Building with Nature in Indonesia

Restoring an eroding coastline and inspiring action at scale

2015 - 2021



February 2022

AUTHORS
Femke Tonneijck (Wetlands International)
Fokko van der Goot *(EcoShape)*
Fred Pearce *(consulting editor)*

REVIEWERS
Fegi Nurhabni *(Indonesian Ministry of Marine Affairs and Fisheries)*, Leo Sembiring *(Indonesian Ministry of Public Works and Housing)*, Jane Madgwick and Apri Susanto *(Wetlands International)*, Henk Nieboer *(EcoShape)*, Amrit Cado van der Lelij *(Deltares)*, Tom Wilms and Joost Noordermeer *(Witteveen+Bos)*, Yusran Nurdin Massa *(Blue Forests)*, Roel Bosma and Dolfi Debrot (Wageningen University & Research) and Sri Rejeki *(University of Diponegoro)*

COORDINATION
Susanna Tol *(Wetlands International)*

DESIGN
Tappan

SUGGESTED REFERENCE
Tonneijck, F., Van der Goot, F., Pearce, F. Building with Nature in Indonesia. Restoring an eroding coastline and inspiring action at scale. Wetlands International and Ecoshape Foundation. February 2022

ACKNOWLEDGEMENTS & CREDITS
Programme leads: The Indonesian Ministry of Marine Affairs and Fisheries, the Indonesian Ministry of Public Works and Housing, Wetlands International, and EcoShape

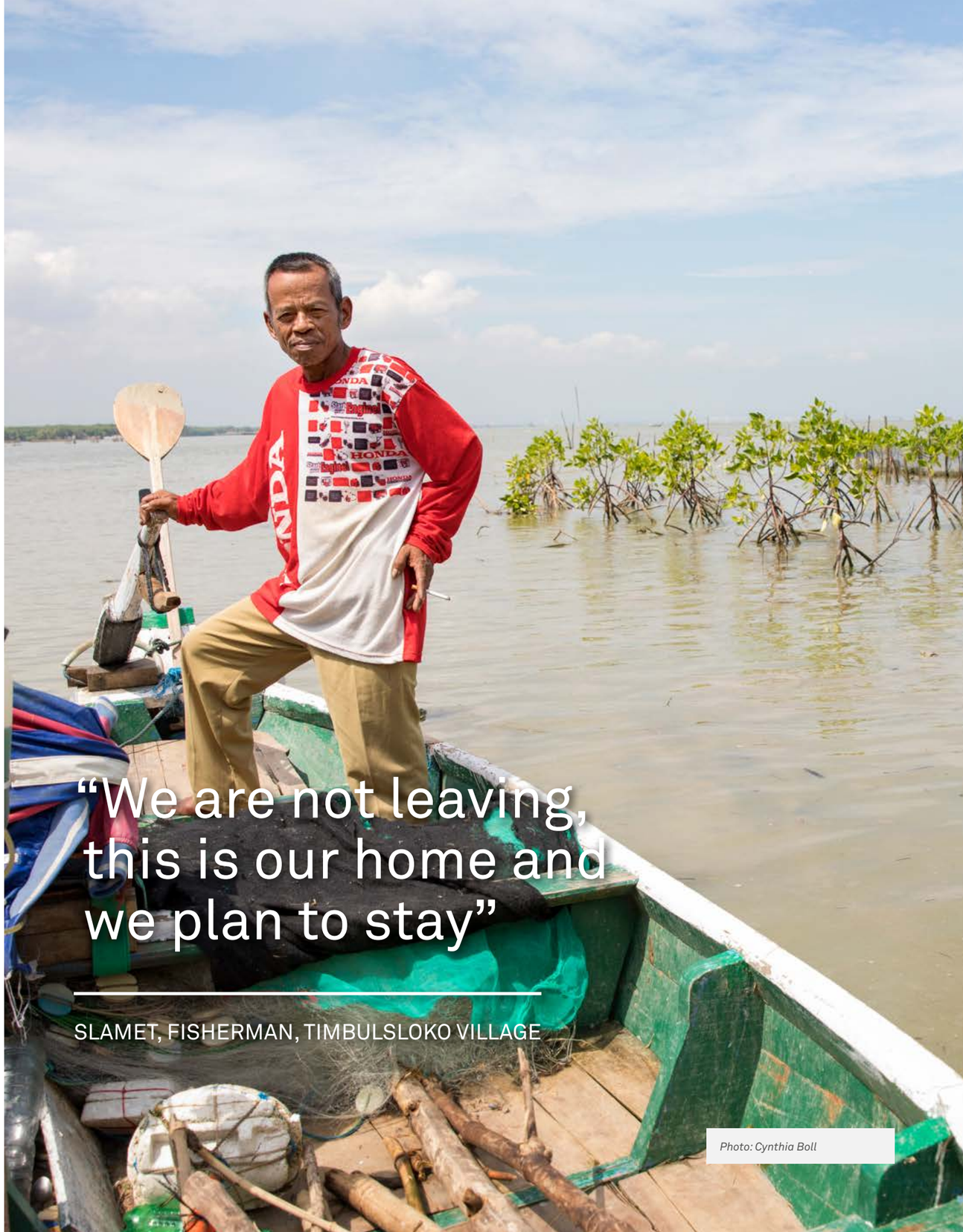
Implementation partners: Witteveen+Bos, Deltares, Wageningen University & Research, UNESCO-IHE, Blue Forests, TU Delft, Kota Kita and Von Lieberman, with support from the Diponegoro University, local communities and local authorities.

