

How can Ecosystem-based Adaptation improve climate resilience for water-related infrastructure?

**Opportunities and enablers for scaling NbS for adaptation in the
infrastructure sector**

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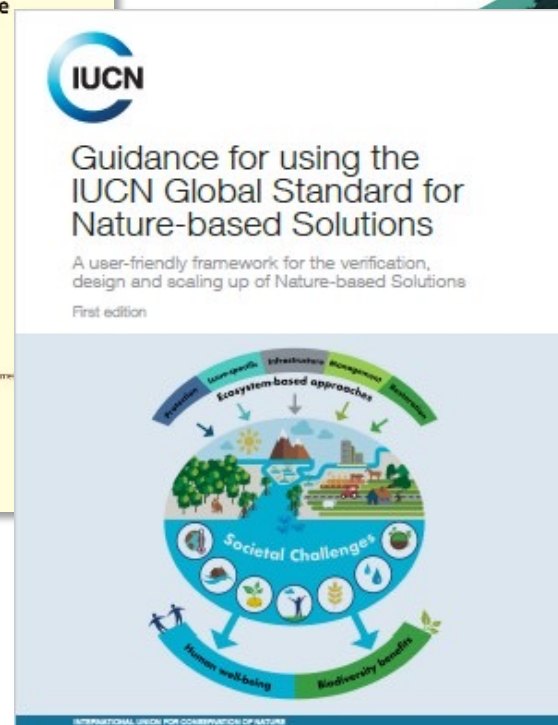
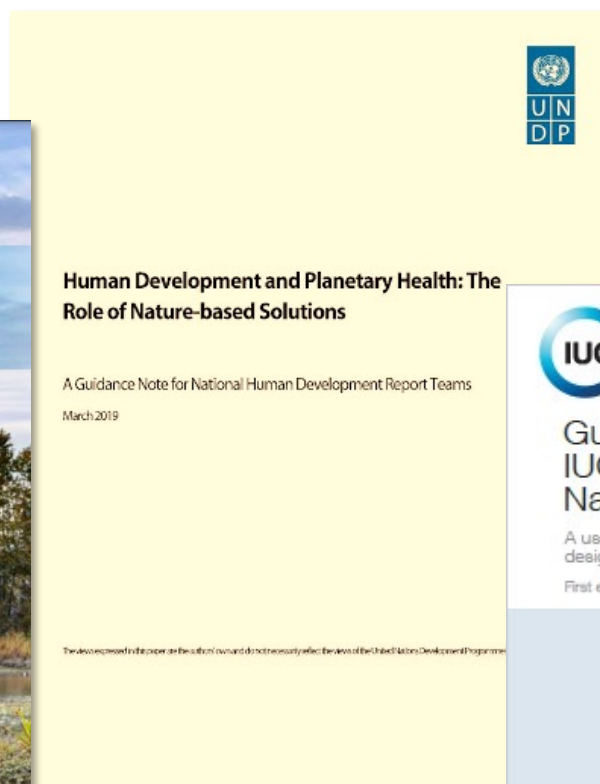
one architecture
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Background



Global trend: Nature-based Solutions for climate resilient infrastructure

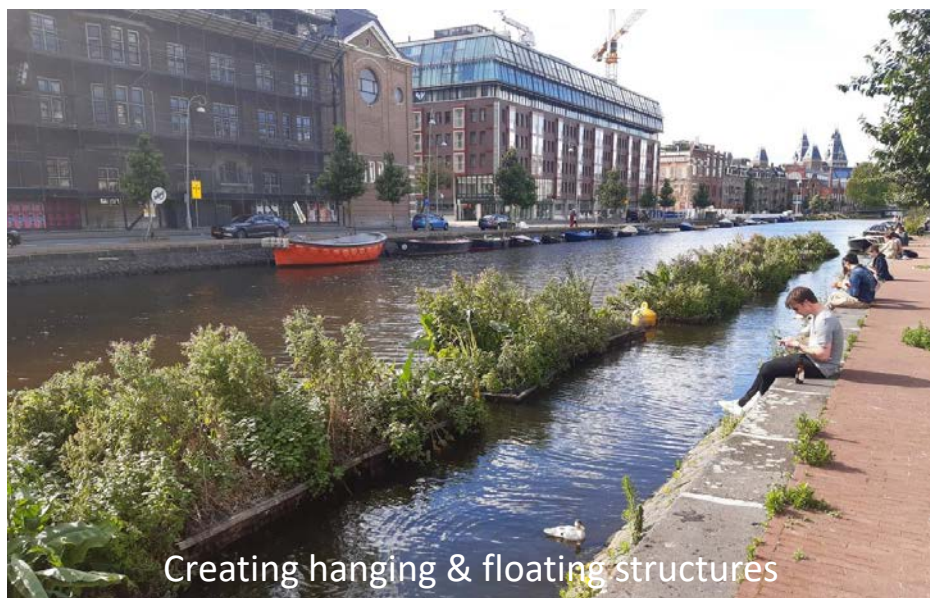




Restoring mangrove belts



Integrating vegetated foreshores



Creating hanging & floating structures

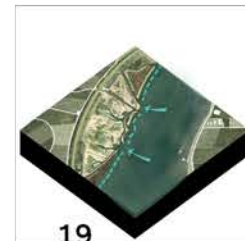
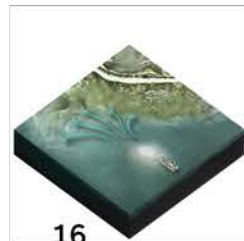
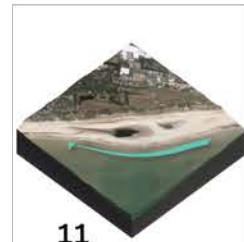
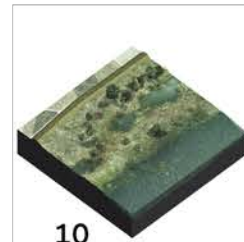
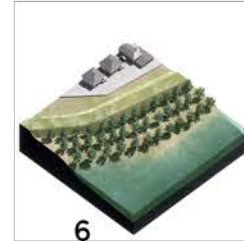
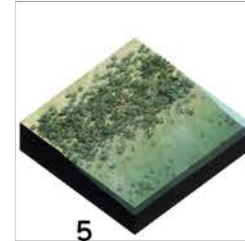
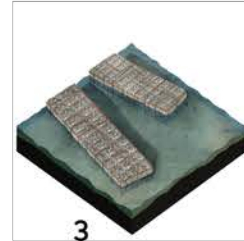
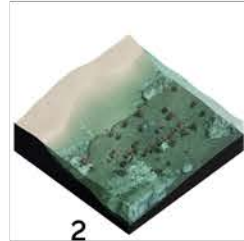
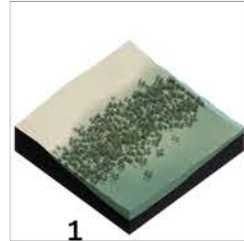


