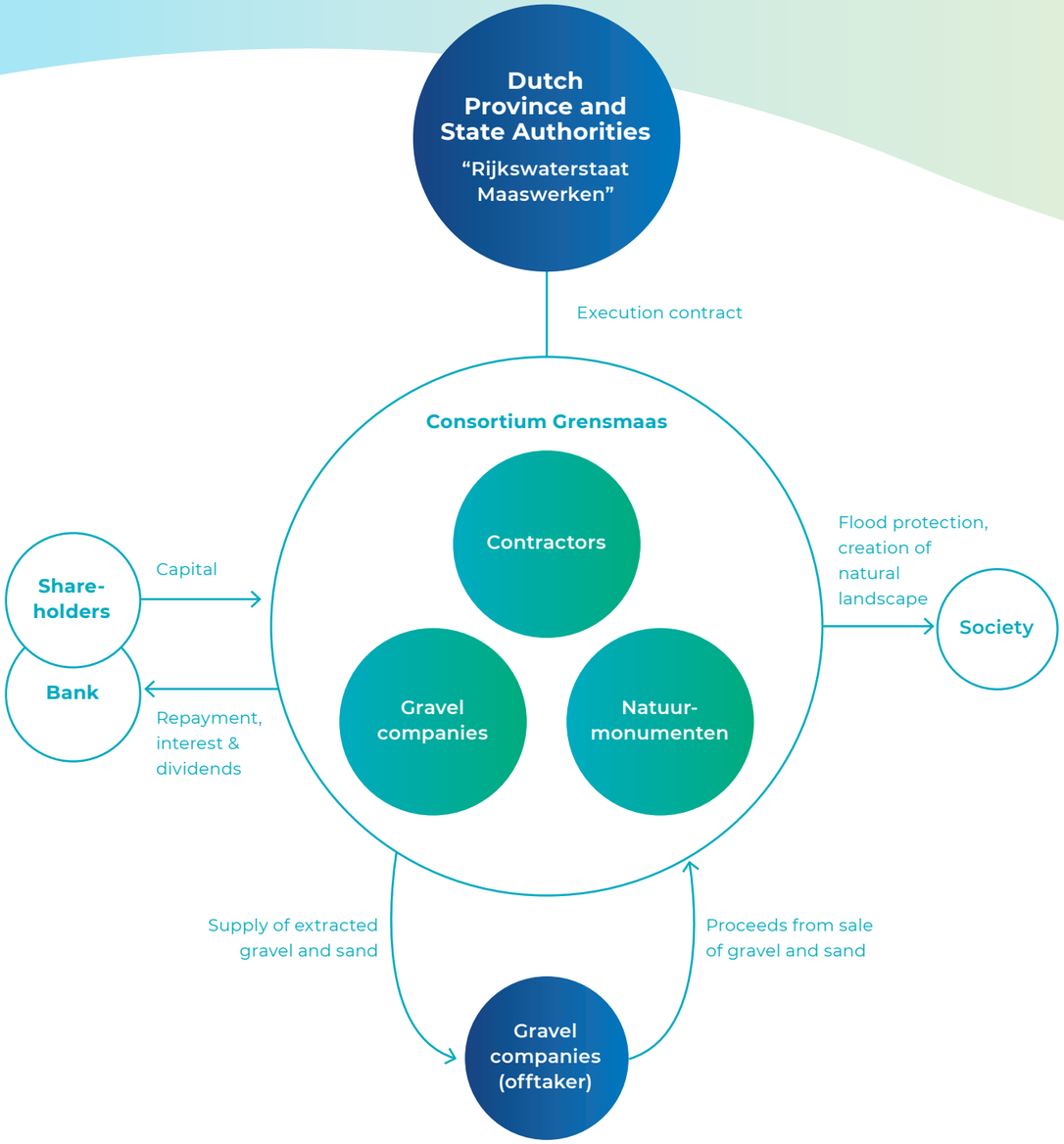
The project is funded by consortium partners and ING Bank through guarantee and debt facilities.

Payback/Revenue model

The financing and running costs of the project, i.e. for the objectives of flood protection and nature development, are paid for with the proceeds from the extraction of gravel and sand (totalling 54 resp. 10 million tons) in the area.

Capital and service flows

Schematic project structure:



REFERENCES

https://www.grensmaas.nl/

https://www.rijkswaterstaat.nl/water/waterbeheer/bescherming-tegen-het-water/maatregelen-om-overstromingen-te-voorkomen/ruimte-voor-de-rivieren/index.aspx

https://www.rijkswaterstaat.nl/water/waterbeheer/bescherming-tegen-het-water/maatregelen-om-overstromingen-te-voorkomen/maaswerken/grensmaas.aspx

https://www.ingwb.com/themes/client-cases-articles/grensmaas-paves-the-way-for-safety-and-nature

Photo: www.rijkswaterstaat.nl.

CASE 3: HULHUMALÉ LAND RECLAMATION, MALDIVES

Land reclamation in the Maldives.

CHALLENGE

Sea level rise is a major concern for the Maldives, which is made up of many small islands and, as such, is one of the most vulnerable countries on earth. With more than 80% of its 1,200 islands less than 1m above sea level and its capital, Malé, only 1.5m above mean sea level (MSL), adaptation is key. At the current predicted rates, by 2100 all of the Maldives' 200 naturally inhabited islands could be submerged. Land scarcity is another pressing issue. With a high population growth and little land, affordable housing in the more populated areas is largely lacking. Malé is already one of the most densely populated cities on earth and, in 2001, households were paying an average 45% of their income on rent.

Solution

To address the issues of land scarcity and limited elevation, land reclamation is a promising solution for creating more space for the growing population whilst increasing the flood-risk protection level. The Maldivian atolls provide ample opportunity for reclaiming new islands, because of their shallow depths and the proximity of abundant sediment for land fill.

In 1997, the Government of the Maldives initiated the major land reclamation of Hulhumalé, located near Malé. By 2040, in various phases, the project will eventually provide 7km^2 of urban land. Hulhumalé is expected to be home to more than 150,000 people by 2050. Phase I (1997-2004) reclaimed 185 ha for predominantly residential use, with infrastructure, houses, schools and a mosque developed on the reclaimed land. Phase II (2006-2016) reclaimed an additional 240 ha, also predominantly for residential use, with approximately 10% of the area reserved for social housing. Climate change considerations, green urban planning and sustainability played a key role in the design of the urban fabric. With an elevation of 2.1m above MSL, Hulhumalé is considerably more resilient to sea level rise.