"Building with Nature Indonesia" was supported by the Dutch Sustainable Water Fund, a programme of the Netherlands Enterprise Agency on behalf of the Dutch Ministry of Foreign Affairs, the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety as part of the International Climate Initiative (IKI), the Dutch Postcode Lottery, Partners for Resilience, the Waterloo Foundation, the Otter Foundation, Topconsortia for Knowledge and Innovation, Mangroves for the Future and with contributions by all partners.

Partners in the Building with Nature Indonesia initiative are committed to inspire a paradigm shift from Building in Nature to Building with Nature, by demonstrating the approach on the ground in Demak. Successful implementation of the Building with Nature approach requires in-depth system understanding, extensive stakeholder engagement, and adaptive management on the basis of monitoring and evaluation. We stimulate and support upscaling of the approach by disseminating knowledge, lessons learned and implementation guidance.

COVER PHOTO
Local community building permeable structures
Nanang Sujana

BACKCOVER PHOTO
BINTORO Forum, Kuswantoro, Wetlands International



Foreword

Indonesia has become a pioneer in embracing Building with Nature, an approach to infrastructure and environmental management that aims to work with the forces of nature, rather than opposing them. This publication summarises the insights and lessons from a landscape scale implementation of the Building with Nature approach between 2015 and 2021 in Demak. Demak is a coastal district in Central Java province that has been plagued by erosion, flooding and devastating land loss that in places has extended for several kilometres inland. The Building with Nature approach was undertaken by a unique public private partnership under the leadership of the Indonesian government, Wetlands International and Ecoshape after the construction of “hard” infrastructure such as sea walls and the planting of mangroves failed to stop the loss of land. This publication gives a voice to the many different partners involved.

Beginning at Timbulsloko, a village that in recent years could only be reached along a five-kilometre causeway through flooded fields, we sought to encourage the natural regeneration of mangroves along 20 kilometres of coastline while simultaneously revitalising aquaculture. This involved techniques such as trapping mud behind temporary permeable structures to stabilise the coastline and allow mangroves to seed and grow and the introduction of environmentally friendly aquaculture practices.

Besides engineering interventions, we engaged deeply with local communities, government agencies and knowledge institutes to address the root causes of coastal breakdown and deliver multiple benefits to coastal communities. Beyond landscape restoration, we have supported upscaling elsewhere in Indonesia through training, knowledge exchange, institutional embedding and stimulating multi-disciplinary and multi-sectoral collaboration. The ecological, social and economic success of our efforts leads us to believe that the same approach can be mainstreamed on many other coastlines with similar problems, and in other types of landscapes.

Building with Nature solutions offer a resilient alternative, or complement, to conventional hard water infrastructure in reducing the risks of disasters and adapting to climate change. These solutions can deliver water infrastructure to protect coasts, deltas, rivers and lakes under rapidly changing conditions, while benefiting both nature, society and the economy. In particular, these solutions can meet the need to repair and protect landscapes that are wide open to erosion and flooding through lacking protective vegetation. Such naturally deprived landscapes can no longer protect our cities, infrastructure and other built assets, and they often fail to deliver food and other vital services derived from nature and to support biodiversity.

The knowledge, approaches and mechanisms used and lessons learned in Demak can support sound replication along the entire northern coast of Java, where millions of people are facing the loss of productive land. Beyond that, we hope that our work inspires and helps enable the recovery of mangroves to protect communities and enhance local livelihoods for other Indonesian islands and for coastlines more widely in South and East Asia and globally.



Fegi Nurhabni
Ministry of Marine Affairs and Fisheries, government partner



Leo Sembiring
Ministry of Public Works and Housing, government partner



Femke Tonneijck
Wetlands International, managing partner



Fokko van der Goot
Ecoshape, co-managing partner

Photo: Cynthia Boll

Contents

Foreword 5

Summary of impact 8

Introduction 9

Building with Nature in Demak 10

1. The problem and way forward 11
2. Mangroves for coastal safety 18
2.1 Permeable structures 18
2.2 Converting ponds to grow mangroves 25
3. Boosting community prosperity 29
3.1 Coastal field schools 29
3.2 Associated mangrove aquaculture 34
3.3 Bio-rights and alternative livelihoods 38
4. Social costs and benefits 48
5. Adaptive management 52
6. Enabling environment 56

Upscaling in Indonesia and wider Asia 60

7. Landscape propositions 62
8. Capacity building and training 70
9. Building with Nature Asia 75

From a small project to landscape scale implementation 78

10. Timeline 80
11. Partnerships 85

Guidance and publications 88

Berkah Alam community group from Surodadi Village on their way to monitor permeable structures.
Photo: Netherlands Enterprise Agency on behalf of the Dutch Ministry of Foreign Affairs

Summary of impact

Inspirational returns:
People that previously lost all hope, suffering from flooding and land loss, were empowered to build a better future. Engineers were inspired to embrace nature and communities as strong allies in coastal rehabilitation. Our solutions inspired uptake by the government across Indonesia and our joint work is being used as a lighthouse example globally.

Natural returns:
Restored mangroves along coasts and rivers that attenuate waves and hold sediment in place, thus helping to counterbalance and delay subsidence and land loss. Fish and bird populations and diversity have increased upon mangrove recovery.