Creating rich revetments

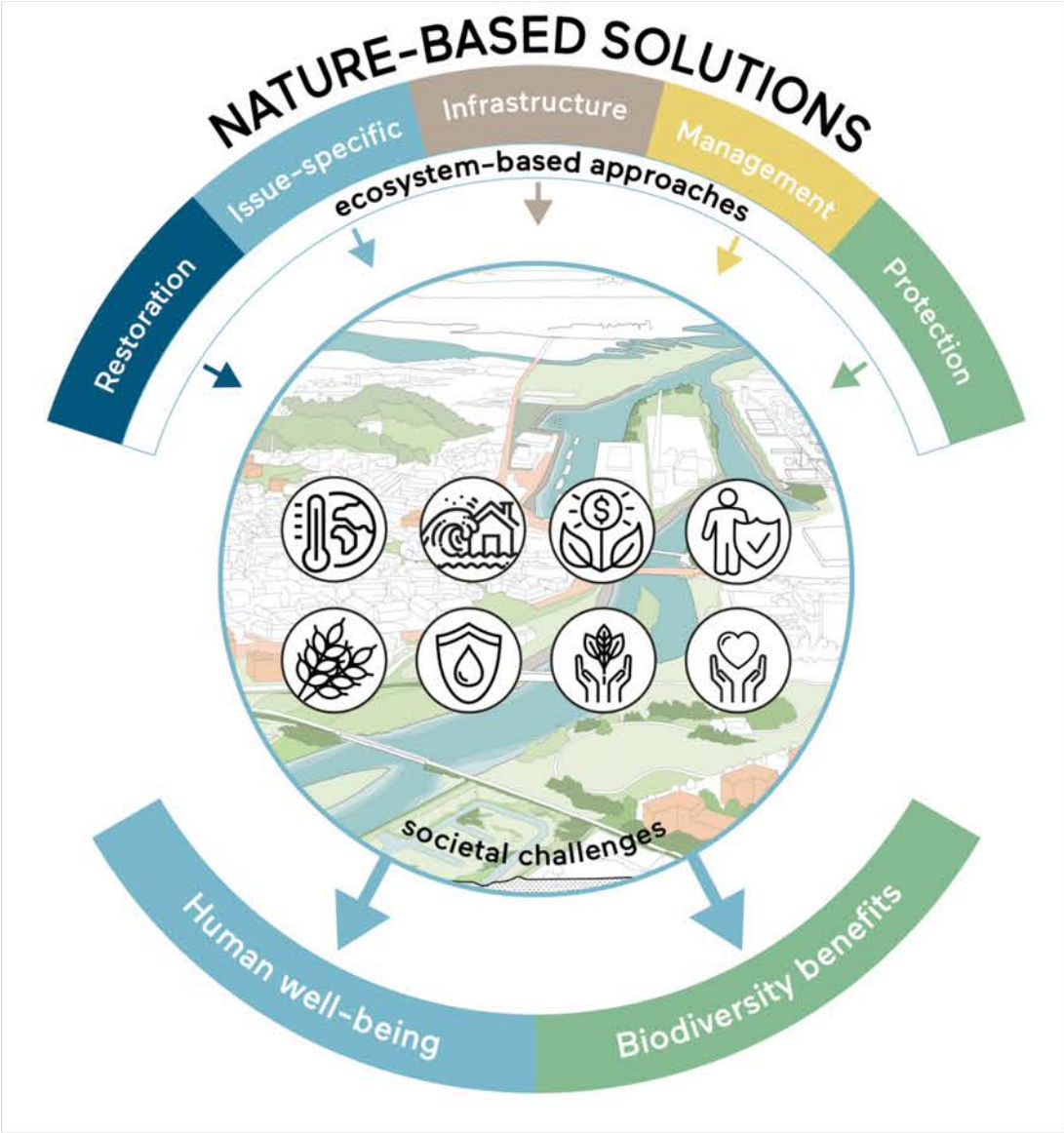


Building with Nature concepts

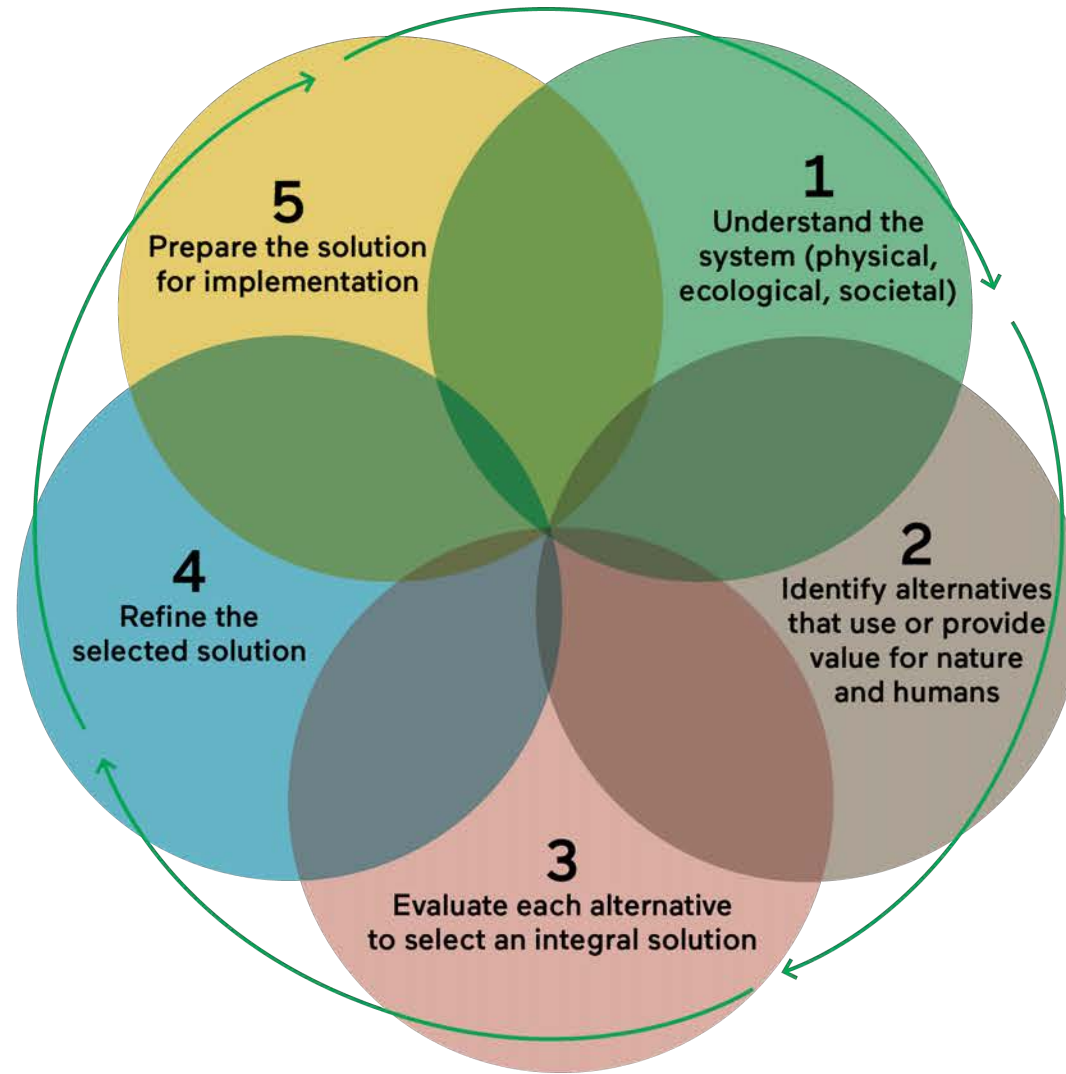
- 1 Restoring seagrass meadows
- 2 Facilitating coral development
- 3 Building shellfish reefs
- 4 Rehabilitating mangrove belts
- 5 Growing salt marshes
- 6 Establishing wetland forests
- 7 Developing wetland areas
- 8 Creating hanging and floating structures
- 9 Creating rich revetments
- 10 Integrating vegetated foreshores
- 11 Applying mega-nourishments
- 12 Constructing nature islands
- 13 Enhancing dune dynamics
- 14 Landscaping the seabed
- 15 Constructing perched beaches
- 16 Strategically placing fine sediment
- 17 Clay ripening and consolidation
- 18 Creating sedimentation basins
- 19 Managing coastal retreat/realignment
- 20 Developing inland buffer zones
- 21 Developing double dike systems
- 22 Restoring connections
- 23 Restoring salinity gradients
- 24 Restoring tidal dynamics
- 25 Creating tidal parks
- 26 Constructing secondary channels
- 27 Optimizing flow patterns



What is Building with Nature?



What is Building with Nature?



The five Building with Nature design steps

Building with Nature concepts

	Sandy Coasts	Muddy Coasts	Lowland Lakes	Rivers and Estuaries	Cities	Ports
1 Restoring seagrass meadows						
2 Facilitating coral development						
3 Building shellfish reefs						
4 Rehabilitating mangrove belts						
5 Growing salt marshes						
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General applicability

Potential applicability

Limited or no applicability

Growing system feature

Featured concept in chapter

Depicted concept in chapter

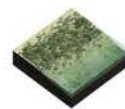
The landscape

Muddy coasts are productive environments that arise in places with an accumulation of fine sediment and, often, limited wave exposure. They represent a large fraction of coastlines globally, including three-quarters of coastlines between the latitudes of twenty-five degrees north and twenty-five degrees south. These fertile areas provide essential resources for humans such as seafood and timber, while their vegetation reduces the risk of flooding. Healthy muddy coastal ecosystems create positive feedback loops that enhance their resilience. Salt marshes and mangrove belts trap sediment, enabling additional vegetation to thrive in the intertidal zone. Yet these flat, low-lying areas are susceptible to consolidation and land subsidence, which increases their vulnerability to flooding and erosion. Even as their populations grow today, these coasts and adjacent inland areas can be challenging places for human settlement, as mud is difficult and costly to build on. Furthermore, sediment dynamics pose a management challenge for active waterfront uses such as recreation, harbors, and access channels.

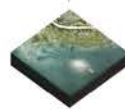
The sediment balance of these landscapes dictates the types of habitats that can develop. It influences seabed composition, water quality, and biodiversity. Interventions alter sediment dynamics and hydrology. Hard infrastructure often exacerbates underlying challenges, while the removal of vegetation and expansion of human activity degrade coastal ecosystem functioning. By contrast, Building with Nature concepts improve existing processes and their complex interactions. They focus on managing fine sediment dynamics and leveraging currents, tides, and winds to rehabilitate natural vegetation. Once restored, ecosystems can flourish again and deliver valuable services.



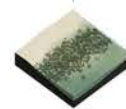
→ Fictional muddy coastal landscape depicting Building with Nature concepts