Disruption of natural systems by land reclamation is unsustainable, on the basis that underwater ecosystems like coral reefs can be destroyed or negatively impacted (e.g. due to increased suspended sediment loads). However, if, as in the case of the Maldives, there is no good alternative to land reclamation (e.g. redevelopment of brownfield and existing sites), efforts can be made to mitigate the negative impacts of land reclamation (e.g. coral translocation, as in the Hulhumalé project).

Type of finance

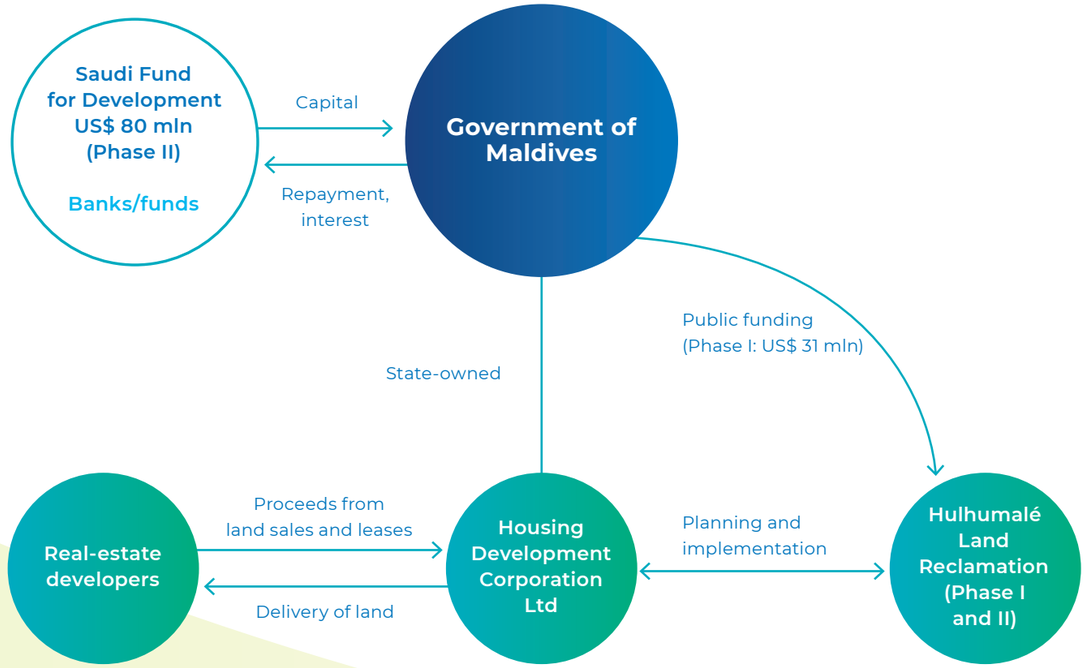
Phase I of the project (US$ 31 million), including land raising, development of infrastructure (such as roads, water and sanitations) and parks, was funded entirely from the Maldives national state budget. Phase II was implemented by a state-owned company, the Housing Development Corporation (HDC), at a cost of US$ 160 million financed in part by the Saudi Fund for Development.

Payback/Revenue model

The HDC leases and sells land to real-estate developers. The revenues are estimated at approximately US$ 4 billion. The 10% transaction tax on land leasing provides a revenue stream to the public sector.

Capital and service flows

Schematic project structure:



REFERENCES

Bisaro, A., de Bel, M., Hinkel, J., Kok, S. and Bouwer, L.M. 2019. Leveraging public adaptation finance through urban land reclamation: cases from Germany, the Netherlands and the Maldives. Climatic Change.

https://hdc.com.mv/hulhumale/

http://www.bbc.com/travel/story/20200909-a-new-island-of-hope-rising-from-the-indian-ocean?referer=https%3A%2F%2Fwww.bbc.com%2Fnews

CASE 4: MAASVLAKTE 2, THE NETHERLANDS

CHALLENGE

The Port of Rotterdam was in need of land for substantial expansion of the port. Land reclamation for new port terminals would offer sufficient new land but would impact the coastal ecosystems.

Solution

Plans were developed in agreement with a wide coalition of stakeholders, including various nature conservation groups. The plans aimed to have minimal coastal impact and to contribute to various other sustainable goals. They included mitigation and compensation measures, development of new coastal habitat, doubling of recreational beaches in the area and a sustainable way of land use. The latter included the development of a wind farm on the new land and a mandatory modal split of 50% through inland waterway transport, to avoid a large increase of cargo transport by truck (increasing emissions and having other negative effects).

Maasvlakte 2 in development.

Type of finance

Total cost of € 2.9 billion, of which € 726 million is invested by the national government and the rest is privately financed via the Port of Rotterdam. The public investment covers the main sea-dyke, breakwater and basic infrastructure, and nature compensation and mitigation. Private finance covers land reclamation, and terminal and port development for the entire new area.