Social returns:
Building with Nature measures enhanced the resilience of coastal communities. The social cohesion within and among coastal villages in Demak increased and villagers established a Community Ocean Forum (BINTORO). Coastal Field Schools boosted the capacity and confidence of farmers. The community voices are now heard in policy dialogues, where they seek support for their mitigation and adaptation measures.

Financial returns:
Best practices as introduced by Coastal Field Schools boosted aquaculture productivity and income. Mangrove recovery enhanced fisheries and increased wild catch. Alternative livelihoods were developed to adapt to the changing environment, including eco-tourism and non-timber products.

The 4 Returns Framework for Landscape Restoration 2021-2030, Commonland, Landscape Finance Lab and Wetlands International

9 (inter) national policies and plans and 9 village development plans enabled our solutions

119 ha dedicated to mangrove restoration and an additional 60 ha of mangrove better protected

20 km of coastline under restoration

23 km of semi-permeable structures mainstreamed by the Indonesian government throughout Indonesia

10.000 people benefiting, (70 000 if subsidence can be halted)

3x increase in farmers income from aquaculture

66 water bird species rely on the restored and protected mangroves

2 prestigious awards in recognition of our success

6 spin-off projects

464 hectares of ponds using best aquaculture practices resilience measures

2 government partners
1 innovation network
5 research organisations
3 private sector partners
3 non-for profit organisations
260 community members

Introduction

Decision makers around the world face the challenge of protecting coastlines in ways that enhance the natural environment and increase the resilience of natural systems and human activities to climate change. Building with Nature is a design philosophy that attempts to accomplish this by integrating the services that nature provides into water and marine engineering practice. It offers an alternative to conventional “hard” infrastructure. Instead of fighting nature with seawalls and embankments, Building with Nature works with nature. For example, by encouraging rivers and sea currents to reinforce the coastline with sediment, and by restoring ecosystems such as mangroves so that they once more provide natural protection against extreme events.

Building with Nature is a no-regret approach to problem solving. It prioritises adaptive management and incremental development to allow flexibility in the facing of changing conditions. Its projects are often less expensive than hard solutions, especially in the long run. And by securing natural capital, they also achieve environmental co-benefits such as carbon storage, biodiversity conservation and improved food security and development of livelihoods such as wild fishing, timber harvesting and recreational activities.

The Building with Nature approach was initiated in 2008 by EcoShape, a consortium involving the Dutch government, private-sector engineering consultancies and contractors, universities, knowledge institutes and NGOs. It believes in “learning by doing”, and has developed a broad expertise in the design and implementation of innovative solutions to flooding and other problems. It has identified six “enablers” characteristic of Building with Nature projects (see figure 1).

Ecoshape partners have developed several full-scale marine infrastructure projects that boost nature, society and economy. The Indonesia programme in Demak, Central Java, managed with Consortium partner Wetlands International and the Indonesian government, is one of the flagship projects that has contributed significantly to each of the six enablers, providing valuable lessons for replication and upscaling. In this publication we look back at the highlights, challenges and lessons of more than five years’ work in Demak and the mainstreaming that has already taken place elsewhere in Indonesia, to assess ingredients for success. We see this as the start of a potentially global programme to maximise community and ecosystem resilience to climate change.

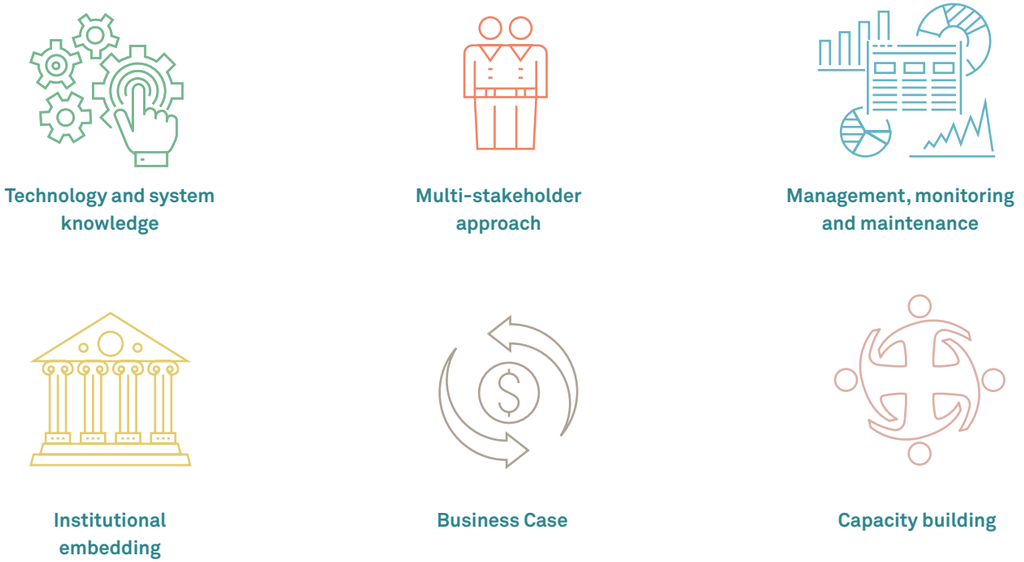


Figure 1: Six enablers that address the unique characteristics of Building with Nature projects, EcoShape

Building with Nature in Demak

Restoring an eroding coastline

1. The problem and way forward

Indonesia's muddy shorelines have recently suffered from severe erosion and flooding, caused in part by the removal of a protective belt of mangroves and their replacement by ponds for aquaculture. Other factors are subsidence due to excessive groundwater extraction, river engineering that deprives coastlines of riverine mud, and ill-judged hard infrastructure such as sea walls that disrupt the sediment and water flows that previously maintained shorelines. To make matters worse, climate change is raising sea levels and increasing the frequency and intensity of storm surges. As a result, more than 30 million people in Java alone are currently at risk of flooding and salt water invading their fields.