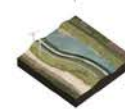
Growing salt marshes



Strategically placing fine sediment



Restoring seagrass meadows



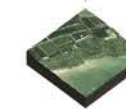
Developing double dike systems



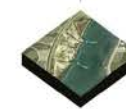
Restoring tidal dynamics



Clay ripening and consolidation

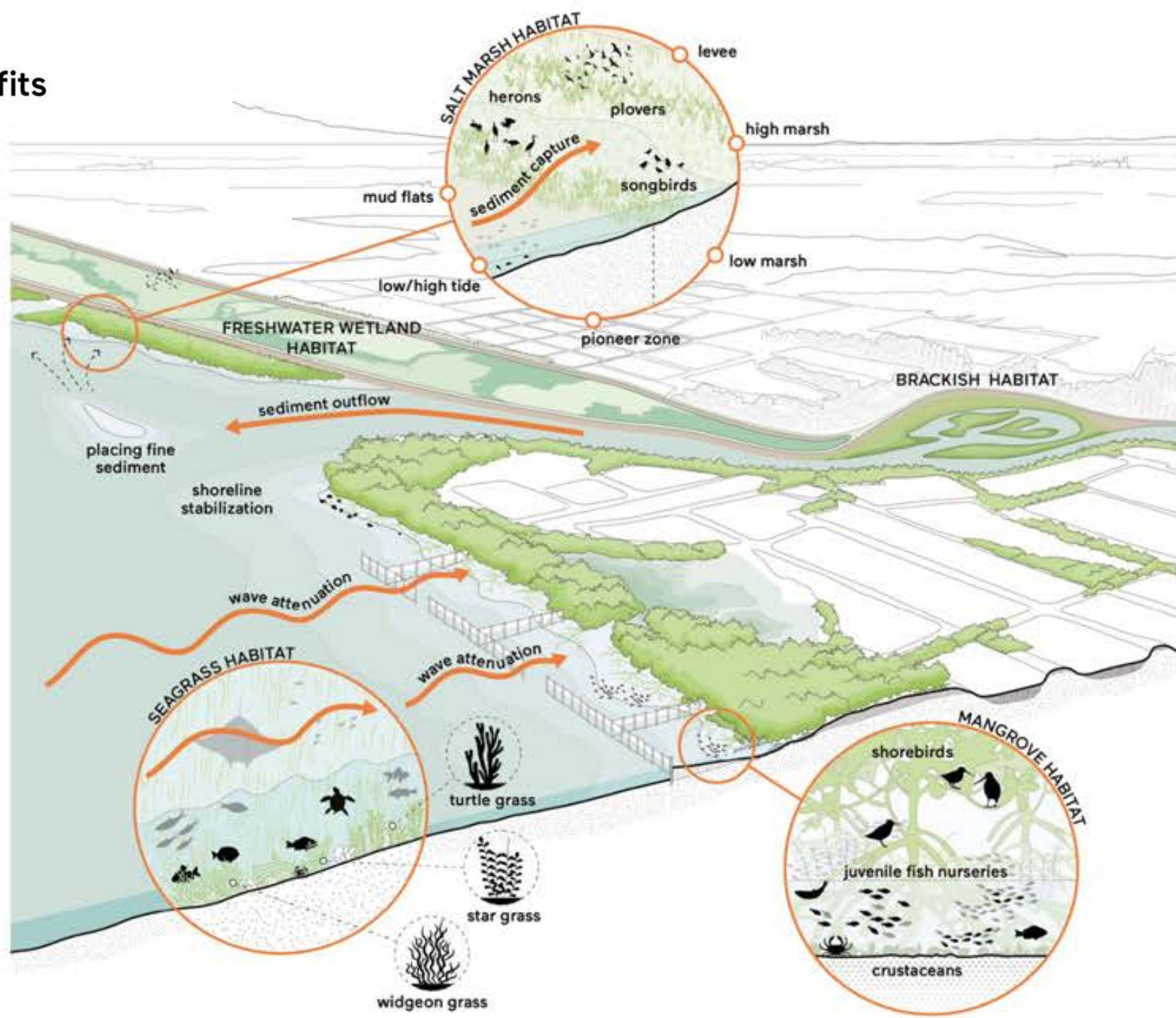


Rehabilitating mangrove belts

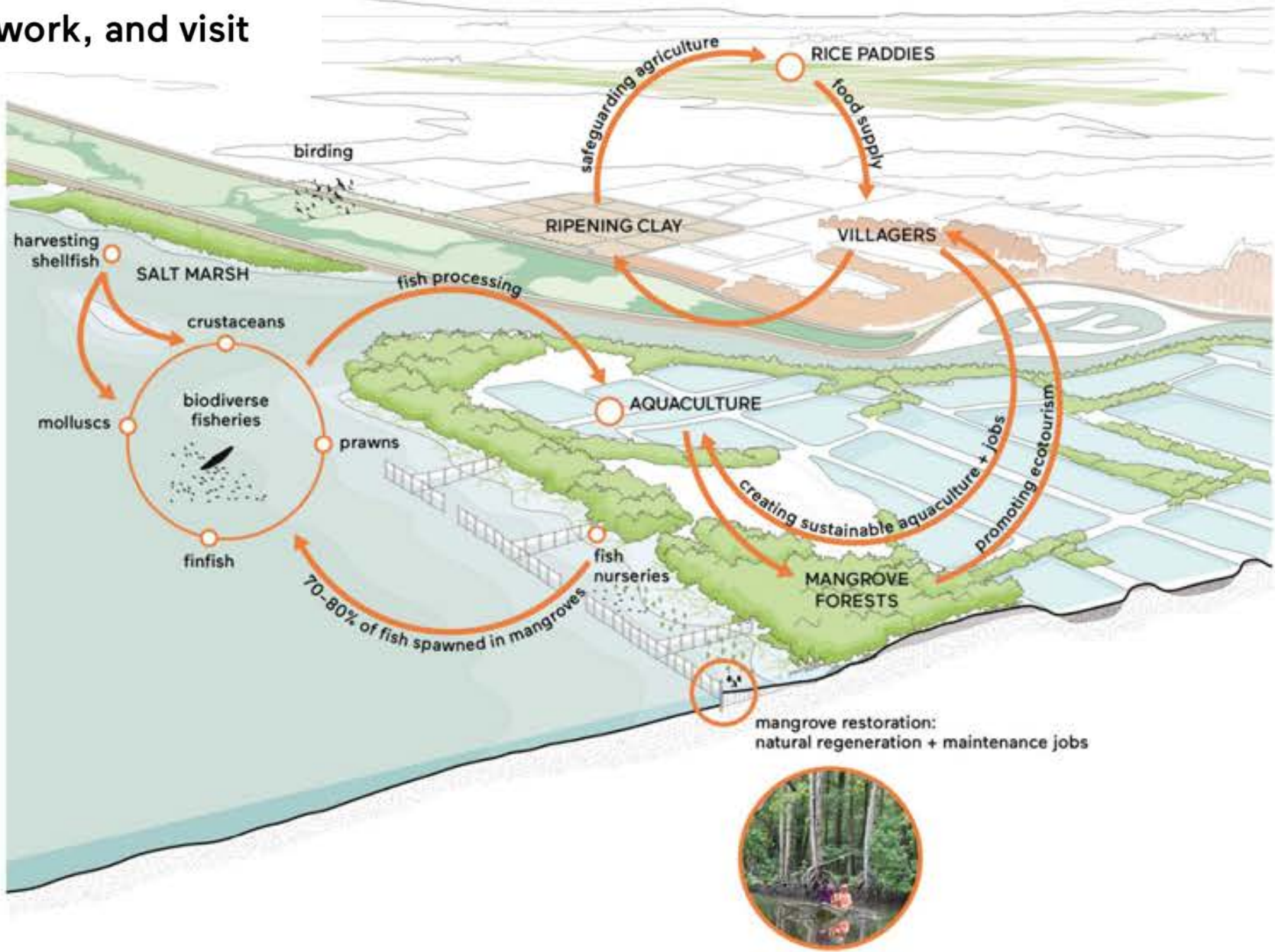


Managing coastal retreat

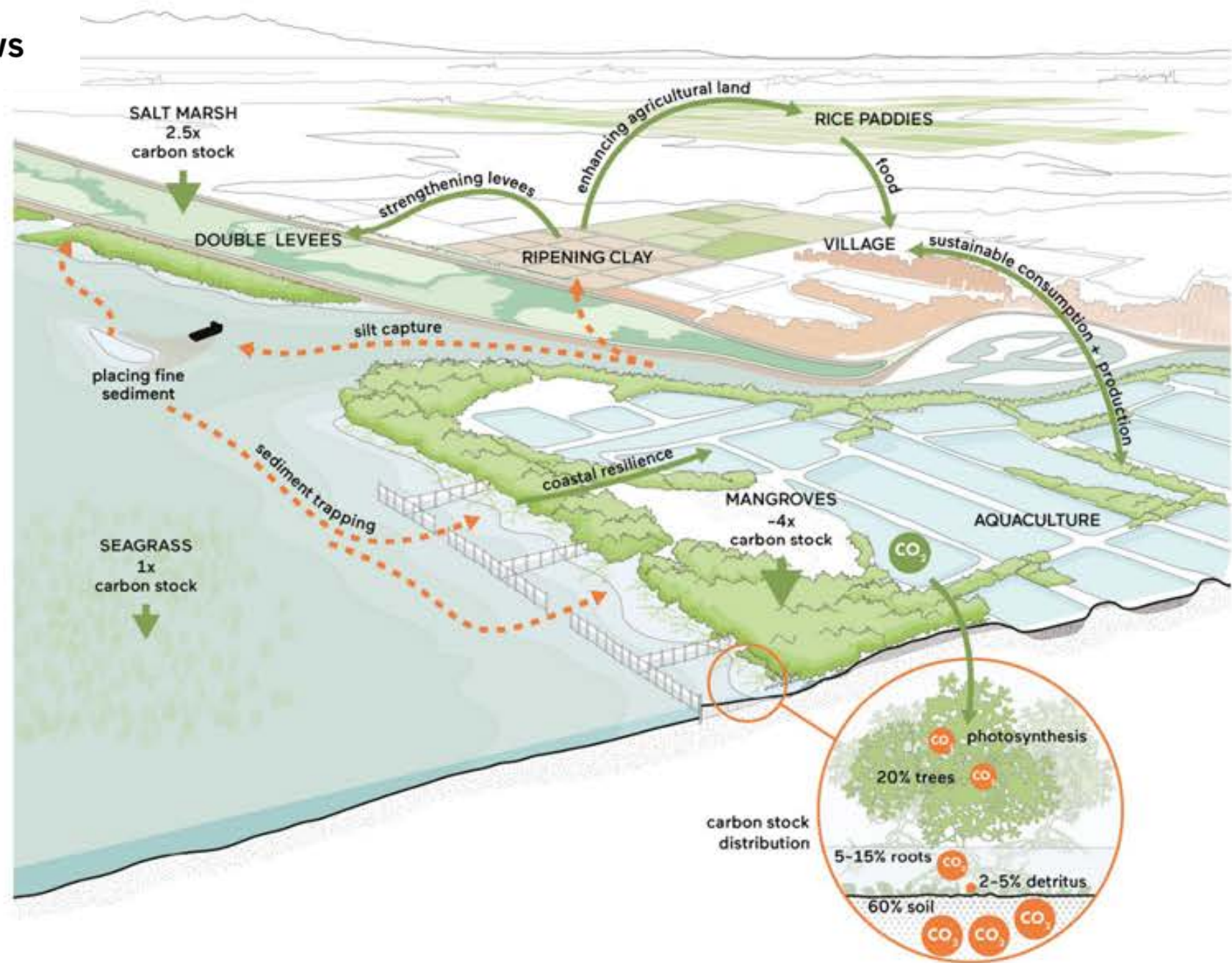
Ecological benefits



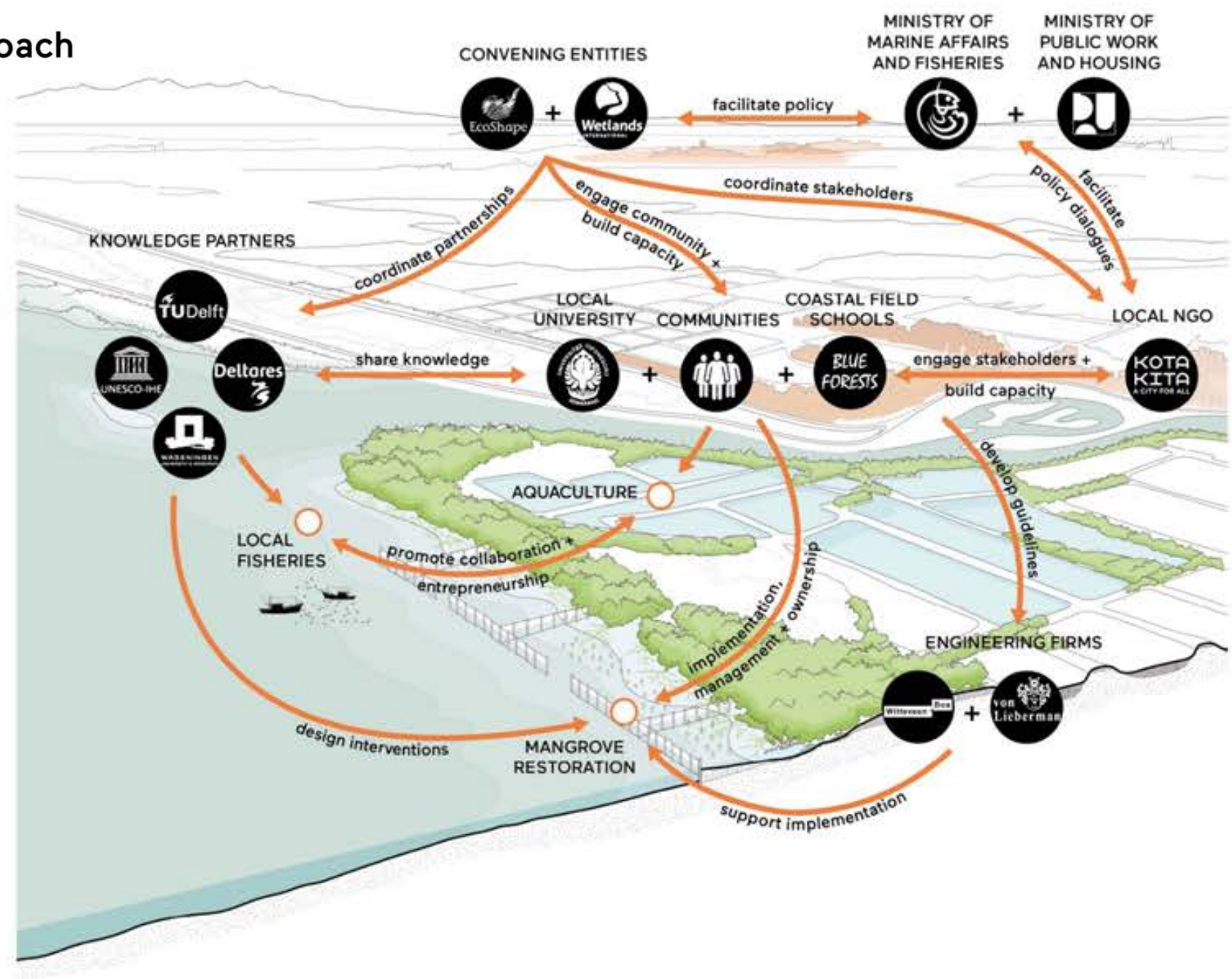
Places to live, work, and visit



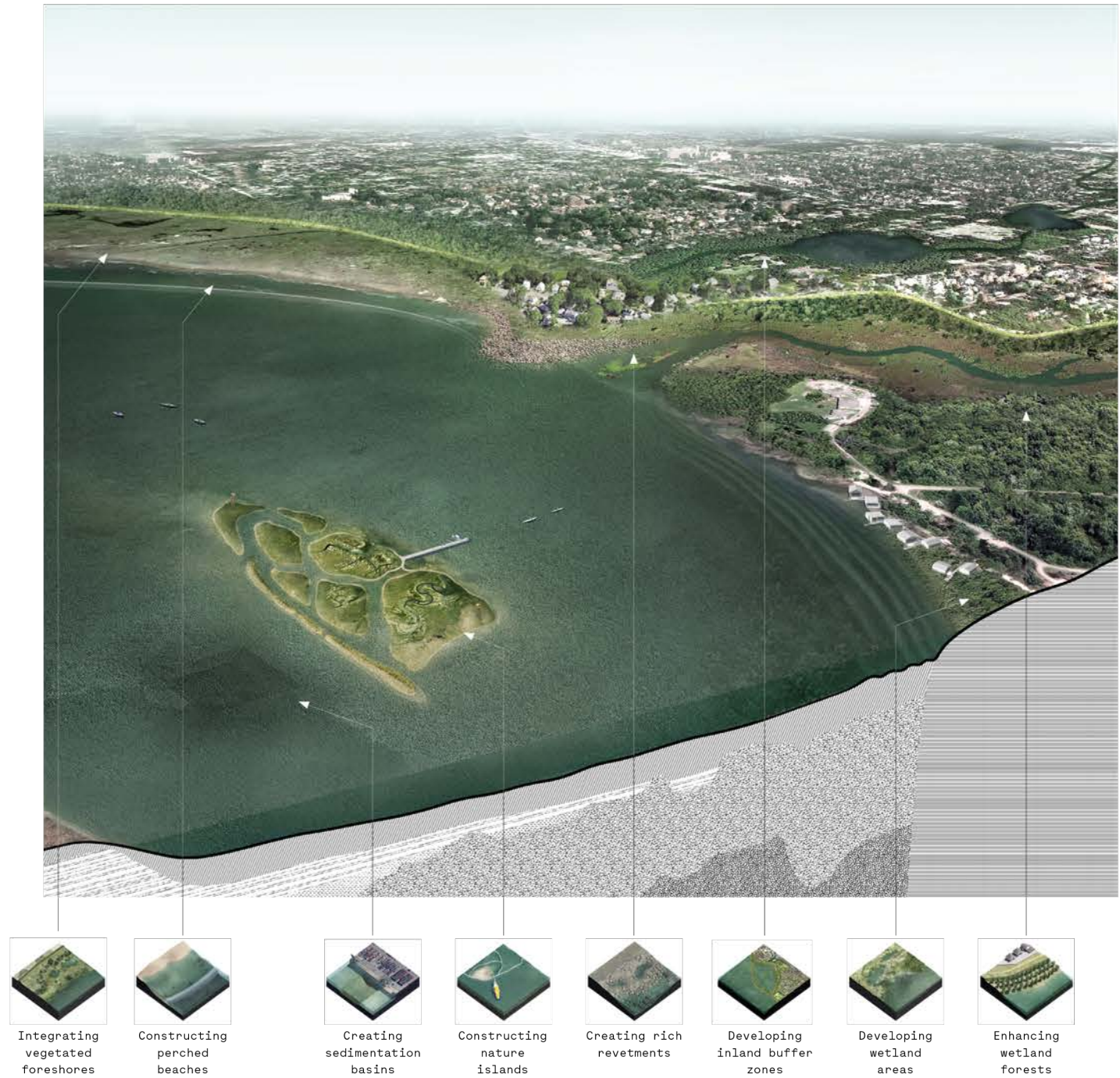
Resource flows



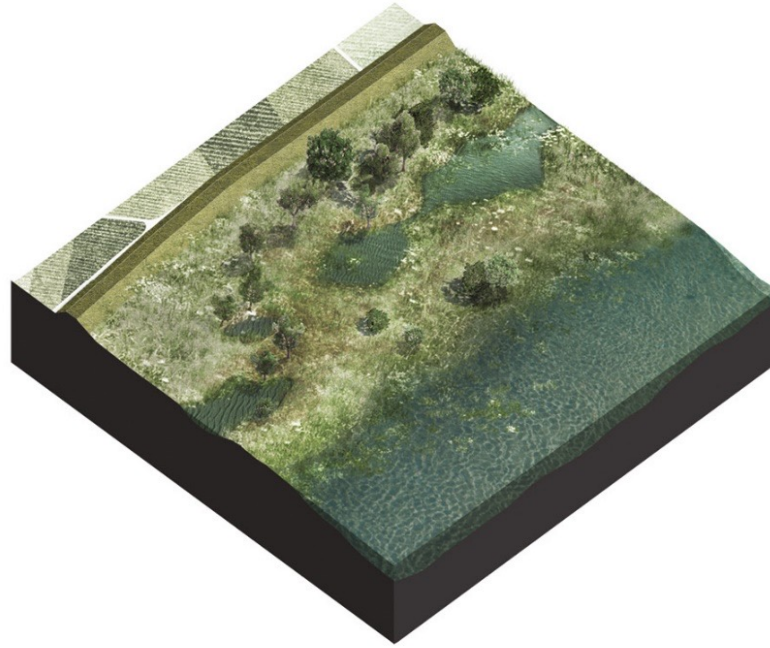
Integrated approach



Lowland Lakes: The landscape



→ Fictional lowland lake landscape depicting
Building with Nature concepts



Houtribdike reinforcement,
Enkhuizen

← Integrating vegetated foreshores

