# Leveraging public finance for coastal adaptation

↘ Coastal adaptation investment presents clear opportunities for social welfare improvements, particularly for densely populated areas with high levels of economic activity

↘ Financial constraints can be overcome by investing in adaptation projects that leverage public resources through various mechanisms

↘ Coastal urban land reclamation or redevelopment projects that include adaptation offer opportunities to leverage public finance through generating revenues from land sale or lease

↘ Nature-based flood defence solutions can leverage public investments by producing co-benefits, such as, improved environmental quality, that generate tax revenues from increased recreation activities

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## Coastal adaptation investment presents clear opportunities for social welfare improvements, particularly for densely populated areas with high levels of economic activity

Coastal areas are coming under increased pressure from sea-level rise and coastal developments. Adaptation measures are expected to bring significant net benefits though avoided flood damage over the longer term particularly in urban areas, thus increasing social welfare (e.g., Aerts et al. 2014; Lincke and Hinkel 2018; Scussolini et al. 2017). Yet despite their economic attractiveness, financing and implementation of such measures has been slow, and many coastal areas are under-protected (Wong et al. 2014). Only a fraction of global coastal adaptation finance needs, which could grow, considering dikes only, to $70 billion annually by the end of the century (Hinkel et al. 2014), are being covered (Buchner et al. 2015). Thus, there are opportunities worldwide to make investments in coastal adaptation and achieve significant social welfare gains by avoiding flood damages.

Coastal adaptation has largely been seen as the responsibility of governments (Biesbroek et al. 2010). Yet public finance is scarce. Public actors, the dominant investors in coastal adaptation, currently cover only a fraction of needed coastal adaptation investments globally, and an even smaller share of this in developing countries.

There are several barriers to public finance of adaptation. First, public actors are often faced with the need to fund many different pressing priorities, of which coastal adaptation is but one, and as such these opportunity costs present a significant barrier to coastal adaptation investments for central governments. In developing countries, opportunity costs are an even more prominent barrier due to very attractive benefit-cost ratios of the health or education sectors investments. Another barrier to public finance of coastal adaptation is the challenge of raising funds for specific projects, e.g. through special levies. Special taxes or levies for coastal adaptation projects raised from households or property owners exposed to coastal flooding often encounter opposition because of free-riding dynamics, and are thus often unpopular with voters (Bisaro and Hinkel 2018).

## Financial constraints can be overcome by investing in adaptation projects that leverage public resources through various mechanisms

Given the constraints on public finance, an increasingly promising approach for achieving coastal adaptation is focussing on adaptation projects that can leverage public finance.

Leveraging public finance refers to achieving increased outputs with the same amount of public investment. For example, if a public actor invests in beach nourishment for flood protection in a given area, and then receives increased tax revenues from increased tourist spending area, the public actor's financing of the flood protection measure has been leveraged. Leveraging public investment in flood risk reduction can be achieved by projects producing co-benefits, e.g. new land or improved natural settings, and generating revenue from these benefits through either market transactions, e.g. selling new land, or tax revenues. Leveraging can also be achieved by implementing a project more efficiently, thus reducing overall public expenditure.

This Policy Brief focuses on three mechanisms shown in Table 1 as examples of this mechanism have been identified in the GREEN-WIN project. These examples involve land reclamation and real-estate development, nature-based solutions leading to ecological co-benefits, and long-term contracting through public-private partnerships.

**Table 1.** Mechanisms for leveraging public investments in coastal adaptation projects.

| **Mechanisms for leveraging public finance** | **Instrument** | **Examples** |
|---|---|---|
| Generating revenues through market transactions | Land sale or lease by the public actor | Urban land redevelopment (HafenCity, Hamburg, Germany) |
| Generating revenues through taxes | General taxes, e.g. VAT, property taxes, Special taxes | Nature-based solution: beach nourishment (Sophiastrand, Netherlands) |
| Improving efficiency of project implementation | Long-term service delivery contracting with private sector | Coastal protection public-private partnership (Pevensey Bay, UK) |

Generally, the potential for leveraging through these mechanisms is highest in areas that are densely populated, or otherwise have high levels of economic value, e.g. from industrial activity. In such urban and developed settings, land values and willingness-to-pay for recreational activities are high, which are necessary conditions for generating either market or tax revenues. Further, for long-term contracting, generally high levels of economic activity are needed because attracting the private sector to such contracts requires a strong public balance sheet, which is generally underpinned by a well-developed economy.