In Demak district, Northern Java, the coast has already retreated in places by several kilometres, consuming rice fields and more than 500 hectares of aquaculture ponds. Both agriculture and aquaculture have suffered production losses worth many billions of Euros. Invading waters have also drowned several villages and left others surrounded by water and connected to the mainland by raised causeways. The construction of sea walls has proved both ineffective and expensive. Furthermore, such hard engineering failed to bring back the economic, environmental and social benefits that healthy mangrove coastlines once offered.

Altogether some 70,000 people and 6,000 hectares of aquaculture ponds in Demak are exposed to future invasions by the sea. A Deltares' modelling report states that based on a 10 year forecast scenario without measures the high subsidence rates will result in rapid loss of coastal areas [29]. Faced with this ongoing crisis, local authorities, communities and other stakeholders sought a new approach. We argued that Building with Nature could help.

From 2015 to 2020, we worked with local communities to design and implement solutions to land loss by stimulating the return of mangroves, while at the same time revitalising aquaculture, and other livelihoods. One novel technology has been the placement of mud-trapping semi-permeable structures to stabilise the coastline by local communities. Another innovation has been the use of an incentives system known as Bio-rights to encourage local communities to adopt more sustainable livelihoods, including forms of aquaculture that preserve and restore the mangroves. In such ways, we aim to align economic development with care for the environment.

Many of these ideas were developed jointly with local and national stakeholders during a series of workshops during the project's inception phase in 2015. We are now using these experiences to share lessons, develop technical guidelines, build local capacity, ignite policy dialogues and connect multiple actors, to help solve landscape problems in other settings.

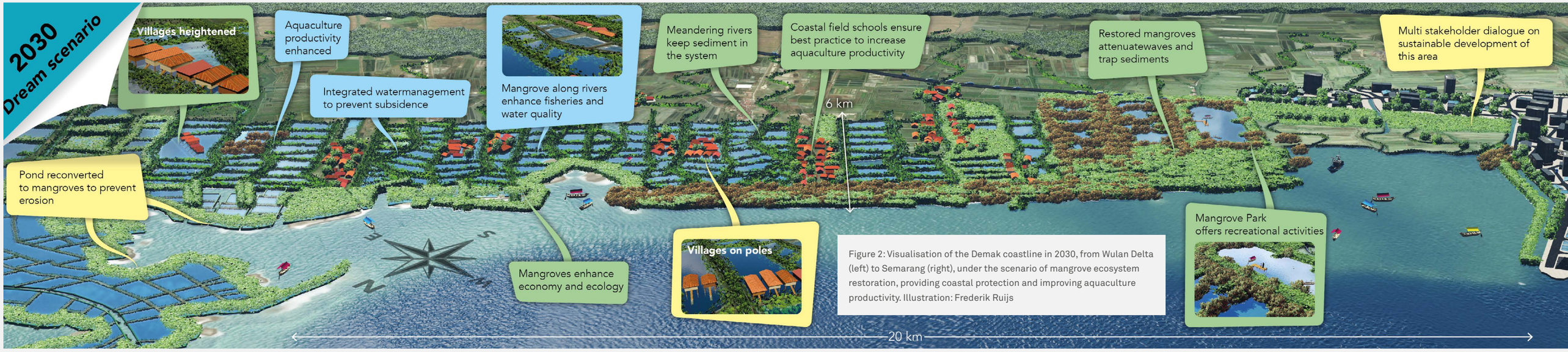


Figure 2: Visualisation of the Demak coastline in 2030, from Wulan Delta (left) to Semarang (right), under the scenario of mangrove ecosystem restoration, providing coastal protection and improving aquaculture productivity. Illustration: Frederik Ruijs

Resources

→ 1. Wilms, T., Van der Goot, F., Tonneijck, F., Nurhabni, F., Sembiring, L. Building with Nature Approach; Building with Nature to restore eroding tropical muddy coasts. Wetlands International and Ecoshape. 2021

→ 2. Van Wesenbeeck, B.K., Van Rees, F.F., Tonneijck, F., Cronin, K., Winterwerp, H. System Understanding; Building with Nature to restore eroding tropical muddy coasts. Wetlands International and Ecoshape. 2021

→ 22. Smits, B., De Lucas Pardo, M., Van Wesenbeeck, B. Effectiveness of ecosystem-based adaptation measures subject to sea level rise and land subsidence. Modelling report of 'Ecosystem-based Adaptation at Scale Through Building with Nature Towards Resilient Coasts in Indonesia' project in Demak. Deltares. 2020

→ 26. Tonneijck, F., Winterwerp, H., Van Wesenbeeck, B., Bosma, R., Debrot, D., Rusila Noor, Y., Wilms, T. 2015. Building with Nature Indonesia Securing Eroding Delta Coastlines: Design and Engineering Plan. Ecoshape Foundation, Dordrecht, The Netherlands. 65 pp. 2015

→ 42. Building with Nature approach: www.ecoshape.org

Permeable structures with natural mangrove regrowth in front of Demak coast. *Photo: Witteveen+Bos*

“Over 30 million people in Java are at risk. Conventional interventions weren’t successful. So we created a coalition that would harness nature and the community to heal and restore our environment.”