Foreshore environments improve dike resilience and enhance flood defenses by dampening wave forces with their shallow slopes, stabilizing the structure with additional mass, and increasing seepage length. Vegetation on the foreshore further contributes to wave attenuation as well as stabilization and creates a range of distinct vegetation zones that support new habitats and opportunities for recreation. Building vegetated foreshores in lowland lakes often combines development with conservation. During the establishment period, foreshores must be protected from herbivorous birds and seasonal water level fluctuation.

- Houtribdike reinforcement, Enkhuizen
- Oeverdijk, Hoorn

A growing system

Fig. C.9

The stability of an existing dike is judged to be compromised.

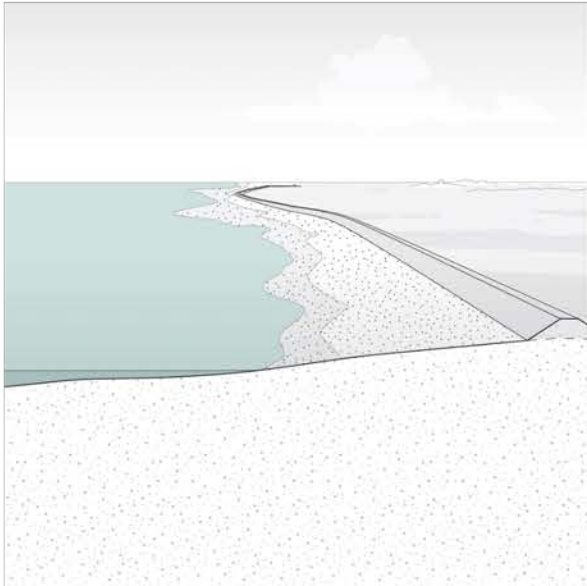


Fig. C.10

A contractor places soil in front of the dike, which adds stability.

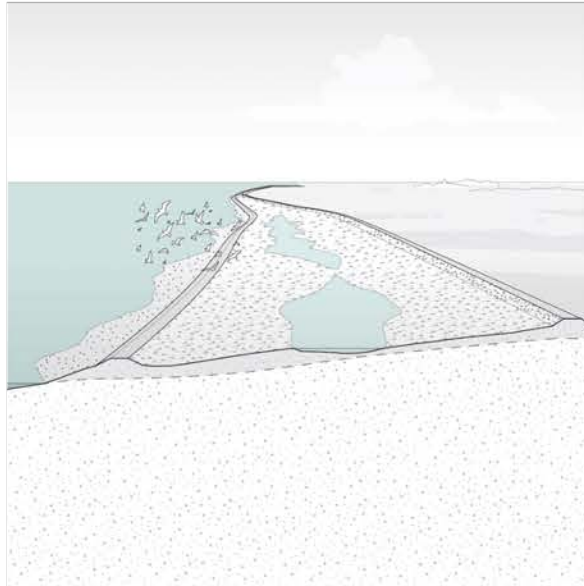
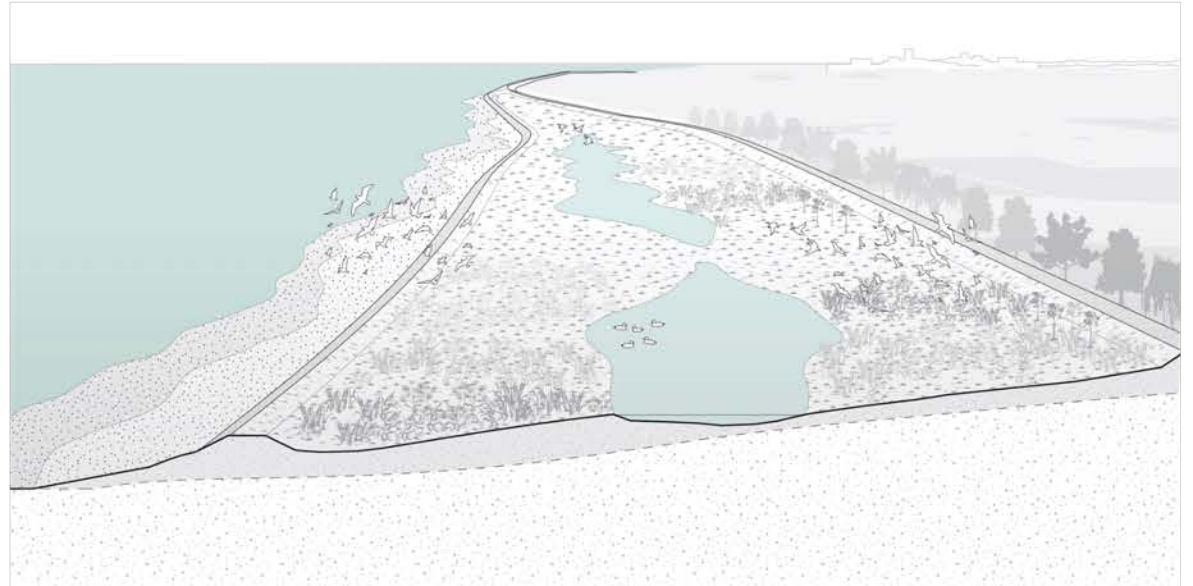


Fig. C.11

The foreshore is planted and habitat opportunities develop.