Payback/Revenue model

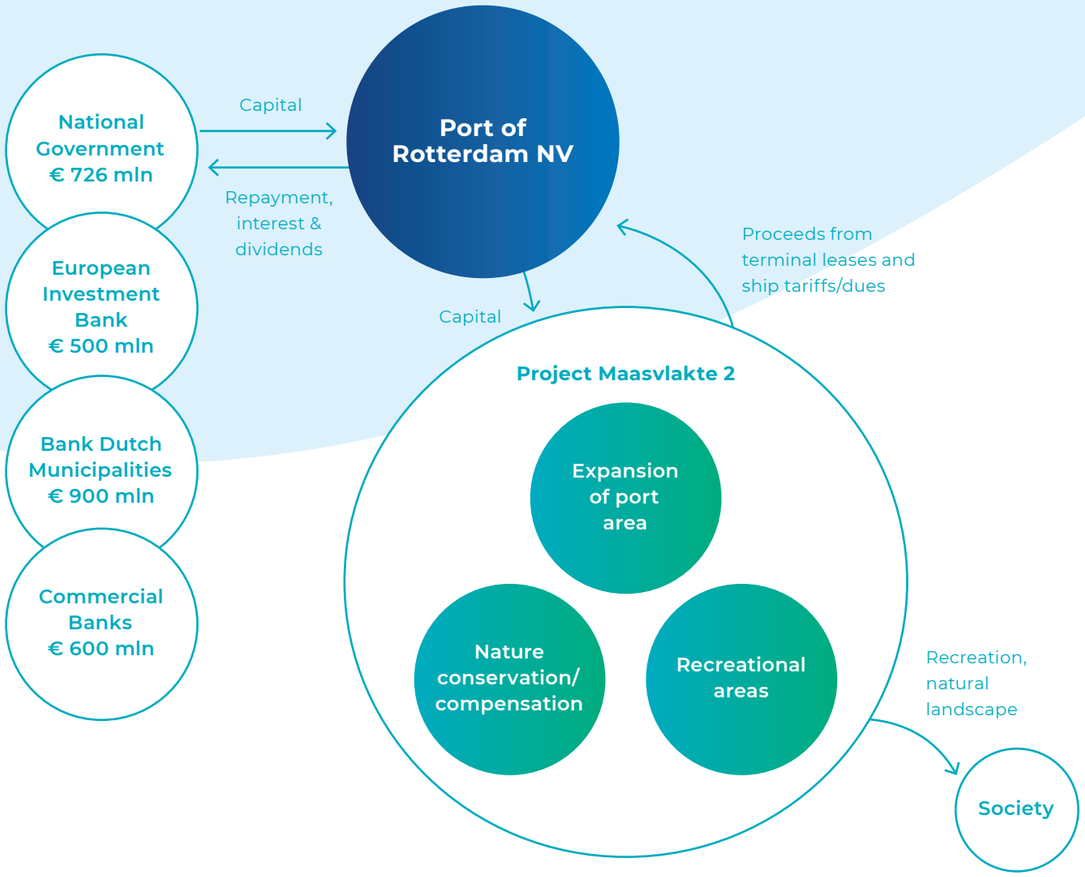
The national government gained a 33% share in the Port of Rotterdam through their investment and receives dividends accordingly. The Port of Rotterdam services the private financing obligations (repayments and interest payments) through terminal leases and increased incomes from port tariffs/dues. Increase on public investment in hinterland infrastructure networks, like highways and railroads, was largely avoided by mandating that at least 50% of new cargo streams would be transported over the existing waterways.

Technical support

Various elements of the plans were developed, and implemented, under supervision of some of the major stakeholders. The national government contributed to shore-side development and local authorities were involved in the development of nature compensation areas. Particular emphasis was placed on dredging activities. The marine ecosystems were disturbed as little as possible by reducing turbidity and effects from borrow pits.

Capital and service flows

Schematic project structure:



REFERENCES

https://www.portofrotterdam.com/nl/onze-haven/havenontwikkeling/maasvlakte-2

CASE 5: MANGROVE RESTORATION

EXEMPLAR CASE OF MANGROVE CONSERVATION AND RESTORATION

The (sustainability) objectives of mangrove conservation and restoration, as elements in coastal landscape propositions, could be manifold and include:

- Enhancing climate change resilience and livelihoods of local communities, by reducing coastal erosion and creating a buffer for flood surges.
- Increasing biodiversity by providing a habitat for a wide variety of species.
- Protecting farmland (mangroves serve as filtration systems by preventing the influx of saline water).
- Enhancing aquaculture productivity (e.g. fish and shrimps).
- Creating social engagement and employment by involving the local villages.
- Serving as major carbon sinks which capture and store greenhouse gases (e.g. CO_2).

Mangrove projects aim to create positive socio-environmental returns, leading to stronger biodiversity and climate change mitigation and adaptation. They represent a promising fit for financiers and international finance institutions (IFIs) pursuing environmental, social and governance (ESG) impacts, rather than purely financial returns.

Revenue generating activities

Revenues and financial returns may be generated through:

- Carbon sequestration representing a value through carbon credits. International treaties exist to reduce greenhouse gas emissions. In that respect, an effective mechanism is the pricing of carbon emissions. Countries and corporates can buy carbon credits to offset, or compensate for, their emissions. A carbon credit represents the capture, or avoidance, of greenhouse gases equivalent to 1 ton of CO_2. Tradeable carbon credits can be created from a project, depending on the (potential) tons of CO_2 captured. Based on this system, airliners offer CO_2-neutral tickets and energy companies can shape their carbon neutral ambitions (e.g. Shell).
- Sustainable bio-businesses relating to the aquaculture (e.g. fisheries, shrimp farms).
- Providing (eco-)tourism activities.

Mangrove restoration in the village of Timbul Sloko, Java, Indonesia.

Challenges for financial viability

- Regarding carbon credits, the potential cashflow is currently not meaningful for bankable project propositions due to limited scale (carbon volumes) and pricing levels. However, demand for carbon offsets is growing substantially with tightening policies as the main driver. Fossil fuel dependent sectors are increasingly engaged with acquiring offsets from, for example, coastal ecosystem projects.
- Lack of scalable and mature sustainable infrastructure projects.
- Lack of familiarity with the opportunities, perceived risks due to governance and land ownership (enabling legal frameworks), and longer-term uncertainties surrounding nature-based solutions under climate change scenarios.

These challenges could be overcome by applying blended finance solutions, where grant and concessional funding from public (and philanthropic) sources are used to attract capital from the private sector. Blended finance helps de-risking and contributes to making the project financially viable.

REFERENCES

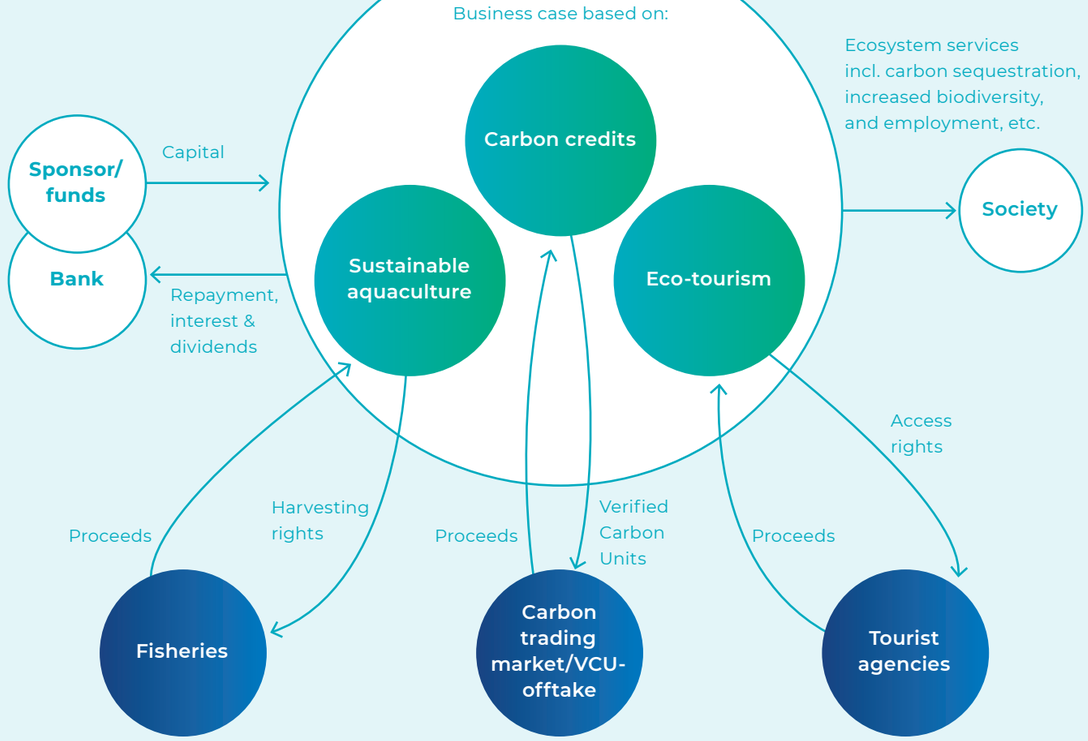
Bankable Nature Solutions: Blueprints for Bankable Nature Solutions from across the globe to adapt to and mitigate climate change and to help our living planet thrive (June 2020), WWF. https://wwfeu.awsassets.panda.org/downloads/bankable_nature_solutions_2__1.pdf