In settings that do not meet these conditions, other mechanisms for leveraging public finance, e.g. co-financing or blended finance, that involves e.g. impact investors, are promising. These are not the focus of this Policy Brief, but we refer the interest reader to other work in the GREEN-WIN project (Kok et al. 2018).

## Coastal urban land reclamation or redevelopment projects that include adaptation offer opportunities to leverage public finance through generating revenues from land sale or lease

### Land reclamation creating economic benefits

Land reclamation projects that include coastal adaptation, generally produce economic benefits through flood damages avoided and newly created land. For example, land reclamation projects may raise reclaimed land to account for sea-level rise, or dikes may be raised to a design standard that accounts for sea-level rise, thus protecting the new land. Including these coastal adaptation measures in the project means that future damages from storm surge flooding will be lower. Benefits for the entire project, i.e. the land value created in the project, can be converted to revenues for public actors through the sale or lease of newly reclaimed land by the public actor.

Due to high demand for land in populous and growing coastal urban areas, the revenue generating potential in such projects is significant. Indeed, many cities around the world have reclaimed large portions of urban land for residential and industrial uses, e.g. Singapore, Helsinki, and Shanghai. Moreover, as reclaiming land in urban settings produces revenues that are often far greater than the costs of reclamation, land reclamation is generally profitable for public actors in many settings around the world (Li et al. 2014).

On the cost side, physical construction costs of new land, including preparation for real estate development, are generally low. Material used to fill in new land can vary depending on location, and can in some setting be less than $10 a cubic meter (Li et al. 2014), thus decreasing flood risk significantly by increasing land levels by 1 meter at relatively modest costs. Infrastructure construction is much more expensive, however the total cost of reclamation generally remains significantly cheaper than purchasing or renting existing land (MacKinnon et al. 2012).

### Example: The HafenCity project, Hamburg, Germany

Beginning 1997, the City of Hamburg embarked on HafenCity, a major inner-city development project that envisioned re-development of 155 ha of industrial and port land in the Elbe river estuary outside the main Hamburg city dikes. The project foresees providing up to 7,000 new residential and commercial units by 2025, expanding the city centre area by around 40%, while providing the same level of flood protection as the main Hamburg city dike. The city dike height is 7.5m above mean sea-level, and thus provides a high level of protection even considering sea-level rise.

To achieve the required flood protection level, roads and public transport infrastructure connecting the project to the rest of the city have been raised by between 7.5m and 8.3m above current sea-level, while private real estate developers are responsible for raising new buildings between 7.5m and 9m above sea-level on land they purchase.

## Policy message: urban land sales can cover a significant portion of major coastal adaptation infrastructure costs

Importantly for leveraging of public finance, segments of HafenCity are being developed and sold gradually. As of 2016, approximately 30 % of the entire project area had been redeveloped. The step-by-step approach, involving selling real estate assets to private real estate developers with the requirement to raise buildings, has reduced major upfront investments for the public actor, spreading them over time and sharing coastal adaptation costs between public and private actors. Only the costs for land preparation and raised road access for a project segment must be borne by HafenCity, which can then be covered by sale of land without much delay. Required investment for the entire project is approximately €10.9 billion of investment. Public funds make up around €2.4 billion, nearly all from the City of Hamburg, and the remaining from private sources, e.g. through purchase of land within the project by real estate developers.