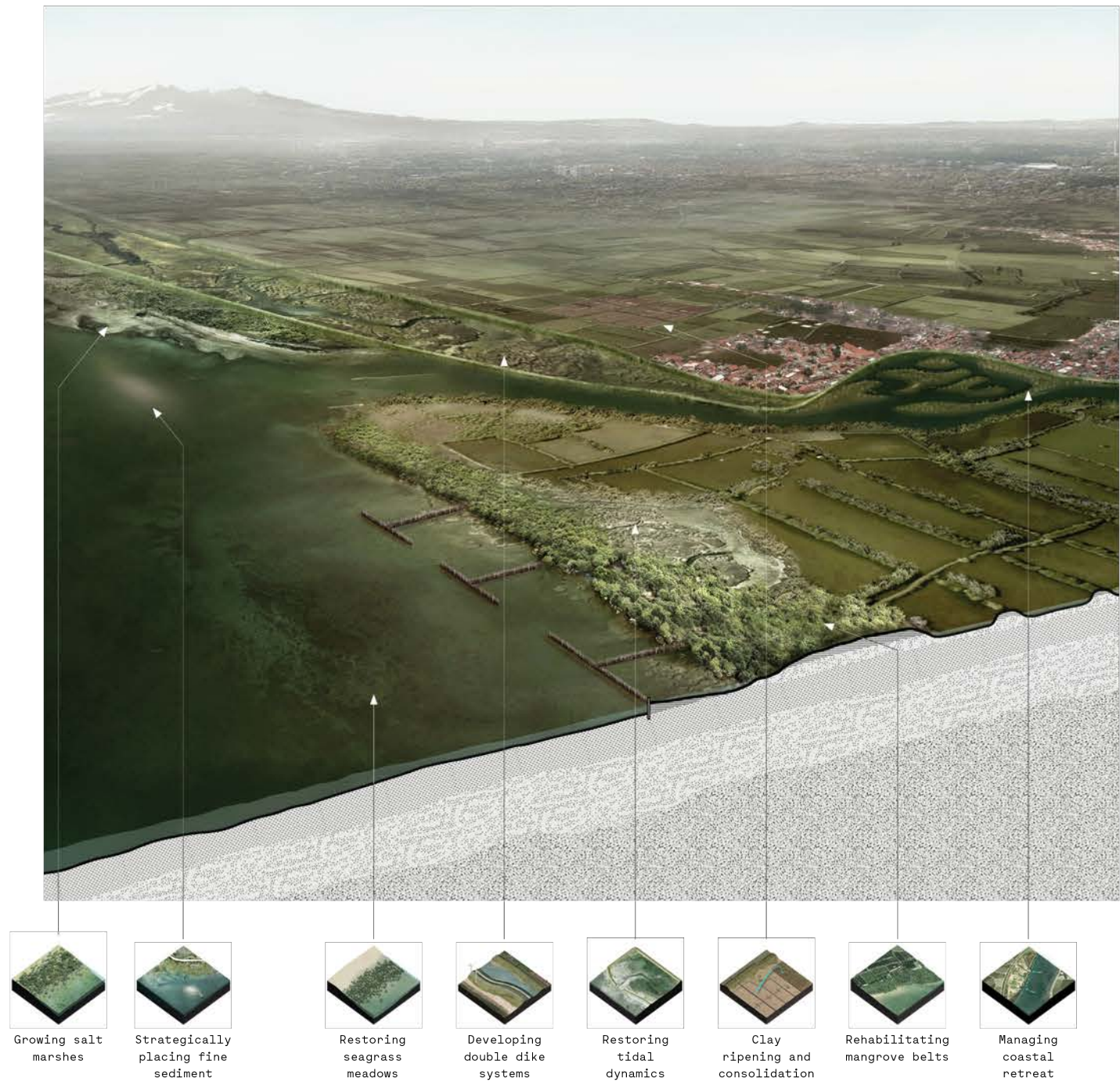


30 April 2021





Muddy Coasts: The landscape



→ Fictional muddy coastal landscape depicting
Building with Nature concepts

→ Rehabilitating mangrove belts

Mangrove belts have dense roots above the soil that capture sediment and dissipate wave energy, creating natural coastal barriers that reduce erosion and limit flooding in inland areas. Rehabilitation projects focus on suitable conditions for sediment accumulation to encourage natural mangrove regeneration, for example, through the use of permeable structures that attenuate waves and trap sediment. At the same time, they seek to create sustainable livelihoods and align economic development with mangrove conservation. Developing wider greenbelts can improve coastal protection, while longer greenbelts best support fisheries. Where space is limited, mangrove development can integrate with dikes or seawalls to achieve coastal protection goals.