FEGI NURHABNI, MINISTRY OF MARINE AFFAIRS AND FISHERIES

Flooding over sea wall. *Photo: Stephan Verschure*



Lady in front of her flooded house. *Photo: Nanang Sujana*



Bregje van Wesenbeeck

Deltares

The secret to protecting a long coastline from being eaten away by the waves is to understand the processes that sustain it – and the threats posed to those processes by human activities, says Bregje van Wesenbeeck of Deltares.

Q: What are the processes and problems on the Demak coastline that are causing its rapid erosion?

A: The low-lying coast is made up of fine sediment: mud. It is maintained by mud brought to the coastline by waves and rivers, but also eroded by the waves, tides and ocean currents, which are constantly moving mud around along the coast. There has been a balance between gains and losses to the coastal system. But in recent years that balance has shifted strongly towards loss. More mud is being removed than is being replaced.

There are three reasons for this. All are about how we use the land there. One is river management. Dams and embankments upstream on the rivers hold back mud and prevent it from reaching the coast. A second is the removal of mangroves in the inter-tidal zone. The old belt of mangroves slowed the currents and lowered the waves, protecting the shore. The trees also captured and held mud in their roots, building up and securing the coastline. But as in many other places, farmers have dug out the mangroves and replaced them with ponds to raise fish and prawns. The loss of mangroves and the mud they hold in place exposes the coastline to erosion by waves and tides.

Finally, there is land subsidence. Industry in the nearby city of Semarang, the capital of Central Java, is obtaining water by pumping it from beneath the ground. As the upper layers of soil dry out, they compact and the land subsides. Because the aquifer containing the water stretches all along the coast, the whole coast is sinking. This is happening many times faster than sea levels are rising.

Q: Are you still learning how these processes interact?

A: Very much so. At the start we knew that the loss of mangroves was important. But while we all along recognised that subsidence was also an issue, we didn't realise how big it was at first. It is not immediately obvious that pumping in a city can affect land levels 20 kilometres or more away in the countryside. My revelation came in the field when I couldn't find monitoring poles that I had put in the intertidal area three years before. It turned out they had sunk with the ground to below sea level, by as much as 30 centimetres within three years in certain areas. Subsidence is very dangerous because it is not just that the ground level falls. It also rapidly increases erosion. When the sinking ground makes water levels higher, you also get higher waves. A doubling of wave height quadruples the stresses that cause erosion. This happens especially in places like Demak, where the main source of sediment is fine mud, which is easily lost.

Working to restore mangroves and trap mud with the semi-permeable structures is right now the only thing protecting many villages. If we can stop the subsidence, then we can start to recover lost ground and push out the coastline to where it used to be. But our analysis suggests that if the subsidence continues, then the structures can only reduce the land loss temporarily.

Q: What about sea walls and levees?

A: These can protect cities of course. But they will not work for long coastlines with irregular shapes. They will be too expensive to construct and maintain. Also, they are likely to increase erosion in other areas. What we need to do is flip the balance along the whole coastline from net loss to net gain. We don't want to stop the waves altogether, because they bring mud as well as causing erosion. So, the trick is to slow down the waves, so they deposit more mud and erode less. That is how our systems thinking about coastal processes came up with the idea of semi-permeable brushwood structures that slow the incoming waves and encourage them to drop mud inside the grids.

They are doing a great job. We can measure how much mud is accumulating. But if the land keeps subsiding, the structures will ultimately not be sustainable. They can only do so much. So, we also need institutional changes to provide alternative water supplies so underground water can be protected and land subsidence prevented.