Blue Infrastructure Finance: A new approach, integrating Nature-based Solutions for coastal resilience (March 2020), IUCN. https://bluenaturalcapital.org/wp2018/wp-content/uploads/2020/03/Blue-Infrastructure-Finance.pdf

Investing in nature: financing conservation and nature-based solutions (March 2019), European Investment Bank and European Commission. https://www.eib.org/attachments/pj/ncff-invest-nature-report-en.pdf

Capital and service flows

Schematic project structure:



CASE 6: ODAW RIVER DRAINAGE BASIN PROJECT, GHANA

A choked Odaw River.

CHALLENGE

During wet seasons, Ghana's Greater Accra Region has repeatedly suffered from heavy flooding, which has caused death, displacement of people and destruction of property. This is a trend that the West African state's government wants to reverse.

Urbanisation and densification of settlements, along with increased levels of paving and limited expansion of the drainage system, leads to more frequent and higher levels of flooding following heavy rainfall. The design capacity of the main drains, especially downstream, is no longer sufficient to safely discharge excess water to the sea. Moreover, the actual capacity of the drains has decreased, due to siltation, improper disposal of solid waste which finds its way into the drains, and lack of routine maintenance. The hydraulic modelling of the Odaw River Basin indicates that, with the existing physical configuration and sediment conditions, the level of flood protection is approximated to be only in the range of protection for a one-in-five-year storm event.

The overall objective of this project is to contribute to achieving flood protection for one-in-ten-year events, in the primary Odaw channel system, by preparing a ready-to-tender Performance Based Contracting (PBC) package.

Solution

The Greater Accra Resilient Integrated Development (GARID) programme has evolved out of several technical assistance and operational support visits from World Bank's teams of experts, following the floods of June 2015. The overall goal of the GARID programme is to achieve clean, resilient, inclusive and integrated development in the Greater Accra Region. The programme follows a multi-phase approach, with 3 potential phases spanning 15 years, to achieve the Government of Ghana's vision of a resilient and inclusive urban development in the Greater Accra Region. This case study describes the results of the feasibility study for phase 1, which aims to achieve a one-in-ten-year flood protection (T10) in the primary Odaw channel system.

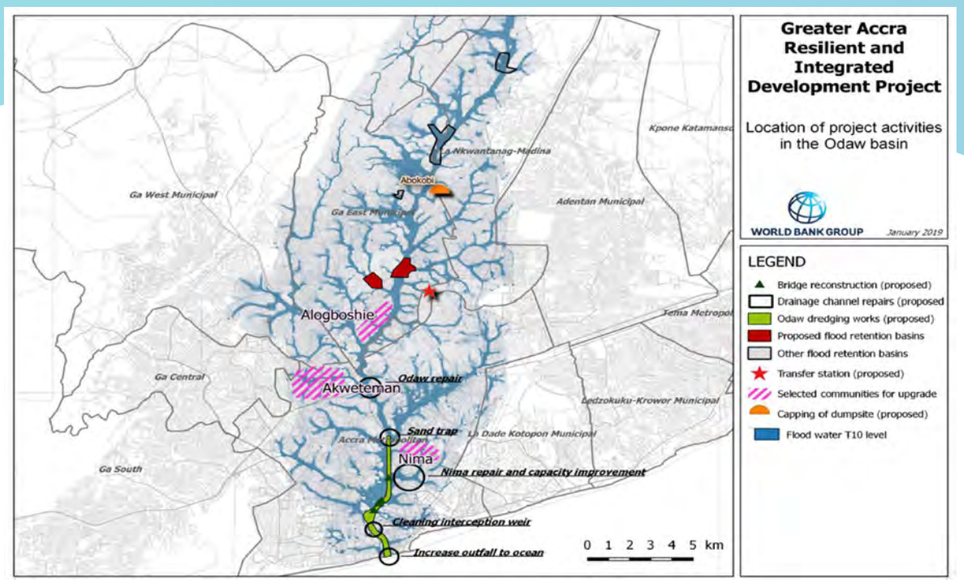


Figure C6: Impression of components under GARID phase 1.

Type of finance

The Odaw basin dredging project will be financed by a World Bank loan. Under a financed PBC arrangement there is potential to extend the role of the contractor beyond the provision of a public service. This potential could be, for instance, in the development and operation of complementary, privately financed commercial activities, where the revenues could contribute to covering the costs of the public drainage service (e.g. re-use of dredged materials, recovery and recycling of plastic waste and sand exploitation are being considered).

Payback/Revenue model

Following the feasibility study, a ready-to-tender PBC package has been prepared. The main problem in the area has been that the required regular maintenance dredging has largely ignored the recommendations of previous studies. A PBC is being regarded as good solution to address the present maintenance problems (caused by an unstructured, reactive approach after floods) for the Odaw and tributaries. A well-structured PBC ensures that flooding is prevented, or alleviated, by maintaining the Odaw and tributaries in good condition.

Reduced recovery costs, after flooding scenarios, is already a win for the local authorities and there may be added benefits to be gained from lower unit prices from the contractor executing the PBC. As the contractor can generate revenues from re-use of dredged materials (e.g. selling of dredged sand and gravel) and plastic recycling, this could cover part of the total dredging and maintenance costs and make the project more affordable over the long term.