## Policy message: A well-executed tendering and regulation process is important to ensure quality developments that enable the achievement of the project's projected outcomes

In order to ensure the achievement of both economic and adaptation objectives, the regulation and tendering process for land sale in HafenCity has played an important role. Regulation is needed in HafenCity because real estate developers do not have incentives to invest in adaptation beyond what the real estate market demands. To maintain some control over achievement of its adaptation objectives, the City of Hamburg set up a careful procedure of tendering process for land sale and building development within HafenCity. Winning bidders received an option period in which they could further specify plans and sell units, before finalizing the purchase and initiating the project.

The tendering process is attractive for real estate developers, as it positively influences the quality of developments within the project, reducing the risk of poorly design or failed developments. These could negatively impact the value of other real estate investments through reducing the attractiveness of, and thus demand for, individual units.

## Nature-based flood defence solutions can leverage public investments by producing co-benefits, such as, improved environmental quality, that generate tax revenues from increased recreation activities

### Generating tax revenues from nature-based flood defence co-benefits

Nature-based flood defence solution (NBFD) are flood defence measures that make use of natural processes in their design (Van Wesenbeeck et al., 2014) and can be used 'stand-alone' or in combination with conventional flood protection measures depending on the local context. NBFD provide a 'win-win' for public actors, meeting both the primary adaptation goal as well as other economic goals: in some cases these solutions may be more cost-effective than conventional measures, such as dike reinforcement, and the Net Present Value (NPV) is often higher due to various co-benefits in the realm of ecosystem services such as recreation and production of biomass. These co-benefits can lead to increased tax revenues for public actors who make the initial upfront investment in flood defence. This is because co-benefits related to the natural setting, e.g. at the beachfront, can make recreation more attractive, and thus increase economic activity through recreation related activities, such as, hotel or restaurant visits. Such economic activity creates revenues for public actors through various channels, such as property tax, VAT, or special purpose levies.

### Example: The Sophiastrand Nature-based Flood Defence Project

Sophiastrand, located in the south-western Dutch Delta, is a beach lying directly in front of a dike. Directly behind the dike is Roompot, a large holiday apartment park, and a marina is adjacent to the park and beach. The beach is the most popular in the area receiving 500 – 2000 visitors daily. The entire Oosterschelde area in which Sophiastrand is located is an important natural area, protected by national law and Natura 2000.

As of 2010, the dike no longer met legal safety standards. Rather than reinforcing the dike, a beach nourishment project, in which the dunal strip and beach is increased, has been implemented for wave attenuation, thus reducing the height requirements of the dike. The rationale for the project is that the beach nourishment lowers flood risk defence costs compared to the conventional option and creates co-benefits through recreational opportunities (Schasfoort et al. 2014). The key co-benefits of the project arise from the creation and increased attractiveness of recreational opportunities, such as sport fishing, windsurfing and kite surfing. Such co-benefits can increase economic activity, generating tax revenues, which in turn lead to leveraging of the overall public investments in the project. Furthermore, the increased beach width allows the construction of 40 beach houses at the newly constructed beach.

The project is fully funded from the Deltafonds (Ministry of Infrastructure and Environment), and executed by its implementing agency, Rijkswaterstaat (RWS). The municipality Noord-Beveland and Roompot provide some beach maintenance, e.g. through re-profiling.

The costs of the beach nourishment & dune reinforcement project were estimated at € 1.3 million, comparable to conventional dike reinforcement costs. Additional co-benefits however made it more attractive than conventional solutions (Leeuwen et al. 2014). The total estimated present value of the co-benefits from the NBS compared to reference situation is € 8.6 million. In contrast, the conventional solution would have had a negative impact on tourism income, mainly due to reduced beach width and thus reclining number of tourists visits.

## Policy message: Nature-based solutions provide co-benefits that can generate tax revenues through increasing recreation-related economic activity

The co-benefits of the project do not just improve social welfare, i.e. by creating economic benefits, but also generate revenues through increased tax income for the public actors through increased attractiveness of the area for tourists. Revenues are generated by the project through four channels: i) the VAT on accommodation and on food and drinks; ii) the housing tax on ownership of houses based on the actual value of houses; iii) VAT on beach house sales; iv) 'tourism tax' charged to tourists staying overnight.