Resources

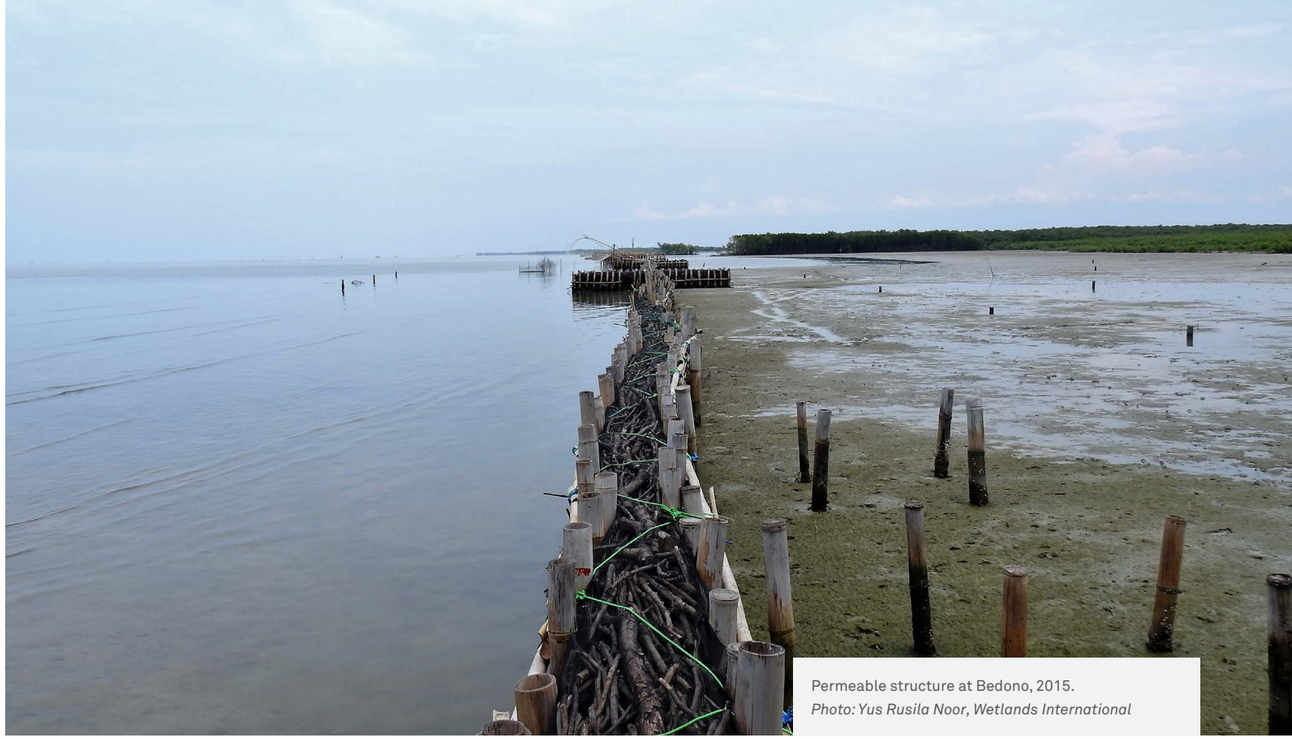
→ 1. Wilms, T., Van der Goot, F., Tonneijck, F., Nurhabni, F., Sembiring, L. Building with Nature Approach; Building with Nature to restore eroding tropical muddy coasts. Wetlands International and Ecoshape. 2021

→ 2. Van Wesenbeeck, B.K., Van Rees, F.F., Tonneijck, F., Cronin, K., Winterwerp, H. System Understanding; Building with Nature to restore eroding tropical muddy coasts. Wetlands International and Ecoshape. 2021

→ 22. Smits, B., De Lucas Pardo, M., Van Wesenbeeck, B. Effectiveness of ecosystem-based adaptation measures subject to sea level rise and land subsidence. Modelling report of 'Ecosystem-based Adaptation at Scale Through Building with Nature Towards Resilient Coasts in Indonesia' project in Demak. Deltares. 2020

→ 26. Tonneijck, F., Winterwerp, H., Van Wesenbeeck, B., Bosma, R., Debrot, D., Rusila Noor, Y., Wilms, T. 2015. Building with Nature Indonesia Securing Eroding Delta Coastlines: Design and Engineering Plan. Ecoshape Foundation, Dordrecht, The Netherlands. 65 pp. 2015

→ 42. Building with Nature approach: www.ecoshape.org



Permeable structure at Bedono, 2015.
Photo: Yus Rusila Noor, Wetlands International

2. Mangroves for coastal safety

The Building with Nature approach adopted in Demak has been based on research showing that even narrow strips of mangroves along shores reduce wave heights, moderate storm surges and trap sediment. A 100-metre strip reduces wave heights by between 13 and 66 per cent, for instance [30]. So their loss has been traumatic.

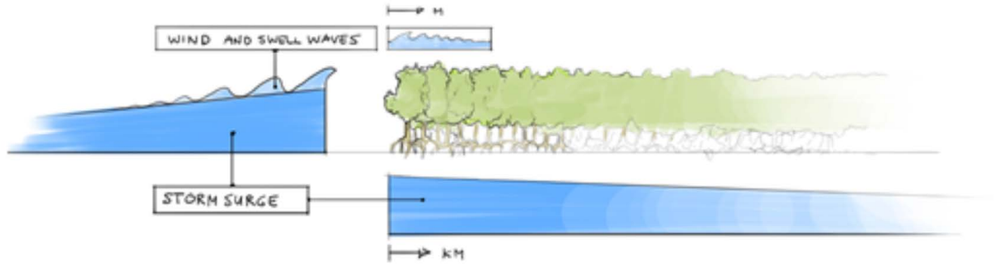


Figure 3: Mangroves reduce damage from waves and storm surges. Illustration: Joost Fluitsma

Years of mangrove removal to create ponds for aquaculture had by 2015 reduced their presence along the shore of Demak to a few scattered patches. As the seas invaded, local communities realised the predicament they had created, and tried to turn the tide by planting new mangroves. But this usually failed. The water was by now too deep and the waves too strong. Planted seedlings were washed away.

Still, mangroves are remarkably robust and opportunistic species, and seeds are ever present in these coastal waters. So successful natural restoration is possible, if the conditions are mild enough for mud to accumulate and capture passing seeds. We set out to create those conditions and applied two measures. First, community members agreed to construct and maintain semi-permeable brushwood structures – some 170 metres long and looking rather like outsize fences – in the mud 50-100 metres offshore. These structures do not stop the tides, but mimic the roots of mangroves, slowing the scouring currents and trapping sediment. Second, villagers donated abandoned and unproductive aquaculture ponds to be re-engineered to reconnect with the ocean, again creating conditions where mangroves can regrow. The work was carried out by village communities after a period of engagement during which they learned about the value of mangroves and the advantages of natural recruitment over planting.