As already mentioned, added value can also be found in other activities related to the proposed project solution, including:

- Strengthening the management of local solid waste;
- Improving the living conditions of the most flood-exposed poor communities in the Odaw river basin; and
- Providing training to enhance the capacity, across local government administrative jurisdictions and sectoral departmental structures, to coherently and effectively operate, manage and maintain the drainage assets built under the project.

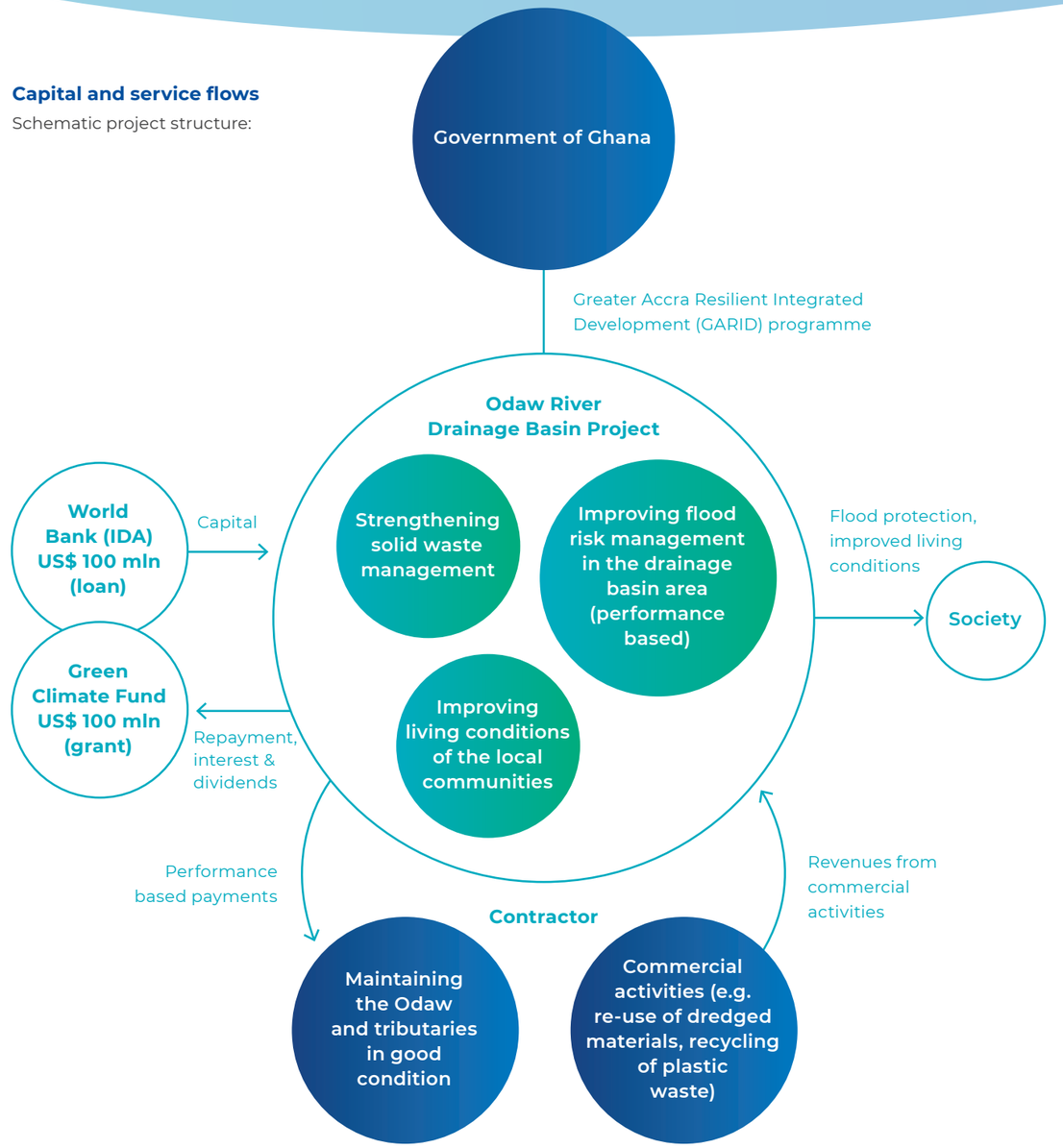
REFERENCES

https://imdc.be/en/news/a-feasibility-study-for-dredging-of-the-odaw-channel-and-korle-lagoon-in-ghana

https://www.worldbank.org/en/news/press-release/2019/05/29/world-bank-supports-ghana-to-improve-flood-resilience-for-25-million-people

Capital and service flows

Schematic project structure:



CASE 7: PEVENSEY BAY SEA DEFENCES PPP PROJECT, UK

Erosion north of Sovereign Harbour in 2008[1].

CHALLENGE

In 2000, in Pevensey Bay, UK, the only protection against flooding was a naturally formed shingle embankment. A permanent breach would result in 50km^2 of land being flooded at high tide (an area that includes over 17,000 properties as well as roads and railway lines).

In 1997, the Environment Agency estimated the cost of a permanent breach at Pevensey would be £125 million. Such a breach would also affect the Pevensey Levels, an important wetland environment designated as both a Site of Special Scientific Interest (SSSI) and a Ramsar site[2]. The bay's defences had received limited maintenance and was being affected by natural erosion. By the late 1990s, many of the beach's 150 groynes had reached the end of their 'useful life' and a 1-in-20-year storm event could cause the embankment to fail. Routine maintenance alone was insufficient to prevent the situation worsening, and major investment was needed to restore the shingle bank to an effective sea defence structure.

Solution

Since Pevensey Bay's sea defences were no longer self-sustaining, they had to be managed to ensure that the required level of protection was provided. Typically, many sea defence schemes involve major capital works followed by minimal amounts of maintenance. At Pevensey the ethos has been a little different. A substantial sum was spent, in 2002, on completing improvements works, but it was recognised that this alone would not be sufficient.

The primary defence is shingle. In absorbing wave energy, it is moved from west to east along the coast in such a way that there is a net loss of some 25,000m^3 of beach every year. It also moves irregularly, with some places seeing excessive erosion whereas others may gain in the short term.

In Pevensey Bay the option of a soft sea defence was favoured. Since 2002, the shingle embankment has been managed to a defined minimum width. As storms have eroded beach material, and moved it east by longshore drift, it has either been recycled back to rebuild narrowed defences or replaced by annual beach nourishment. This has been achieved by dredging similar sediments from the seabed and pumping them onto the beach.