- Building with Nature Indonesia, Demak
- T-shape structures, Mekong Delta
- Bamboo fences, Bangkok
- Weg naar Zee, Paramaribo
- Gresik, Java

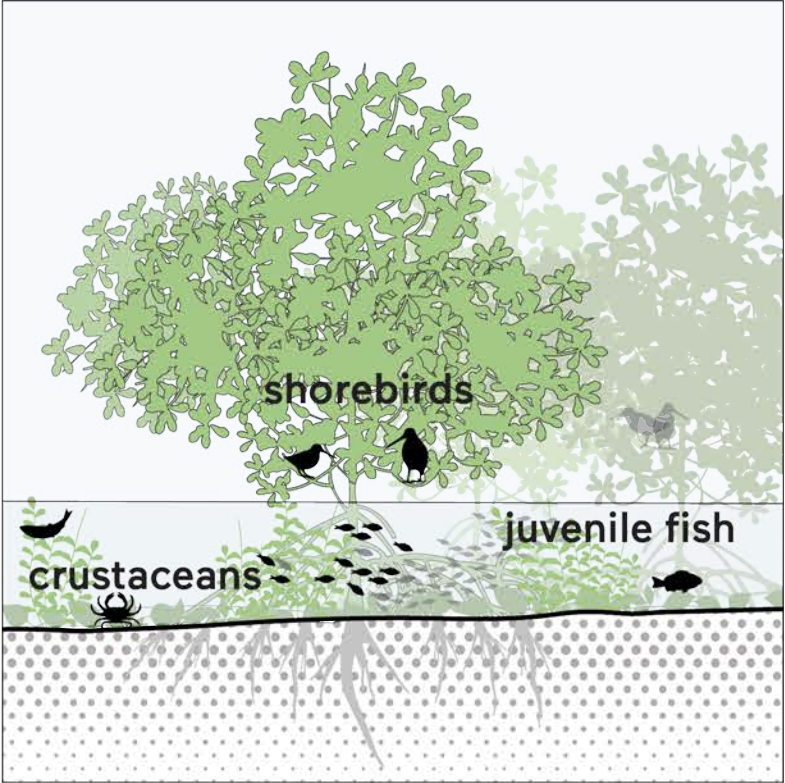
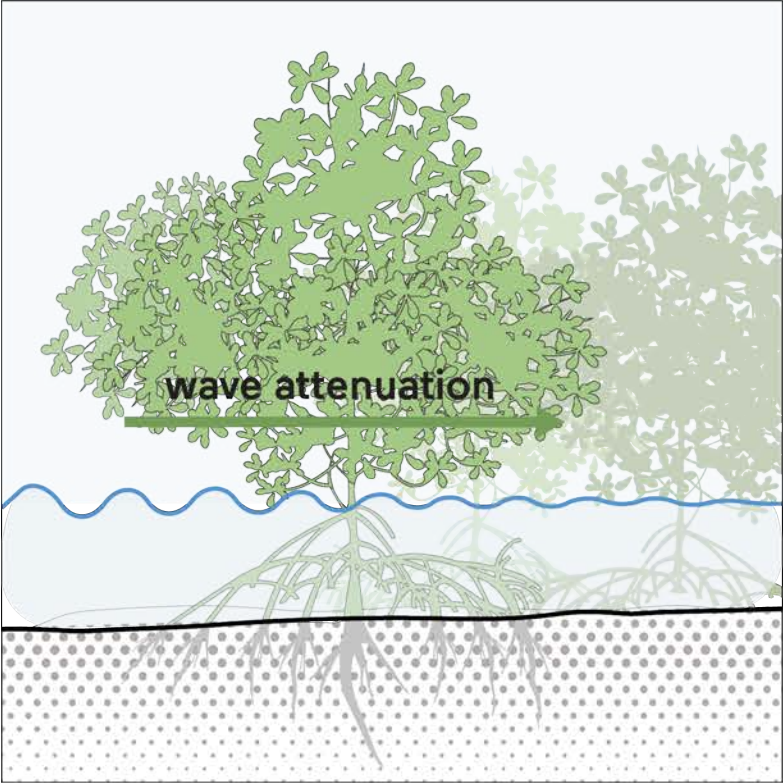
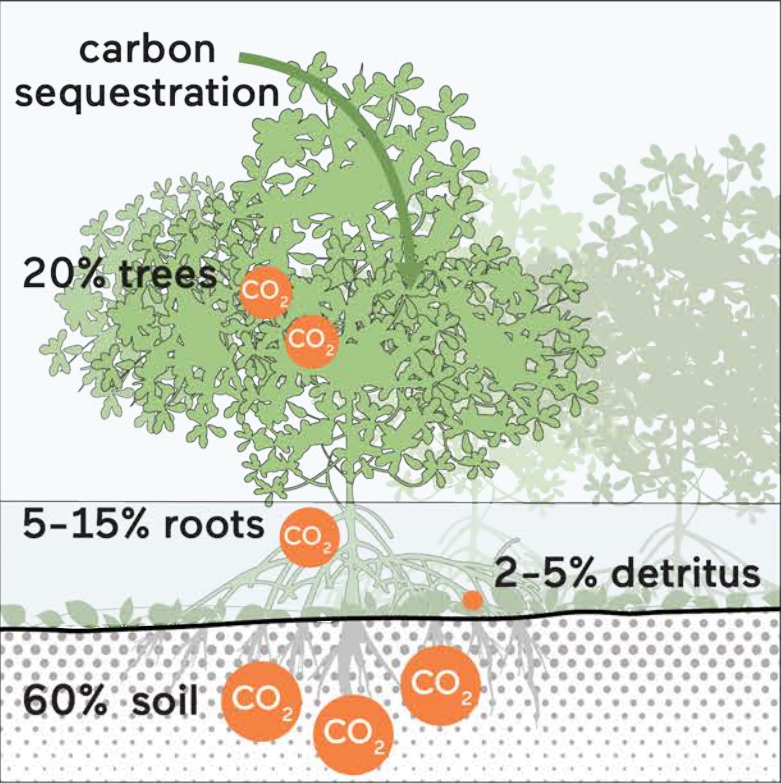


Bogorame-Timbulloko, Demak



Everglades City, Florida

Mangrove benefits



Mangrove benefits





6

"Restoring mangroves is about much more than planting . . . too often, the saplings get washed away. What is crucial is restoring their habitat by encouraging the accumulation of stable sediment. We have proven that permeable structures are capable of restoring coastal ecosystems, and such an approach should be regionally introduced and upscaled."



7



Abdul Muhari
Formerly of the Ministry of Marine Affairs and Fisheries; currently Head of Early Warning, National Disaster Management Authority



Yus Rusila Noor
Program Manager, Building with Nature, Wetlands International Indonesia

"Projects meet local needs while boosting benefits such as fisheries, carbon sequestration, recreation, and biodiversity."



8



9

Building resilient coastlines and communities depends on a multi-stakeholder approach, one that pairs physical intervention with sustainable land uses for inclusive economic growth. Mangroves require stable coastal conditions to repopulate areas that have been deforested. Mangrove greenbelts provide multiple benefits for local economies: coastal protection, nurturing fisheries, and supporting ecotourism.

6

Building permeable structures along the coastline on land that once sustained mangrove belts.

7

Completed permeable structures in Bedono village.

8

Natural mangrove regrowth in Betahwalang village, where a coastal pond was converted using ecological mangrove rehabilitation (EMR).

9

Sediment accumulation commences due to lower waves inside the grid of permeable structures.

Apri Susanto Astra
Coastal Safety Manager, Wetlands International Indonesia



"The implementation of Building with Nature in Indonesia can help manage degraded coastal areas, because the approach pairs environmental restoration and economic improvement of the community. This is one of its strengths."