2.1 Permeable structures

So far, permeable structures have been placed along more than nine kilometres of the Demak coast together with the Indonesian government. The structures are made from local brushwood and bamboo attached to poles. Over time, the aim is for a restored belt of mangroves to take over the role of the structures, recreating a natural defence against further erosion. There have been setbacks. Some structures have been damaged by shipworms, others by storms. We abandoned a few, because they could not survive the elements that were particularly harsh in some locations. The rest have required frequent maintenance. To increase their durability, we have changed designs and materials – for instance replacing wood poles with hollow PVC filled with concrete. But behind most of the maintained structures, sediment more than 25 centimetres deep accumulated in the first three years.

The idea was for mangroves to take root and grow in the newly trapped sediment behind the permeable structures. In some places that happened, with mangroves reaching about 1 metre in height. But in 2017, we noticed that some new mangroves were disappearing, and monitoring poles in the water were becoming submerged. We diagnosed the problem as subsidence of the land and foreshore, which was wiping out the gains from mud accumulation. The subsidence was worst in the west of the project area near the city of Semarang, where it reached eight centimetres or more per year in places, but it spread right along the Demak coast. The cause is the extraction of groundwater, mainly by industry in the city and along the highway. Groundwater extraction resulted in compaction of the deep soil layers that are underlaying the delta, lowering the land surface. This is a serious setback to coastal restoration. Nonetheless, it is clear that the structures have been successful in capturing mud. They have stopped erosion, delaying marine invasion and land loss. This is a significant achievement, and provided they are maintained, structures can continue in this role.

But mangroves may not return on the scale anticipated until subsidence is substantially reduced. The structures may need to be maintained in place for longer than once thought. Still, the benefits are tangible, and they have happened because of the actions of the community participants. Besides providing their labour to construct and maintain the structures, they have become ever more involved in planning. During the project, they proposed and implemented structural improvements, and organised to amend existing local regulations to protected newly gained land from future exploitation for ponds.

In 2018, the communities formally took ownership of the structures. Our role is now restricted to providing advice and funding maintenance. We see this successful transfer as being of equal value to the technical innovation, providing a social and institutional model that can be replicated in other Building with Nature projects elsewhere.

To plant or not to plant

While tens of millions of euros have been spent globally on mangrove restoration in recent years, the success rate of mangrove restoration projects ranges between 15-20% [21; 25]. This is a result of the use of inadequate techniques and of failure to resolve socio-economic and institutional barriers to effective restoration. We recommend a move away from traditional mass planting approaches to ecological mangrove restoration, as we applied in Demak. This approach focuses on creating suitable ecological and socio-economic conditions allowing mangroves to settle on their own. This is achieved by reinstating natural hydrology, sediment dynamics and soil conditions. Planting is only applied in sites where seedlings fail to settle naturally, for example in the absence of a nearby feedstock. The ecological mangrove restoration approach also addresses land tenure and use rights issues and the development of alternative livelihood options. Research has shown that this approach provides a more resilient and functional forest at a lower cost, compared to traditional planting.

Source

→ Leaflet: Wetlands International: Mangrove restoration: to plant or not to plant? Wetlands International. 2016
→ 40. Van Bijsterveldt, C.E.J., Debrot, A.O., Bouma, T.J., Maulana, M.B., Pribadi, R., Schop, J., Tonneijck, F. To Plant or Not to Plant: When can Planting Facilitate Mangrove Restoration? Frontiers in Environmental Science, section Interdisciplinary Climate Studies. 2022