Managing the defences now involves a variety of techniques, most of which are reactive and undertaken in response to weather events. Because of this, the various works undertaken are not planned in advance, as resources have to be mobilised in response to events as they happen.

1. **Sutherland, J. and Thomas, I. 2011. The management of Pevensey shingle barrier. Ocean & Coastal Management 54. pp. 919-929**
2. **A Ramsar site is a wetland site designated to be of international importance under the Ramsar Convention. The Convention on Wetlands, known as the Ramsar Convention, is an intergovernmental environmental treaty established in 1971 by UNESCO, which came into force in 1975. It provides for national action and international cooperation regarding the conservation of wetlands and wise sustainable use of their resources (https://www.ramsar.org/).**

Type of finance

With limited funds for the necessary capital expenditure, the Environment Agency looked at alternative funding through partnership with the private sector. In 2000, it awarded a 25-year contract to a consortium of Boskalis (previously Westminster Dredging), Dean & Dyball, Mackley Construction and Mouchel, to restore and maintain the beach to the required levels. With a value of around £30 million (at 1999 prices), the public-private partnership (PPP) - the first of its kind for flood protection - is fairly small in comparison with more typical PPP schemes for roads, schools and hospitals. As a result, the four firms were able to finance the contract themselves, instead of borrowing money. At the time of the appointment, they created a special company Pevensey Coastal Defences Ltd (PCDL) to deliver the contract. In simple terms, the consortium has been contracted to provide protection against a breach of the shingle bank, for any storm, with a return period of 1-in-400 years or less.

Payback/Revenue model

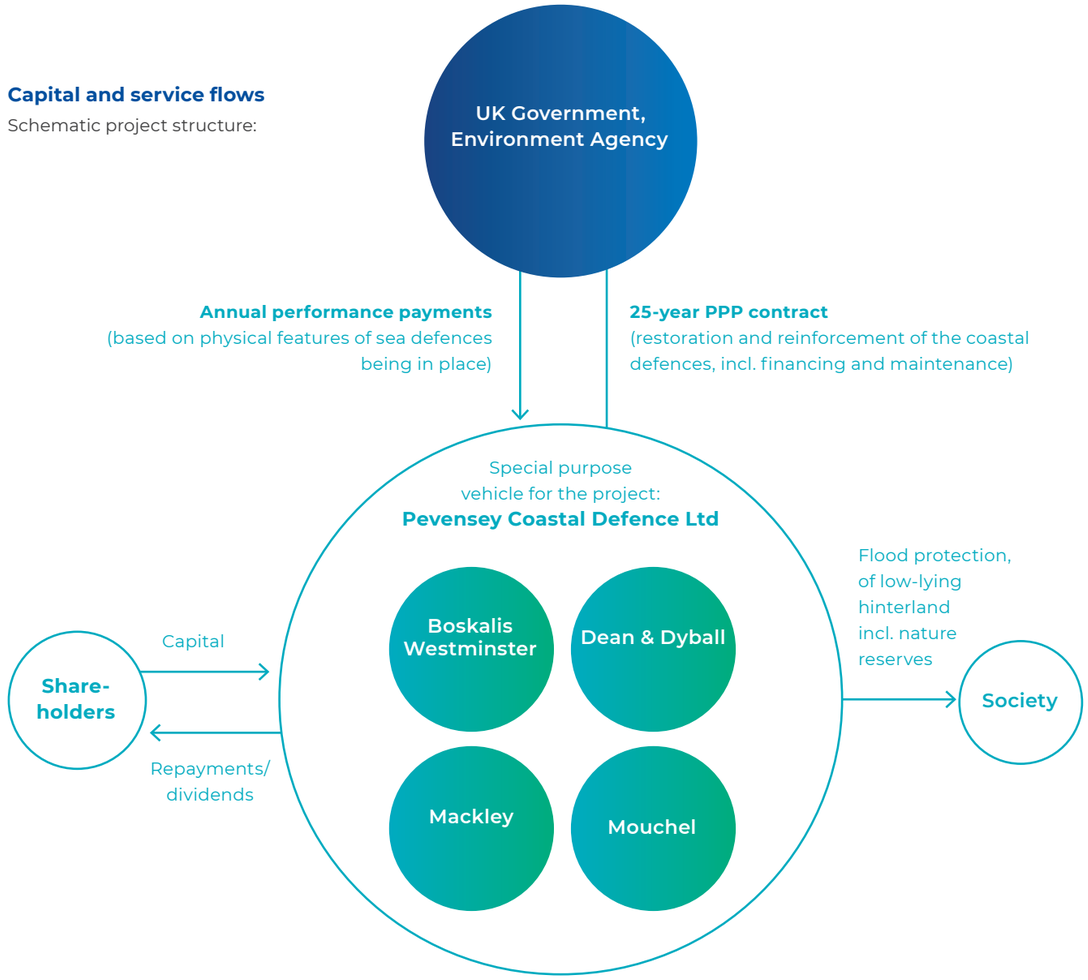
While costs may be higher, due to private financing costs over the life of the concession, the benefits of a 25-years PPP contract for the client (in this case, the Environmental Agency) include: early construction of the coastal defences (as opposed to gradually building up sections of the coastal defences according to annual budgets) and the ability to gradually pay for the service over the 25-year period. For the consortium, the benefits include: possibilities to apply innovative and more cost-effective methods, and flexibility for the contractor to pursue the desired coastal defence outcomes, as opposed to maintenance on a fixed schedule.

REFERENCES

https://www.iadc-dredging.com/wp-content/uploads/2017/02/article-long-term-coastal-defence-and-management-at-pevensey-bay-uk-a-public-private-partnership-113-2.pdf

Capital and service flows

Schematic project structure:



CASE 8: PRINS HENDRIK ZANDDIJK, THE NETHERLANDS

CHALLENGE

In 2006, a coastal safety assessment in the Netherlands showed that more than 70% of the 24-kilometre-long Waddensea dyke, on the island of Texel, failed to meet safety standards. A refurbishment was executed on 14 kilometres of the dyke, increasing its width and height, and adding a cover layer of grass and asphalt. Along a 3.2-kilometre-long section, in front of the Prins Hendrik Polder, the conditions were right to accommodate a soft coastal protection design instead of the conventional approach of upgrading the existing dyke. This nature-based solution included development of a sand body in front of the old dyke (the Prins Hendrik Zanddijk (PHZD)). As it is a Natura 2000 site (Habitats and Birds Directive) and a UNESCO World Heritage Site, the Waddensea is a fitting place for an upgrade of low-value natural habitats.