Cities: The landscape



→ Fictional city landscape depicting Building with Nature concepts



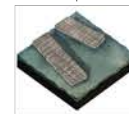
Integrating vegetated foreshores



Restoring connections



Developing inland buffer zones



Building shellfish reefs



Creating hanging and floating structures



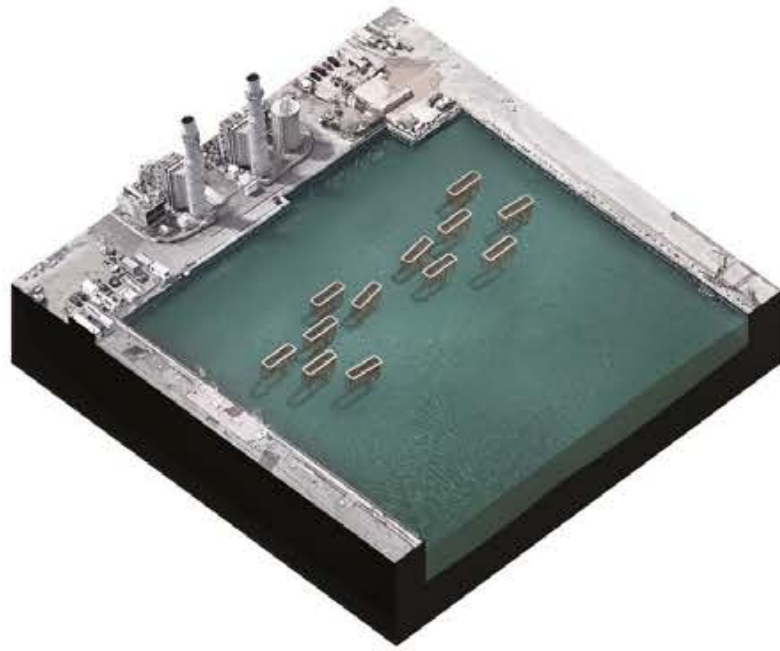
Creating tidal parks



Developing wetland areas



Creating rich revetments



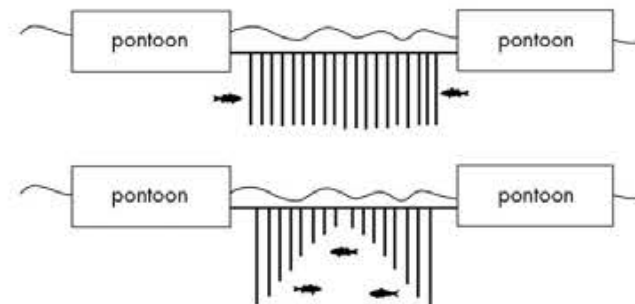
Floating islands, Amsterdam



← Creating hanging and floating structures

Hanging and floating structures add variation to otherwise smooth underwater environments and provide artificial substrates for habitat creation. These installations promote settlement, which enhances the population of filter feeders and provides fish habitat, thereby improving biodiversity. Filter feeders contribute to improved water quality, often a significant motivation for implementation in cities. Two further benefits are new opportunities for recreational fishing and the potential for wave attenuation where structures have grown heavy with marine life.

- Hula pilot project, Port of Rotterdam
- Floating park, Rijnhaven, Rotterdam
- Floating islands, Amsterdam



A growing system

Fig. E.5 Contractor installs the framework with seabed anchors.

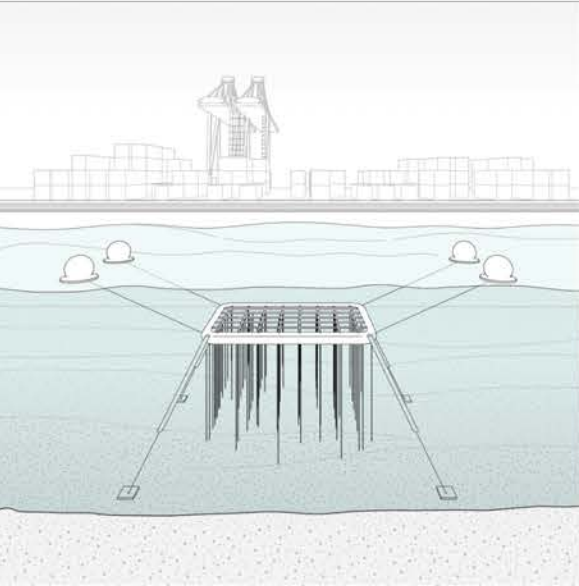


Fig. E.6 Filter feeders begin to settle on the hanging structures.

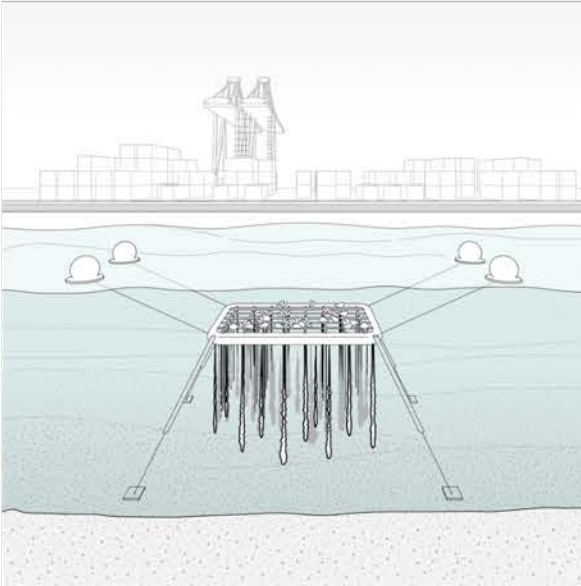


Fig. E.7 Filter feeders grow and propagate, filtering the water.

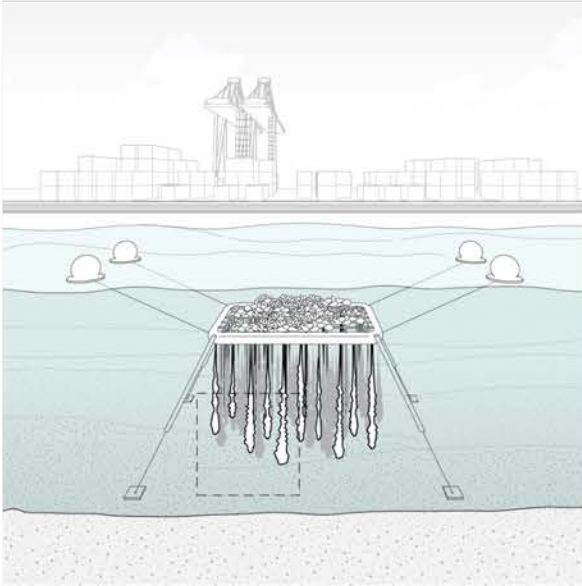
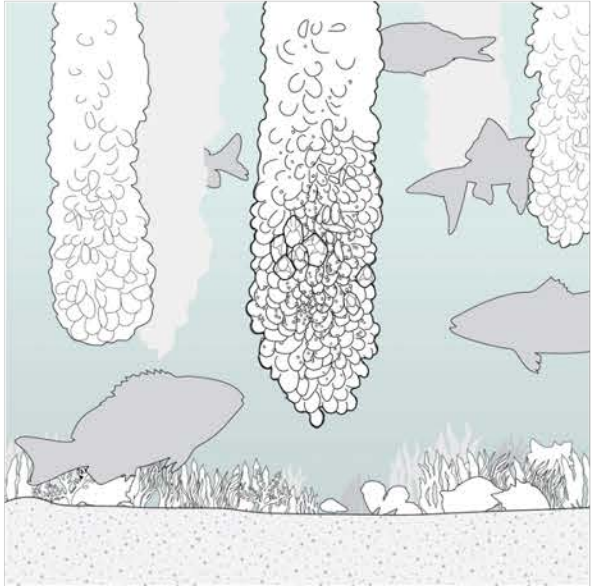


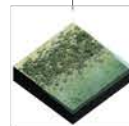
Fig. E.8 The hanging structures create a rich, new habitat for marine life.



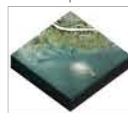
Ports: The landscape



→ Fictional port landscape depicting Building with Nature concepts



Growing salt marshes



Strategically placing fine sediment



Optimizing flow patterns



Creating rich revetments



Constructing sedimentation basins



Building shellfish reefs



Restoring salinity gradients

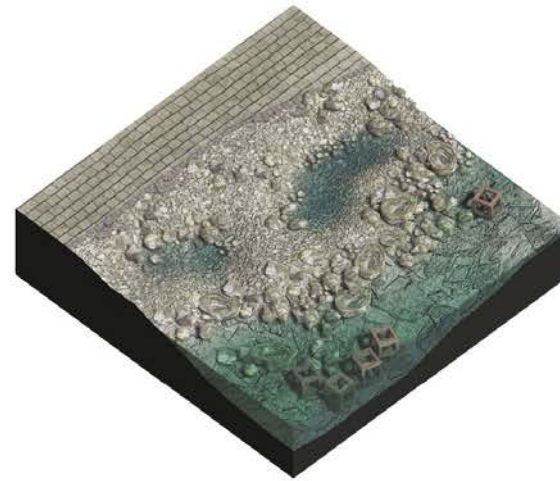


Creating hanging and floating structures

→ Creating rich revetments

Small changes in the texture, form, and material of the hard structures in the intertidal and underwater landscapes can encourage habitat creation and support biodiversity. Even with limited space, rich revetments can enable algae, seagrass, corals, and other organisms to settle and propagate in a food source that attracts shellfish, fish, and birds. Varied concrete surfaces and specialized seawall tiles offer cracks and spaces for protected habitats. Tide pools or “eco-basins” can be constructed at the toe of coastal dikes or estuary edges. At scale, these enhancements and their marine life contribute to improved water quality, serve as an educational tool, and strongly appeal to divers.