As shown in Figure 1, the present value (PV) of total revenues generated through increased general taxes related to the project are €2.4 million. The leveraging percentage for the public actor as compared to the investment costs is thus € 2.4 million revenues for € 1.3 million investment costs, which gives 185 %.

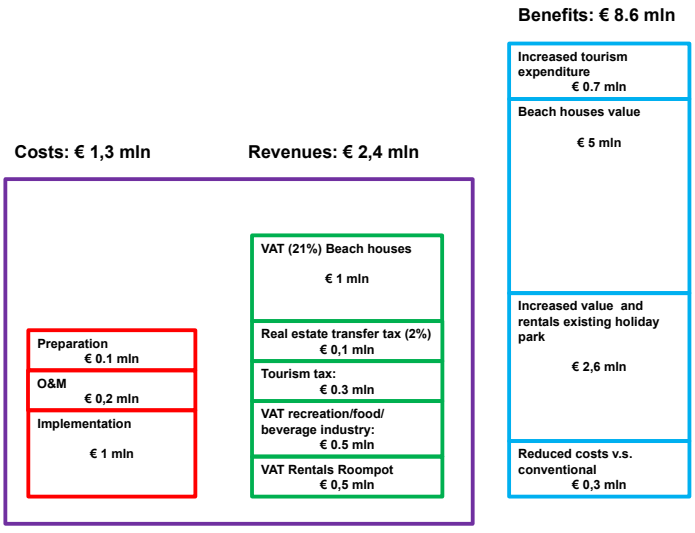


**Figure 1.** Present Value of costs, benefits and revenues generated in the Sophiastrand Beach Nourishment project.

## Long-term contracts involving the private sector offer the opportunity for learning and thus efficiency gains, which can reduce costs for the public actor

### Improving efficiency through long-term contracts

Coastal adaptation projects that involve the private sector through long-term contracting, e.g. 20–30 years, can leverage public finance by improving the efficiency of the project, and thus delivering adaptation outcomes for less cost to public actors. For example, in public-private partnerships, the public actor grants a long-term contract to a special purpose vehicle (SPV), a legal entity established solely for purpose and duration of the coastal adaptation project. The SPV may be exclusively privately owned or may also include the responsible public actor as a shareholder. The motivation for public actors entering into such contracts with the private sector is that the private sector can potentially deliver the project at lower cost than a public entity, particularly, when contracts are long-term.

Long-term contracts offer the opportunity for private actors to learn over time about the area in which a project is being implemented, and provides incentives for the private actor to make investments in such efficiency gains. Generally, such long-term contracts involve service delivery, e.g. protection against a 1-in-50 year event, as opposed to a design specification, e.g. a dike height or a volume of sand. This provides flexibility for the private sector in how they deliver the service contracted. Specifying the service delivery rather than design specification incentivises the SPV to invest in efficiency improvements because they stand to profit themselves from such investments, at the same time lowering expenses for the public actor.

### Example: The Pevensey Bay Public-Private Partnership

At Pevensey Bay, a 9km stretch on the south-east coast of the UK, around 17,000 property owners and a wetland of global significance (i.e. a Ramsar wetland) are protected from coastal flooding by a sand shingle bank operated through a PPP. In the UK, the Environment Agency, responsible for coastal protection, was faced at the end of the 1990s with large investment needs, as the shingle bank and existing groynes at Pevensey Bay were deteriorating. The Environment Agency chose to set up a PPP, tendering a long-term contract from 2000 to 2025 eventually won by the Pevensey Coastal Defence Limited (PCDL), a consortium of four dredging and construction companies, at a value of £30 million. The contract stipulated an initial 200,000 $m^3$ of shingle be provided by PCDL to upgrade the shingle bank to a 1/400 year flood protection standard, and that this protection standard be maintained for the contract duration, also incorporating sea-level rise. To ensure achievement of flood protection level and facilitate monitoring, performance measures over the life of the contract were also agreed.