This project was a major dyke reinforcement operation in the Netherlands, and Swiss Re Corporate Solutions supported the construction with a 'Construction All Risks' (CAR) policy - traditional insurance cover for an innovative project. Insurance is traditionally seen as a mechanism to compensate and absorb the shocks and costs of the unexpected. But it also helps to control risk, making investment more attractive and subsequently encouraging and enabling more nature-based solutions.

Solution

A 5.5 million m^3 sand body was placed at the seaward side of the existing dyke, creating a dune-and-beach system that takes over the primary coastal protection function. This concept had some extra design challenges, including the risk of seawater infiltration and aeolian sand transport into the polder and existing polder outfalls and water conduits, and electricity and telecom cables, which crossed the project site. However, the benefits were deemed worth it. This concept has created new natural habitats and has a strong recreational appeal. The design-and-build tender was set up in such a way that it awarded clever solutions which minimised negative impacts and maximised the positives.

Planting of marram grass at the project site.

Type of finance

The PHZD is part of the Dutch government programme to protect the Netherlands against floods (Hoogwaterbeschermingsprogramma 2 (HWBP-2)). The programme is managed by an alliance of the Ministry of Infrastructure and Water Management and the responsible water board (Hoogheemraadschap Hollands Noorderkwartier). Funds for the project mainly come from this programme, in total approximately € 17 million. As the costs for this nature-based solution were higher than for the conventional solution, additional funding had to be found. The following institutions provided additional funding (mainly because of the nature development character of the project):

- The Wadden Fund ('Waddenfonds'): € 12.2 million;
- Province of Noord-Holland: € 1.5 million; and
- Municipality of Texel: € 1 million.

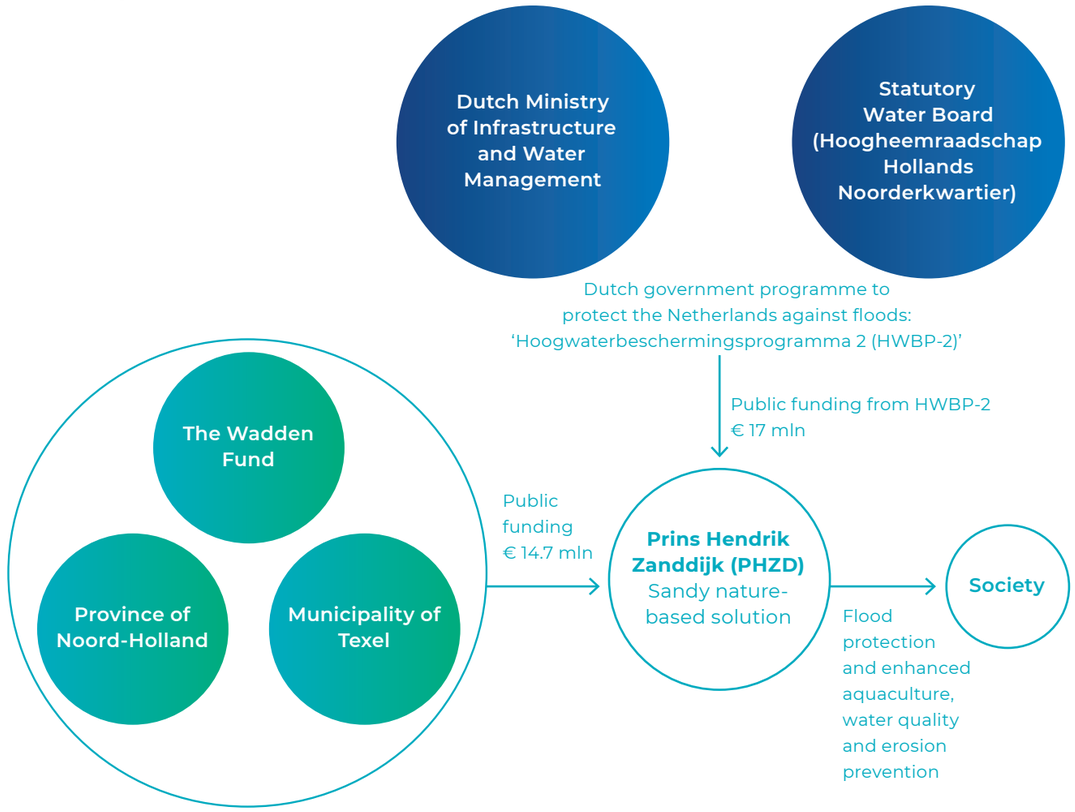
The project requirements were adapted to accommodate the interests of the different stakeholders. The site is now a nature reserve with limited access and defined minimum habitat areas (Waddenfonds) and visitors can enjoy the site from the bird watching platform and the cycle path (Municipality of Texel).

Payback/Revenue model

The advantages of the PHZD design do not result in concrete cashflows/revenue streams. However, the ecosystem services delivered by this solution can be monetised. Results indicate that the nature-based solution, compared to the conventional one, creates an additional € 0.4-1.07 million in ecosystem services benefits, annually. This is mainly due to enhanced fish production, climate regulation, water quality regulation and erosion prevention. The creation of the PHZD also generates negative effects on existing ecosystem services. By replacing a shallow sand bank area, with a beach, emissions of carbon and nutrients are increased. However, these negative effects are more than compensated for by positive effects on ecosystem services. It is estimated that the additional cost, compared to the conventional dyke refurbishment alternative, would be economically compensated for, within five to seven years, through the beneficial ecosystem services.

Capital and service flows

Schematic project structure:



REFERENCES

Fordeyn, J., Lemey, E. and Perk L. A holistic approach to coastal protection for the Prins Hendrik Polder. Hydrolink 1/2020. pp. 11-14

Fordeyn, J., Van der Biest, K., Lemey, E., Boerema, A. and Meire, P. An ecosystem services assessment of the Prins Hendrik Zanddijk, Terra et Aqua 157 (4) Winter 2019. pp. 31-46 Swiss Re. 2020. World Heritage Site nature-based solution leads the way in reducing the risk of rising sea levels. https://www.swissre.com/our-business/public-sector-solutions/our-solutions/nature-based-solutions/world-heritage-site-nature-based-solution-leads-way-reducing-risk-rising-sea-levels.html

CASE 9: SIGMA PLAN, BELGIUM

CHALLENGE

Flood risk is high in the areas surrounding the Scheldt river, and its tributaries, and is exacerbated by climate change and sea level rise. The recent devastating river floodings in Germany, Belgium and the Netherlands, due to heavy rainfall in July 2021, make the importance of water management clearer than ever.