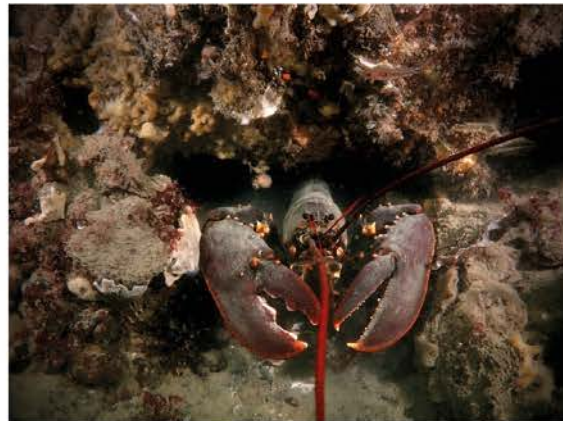
- The Green Gateway, Rotterdam
- Tide pools, Ouwerkerk
- Foreshore strengthening, Zeelandbrug



Tide pools, Ouwerkerk



Eco-reef with lobster





Eco-reefs



Enablers for Building with Nature implementation

Technology and system knowledge



Multi-stakeholder approach



Management, monitoring and maintenance



Institutional embedding



Business case



Capacity building



Getting started

Building with Nature enablers help to frame key considerations at the start of any project and make the development process achievable. Context will determine the particular importance of each enabler in a project or initiative, though all projects benefit from the consideration of all enablers. The following pages detail how enablers supported specific Building with Nature projects. More detailed information on the enablers and other tools is available on EcoShape's online platform.



Institutional embedding

Building with Nature should fit into the local institutional context, following its norms and regulations. Further policies and processes can be developed to support the co-creation, partnerships, and funding schemes necessary for Building with Nature implementation. Key aspects to consider:

- Fitting Building with Nature in the existing context, norms, and regulations
- Creating a policy environment in which conservation laws and formal instruments are addressed
- Connecting with international enablers including the Paris Agreement, Sendai Framework, Aichi Biodiversity Targets, the Convention on Biological Diversity, and resolutions advocated by the Ramsar Convention on Wetlands, the United Nations Convention to Combat Desertification, and the sustainable development goals



Business case

A sound and convincing business case can effectively generate support and financing for Building with Nature applications. A key challenge is the difficulty quantifying the wide range of savings and co-benefits of Building with Nature, due to the soft advantages and performance uncertainty of natural dynamics. Key aspects to consider:

- Defining the optimal business model based on traditional engineering and nature conservation expertise as well as financial knowledge
- Improving estimates of maintenance costs and additional services and benefits (i.e., coastal access, fish production, carbon sequestration)
- Developing financing arrangements and prerequisites (bankable value-creation streams)



Adaptive management, maintenance, and monitoring

Building with Nature designs are dynamic: they develop under changing climatic conditions. This requires an adaptive approach to manage, maintain, and monitor their performance long term.

Key aspects to consider:

- Balancing initial efforts and investments against adaptivity and resilience
- Making maintenance strategies an integral part of the development process
- Planning and techniques for adaptive management and monitoring to deal with natural dynamics along various time and spatial scales



Multi-stakeholder approach

Building with Nature can rarely be implemented by a single party. Successful projects require stakeholder engagement from the start and through all the phases of design, implementation, operation, and ongoing maintenance. Key aspects to consider:

- Cooperation between stakeholders and integral, multifunctional approaches
- Coalition building, co-creation, and public participatory approaches to align ambitions
- Stakeholder assessment and engagement



Technology and system knowledge

Building with Nature requires knowledge of specific concepts and technology to design Nature-based Solutions. In addition, knowledge of the local ecosystem, social system, and physical system is essential for any Building with Nature project to work.

Key aspects to consider:

- Large-scale system analysis, comprehension of driving processes (physical and ecological), and natural dynamics
- Building with Nature concepts that fit different landscapes
- Building with Nature design approaches and assessment tools



Capacity building

Capacity building among policy makers, industry managers, and the local community is essential. It takes place through education, training, and knowledge sharing.

People familiar with the Building with Nature philosophy are more likely to support and participate in its applications, which is a benefit to scaling up and especially critical for the maintenance of Nature-based Solutions. Key aspects to consider:

- Increasing awareness of the philosophy and potential of Building with Nature
- Educating emerging practitioners on Building with Nature through training programs
- Creating Building with Nature communities around your project



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Building with Nature Asia



Building with Nature in Demak



Mixed mangroves aquaculture practice

Semi-permeable fences

Sediment transportation by rivers

Elevated road

Retention areas



Demak, Indonesia



Implementation of 15 landscape scale projects started by multi-sectoral consortia

Demak, Indonesia



INDONESIA

Cimanuk River

Seimasong

Kali Welang
Lombok

Bima





Bohai Sea



CHINA

INDIA

East Kolkata Wetland



North Coast of Manila Bay

PHILIPPINES

MALAYSIA

Setiu Lagoon



INDONESIA

Demak, Indonesia



Cimanuk River

Seimasong

Kali Welang

Lombok

Bima





Kalindi Kunj/Delhi

INDIA

East Kolkata Wetland

Odisha Coast

Ashtamudi Lake

MALAYSIA

Teluk Tempoyak

Seliu Lagoon

SG.H/Dorani

Klang River Delta

Basir Panjang

INDONESIA

Demak, Indonesia

Cimanuk River

Seimasong

Kali Welang

Lombok

Bima

CHINA

Chongqing

Bohai Sea

Yangtze Delta

Central Coast

Pearl River Delta

Hainan

North Coast of Manila Bay

PHILIPPINES

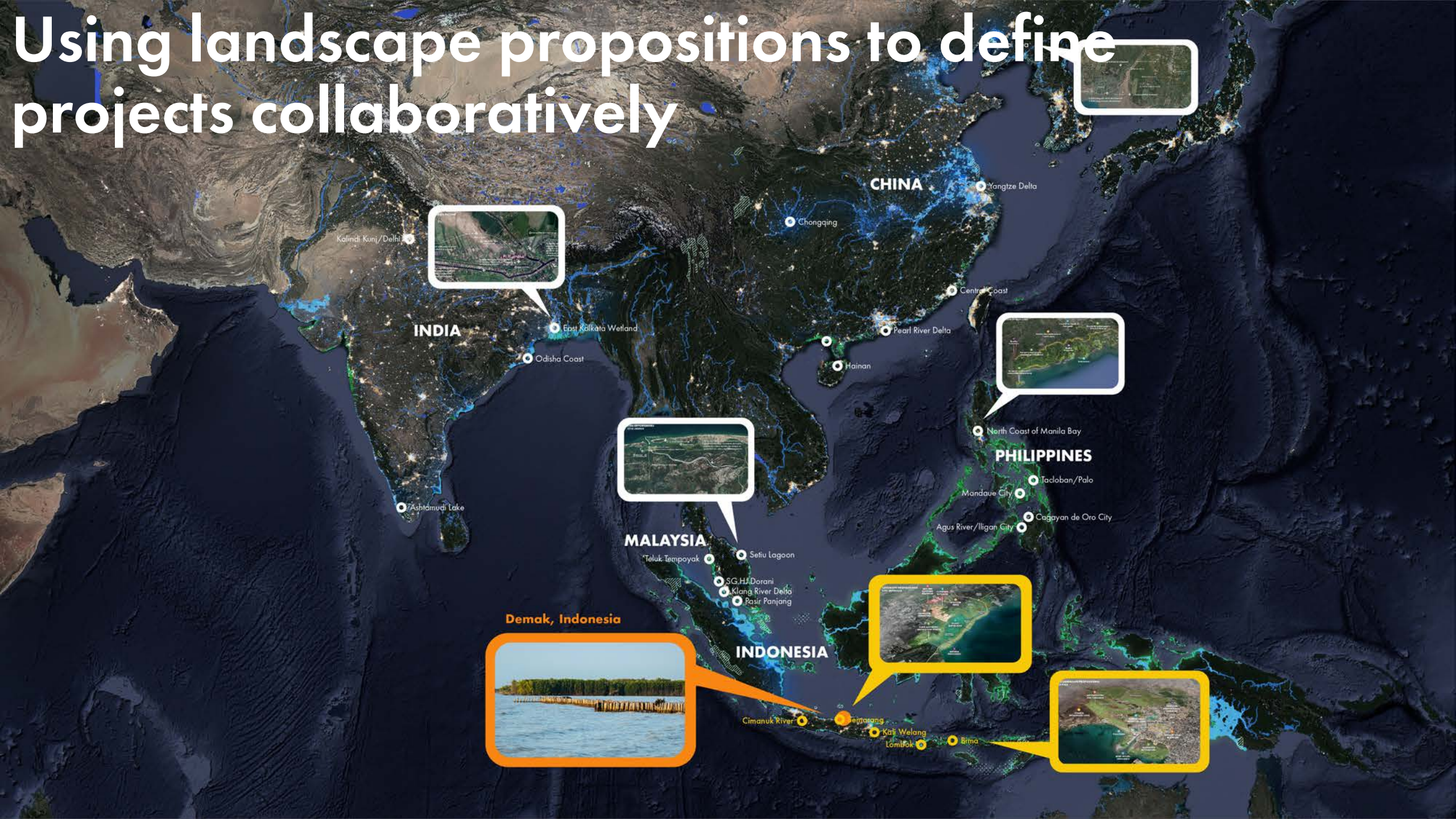
Tadloban/Palo

Mandaue City

Agus River/Iligan City

Cagayan de Oro City

Using landscape propositions to define projects collaboratively



Development of a regional platform



KNOWLEDGE AND
CAPACITY BUILDING



POLICY AND
FINANCING



AWARENESS
AND BUY-IN





Thank you!

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