These measures included 20,000 $m^3$ of annual shingle supply, a 2 million $m^3$ shingle volume for the entire coastline and a minimum width of the bank at its crest (22m). As a service provision contract, it does not specify how these targets are to be met, which is key for achieving efficiency gains from private involvement. An Environment Agency ex-ante assessment of the project estimated 15 % savings of the PPP over traditional public provisioning (Chester 2000).

## Policy message: Long-term contracts offer the opportunity for learning and thus efficiency gains, provided that operational costs are a significant portion of the overall adaptation project costs

One means of increasing efficiency in the project is the long-term nature of the contract offered by the Environmental Agency, which provides the opportunity to improve efficiency of service delivery over time as the PCDL learns about the project site over a longer period. The contract provides incentives to PCDL to make such improvements because they are translated into profits. Indeed, the PCDL has improved efficiency by monitoring sediment flows at the site and improving timing of shingle delivery with respect to tides. Generally, in order for such learning opportunities in long-term contracts to translate to economic incentives for private investors, operating costs need to make up a significant share of the overall project costs. In the UK, PPP contracts are required to consist in over 50 % of their present value from operation and maintenance costs, as is the case for the Pevensey PPP.

## Policy message: Flexible contracts, e.g. for service delivery rather than capital works, allow for efficiency gains because they allow private companies to optimise their resources over time and across multiple projects

Opportunities to increase efficiency in the project also arise from the flexible nature of the PPP contract in terms of service delivery. For instance, the required annual volume of shingle supply can be delivered at any time during the course of the year, rather than at regular intervals. This allows for efficiency gains by PCDL because shingle is supplied using a near-shore dredging ship owned by one of the PCDL shareholders. As the ship is also engaged in other projects, e.g. dredging coastal harbours on the south coast of the UK, the flexibility of the contract allows PCDL to integrate the planning of dredging with its other projects. Dredging costs for the PCDL are thus lowered because dredging can be scheduled at the times when the ship is not otherwise in use.

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# Green growth and win-win strategies for sustainable climate action (GREEN-WIN)

The GREEN-WIN Project identifies, develops and critically assesses win-win strategies, green business models and green growth pathways that bring short-term economic benefits, while also supporting mitigation and adaptation goals within the broader sustainable development agenda.

## Work programme

↘ At national levels, GREEN-WIN analyses win-win opportunities that arise through integrating policies across different sectors, and advances state-of-the-art macro-economic models in order to identify green growth pathways.

↘ At local levels, GREEN-WIN carries out action research case studies to develop green business models and enabling environments in the following three areas: i) coastal flood risk management in Jakarta, Kiel, Rotterdam and Shanghai; ii) transformations in urban systems in Barcelona, Istanbul, Shanghai and Venice; and iii) energy poverty and climate-resilient livelihoods with case studies in India, Indonesia and South Africa.

↘ Cutting across both levels, GREEN-WIN investigates financial products and policies, as well as financial system reforms that redirect financial flows towards sustainability and climate action.

↘ All of these activities are embedded in an open dialogue between research institutes, international organisations, business, and civil society that co-develops shared narratives around win-win strategies, business opportunities and green growth pathways

## Project partners

Global Climate Forum (GCF), Germany (coordinator) | The Institute of Environmental Sciences and Technology, Autonomous University of Barcelona, Spain | E3-Modelling, Greece | Environmental Change Institute, Oxford University, UK | Ecole d'Economie de Paris, France | University College London, UK | The Ground_Up Association, Switzerland | Stichting Deltares, The Netherlands | Institute for Advanced Sustainability Studies, Germany | Global Green Growth Institute, Republic of Korea | Jill Jaeger, Austria | European Centre for Living Technology at Università Ca' Foscari Venezia, Italy | Institute of Environmental Sciences at Boğaziçi University, Turkey | Universitas Udayana, Udayana University, Indonesia | University of Cape Town, South Africa | 2° investing initiative, France | Sustainability and Resilience, Indonesia

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