Solution

The Sigma Plan was developed by the Flemish government, as an integrated river basin management plan to protect the areas surrounding the Scheldt river and its tributaries from flood risk. The Plan combined 'grey' infrastructure measures, such as strengthened dyke protection, with 'green' measures to make more 'room for the river' and to support conservation and biodiversity objectives. The flood risk of more than 20,000 ha of land are addressed under the Sigma Plan and around 3,000 ha of natural habitats will be restored by 2030.

In 2005, the Plan was re-evaluated to incorporate (i) climate risks, such as sea level rise, (ii) to develop river nature and recreational facilities, and (iii) the economic functions and local economies of the Scheldt region, such as shipping and agriculture.

The Plan consists of a pipeline of projects with similar themes. This first tranche of projects is in progress and is expected to be completed by 2030. Typical examples include:

Themes	Number of Projects
Flood control area development	12
Depoldering	10
Wetlands development	6

The compartmentalisation levee between the northern and southern part of Vlassenbroek.

Figure C9: Locations of Sigma Plan projects in the Scheldt river and its tributaries[1].

Type of finance

Publicly funded by the Flemish government.

Payback/Revenue model

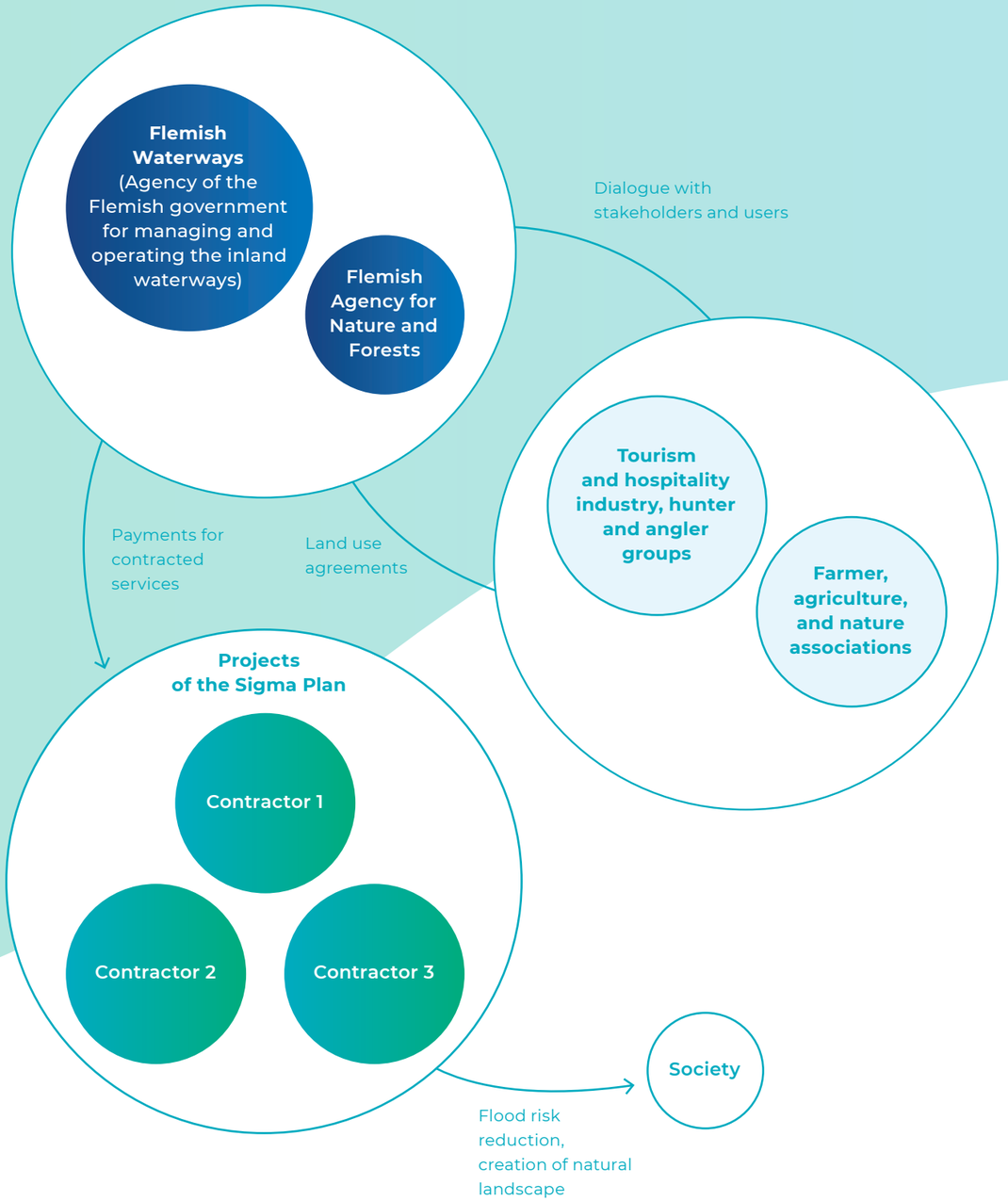
Due to sea level rise and economic developments, it is generally assumed that flood risks will increase significantly in the 21st century. Cost-benefit analyses by the Flemish government concluded that the costs of building floodplains to decrease flood risk were substantially lower than other flood protection methods, including building a storm surge barrier for the city of Antwerp (€ 500-600 million), developing a large canal ('Overschelde') to connect the Western and Eastern Scheldt (€ 1500 million) and heightening dykes. Developing floodplains had the lowest costs and the highest net benefits.

The Flemish Waterways (De Vlaamse Waterweg) is responsible for the majority of the funding for Sigma Plan projects. From 2006 to 2020, overall investments in direct project expenditure for the Plan were approximately € 600 million.

1. Climate Adapt. An integrated plan incorporating flood protection: the Sigma Plan (Scheldt Estuary, Belgium) (2014). https://climate-adapt.eea.europa.eu/metadata/case-studies/an-integrated-plan-incorporating-flood-protection-the-sigma-plan-scheldt-estuary-belgium

Capital and service flows

Schematic structure:



Citation

IADC, CEDA, Vital Ports. 2021. Financing Sustainable Marine and Freshwater Infrastructure: A joint study to explore private financing of green coastal, river and port projects.