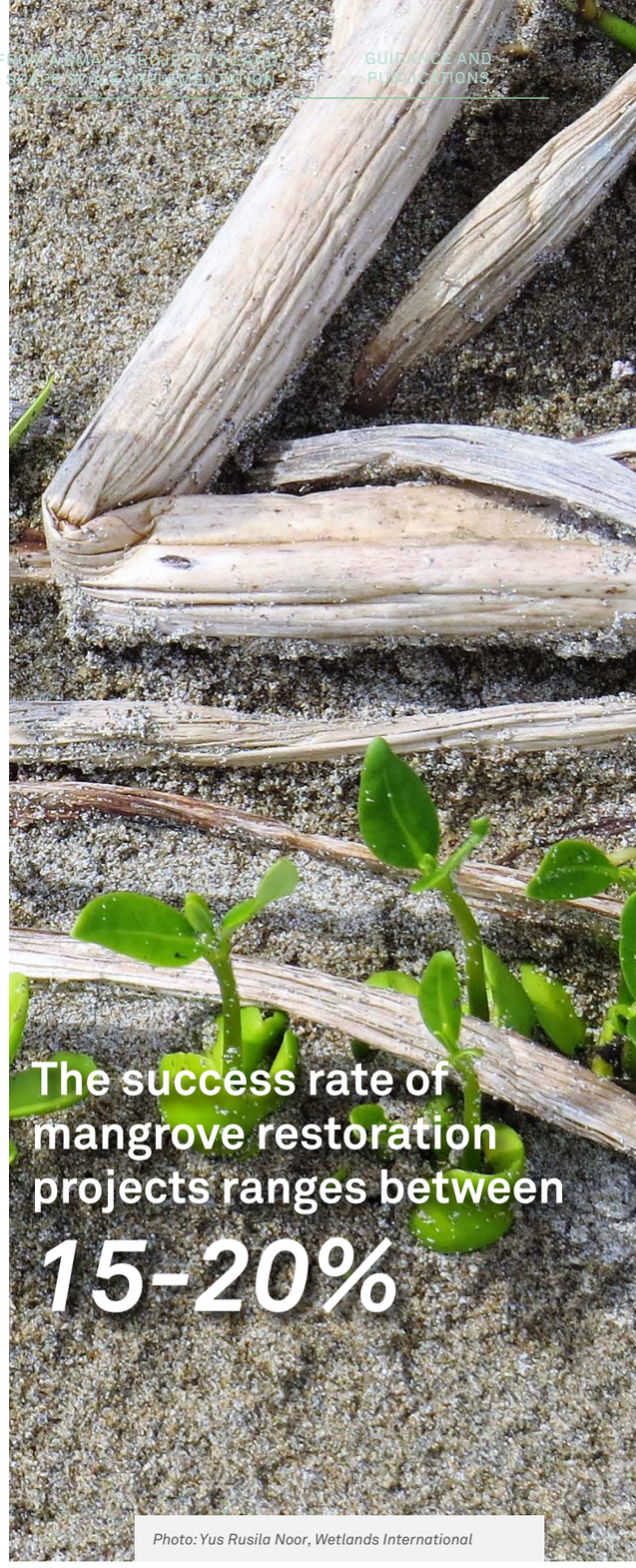


Photo: Yus Rusila Noor, Wetlands International



Monitoring of permeable structures.
Photo: Kuswantoro, Wetlands International



Mat Sairi

Chair of the Barokah community group in Timbulsloko

Mat Sairi, takes us on a boat to see the permeable structures that his community erected to stimulate mangrove growth and protect the village:

Our parents warned us that we should protect the mangroves, and not remove them for fish ponds. They said the mangroves provided many benefits, like the oysters, crabs, and fish growing among their roots, as well as protection of the coastline. But back then our people wanted to make money and feed their families. They didn't listen. Now with the mangroves mostly gone, the sea has washed away the bunds around our fish ponds. It has penetrated inland for about a mile, and the village lost 25 rows of ponds.

Timbulsloko was the first village to volunteer to place these structures. They act like mangrove roots, capturing sediment and acting as a barrier against the waves. New mangroves can grow in the sediment. Construction was hard work. Each of the structures is 170 metres long and required the labour of 25 people for four weeks. There have been teething problems. We have to do repairs after storms. But you can see, when I put our boat paddle into the water, that it is deeper outside the barrier because it is capturing mud on the landward side. In some places it has accumulated 50 or 70 centimetres in a year.





Tom Wilms and Joost Noordermeer

Witteveen+Bos

The idea of using permeable structures to restore muddy coastlines began in Europe's Wadden Sea, but is proving effective on the retreating formerly mangrove-protected shoreline of northern Java, explain Tom Wilms and Joost Noordermeer of engineering consultants Witteveen+Bos, who are perfecting structure designs.

Q: How did your work begin in Indonesia?

T: Deltares and Wetlands International began experimental trials with permeable structures in Timbulsloko in 2012. We at Witteveen+Bos became involved in design and implementation when large scale implementation got going in 2015. The coastline has been retreating fast, since the removal of mangroves for shrimp ponds, canalisation of rivers, building of coastal structures and land subsidence. But the conditions are right for recovery. The waves are relatively mild, and the coastline is muddy, so there is a lot of material to capture to remake the shore.

Q: What is the best design of permeable structure?

J: We are still working on that. We began with brushwood stretched between wooden poles. But the structures required a lot more maintenance than we initially expected, so we have improved the design. The wooden poles didn't last long in the saline water. We replaced them with bamboo, but that was eaten by shipworms. So, we have wrapped some in protective carpet sleeves and replaced others with PVC poles filled with concrete. To reduce wave damage to the brushwood, we have created more fence-like structures.

This work has increased the lifetime of the structures, but they still need regular inspection and repair. The good news is that the communities, who do all the construction and maintenance, are very assiduous. Now that they are the owners of the structures, they have developed their own maintenance and replacement routines, using local materials.

Q: How long will the structures have to last?

T: The original idea was that they would be needed for up to ten years, long enough for mangroves to regrow in the mud that the structures capture. But unless the local authorities can halt the land subsidence caused by groundwater extraction in the region, they may be needed for longer. But if subsidence is stopped in the future, structures could be placed further out to sea, to grow more land.

J: Further along the coast at Gresik in East Java, where the Indonesian government has installed its own permeable structures since 2015, they have gained about 100 metres of land already. So, our feeling is that if subsidence is ended and structures are well-maintained, they offer great potential not just for stabilising eroding coastlines but for natural land reclamation, too.

Mainstreaming of permeable structures by the government

Following the collaboration in Demak, the Indonesian Ministry of Marine Affairs and Fisheries (MMAF) began installing its own permeable brushwood structures to halt coastal erosion in 13 districts of Java and in the islands of Lombok and Sulawesi. Between 2015 and 2019, MMAF altogether installed 23.5 kilometres of structures, at a cost of around 2.5 million EUR (see Table 1). The combined initiatives have stimulated growing interest across Indonesia both in upscaling the technology and using the principles of Building with Nature to address other engineering problems in different settings. To go ahead, these ideas will require mobilising resources for feasibility studies and ultimately for full-scale implementation.
The Ministry of Public Affairs and Housing (MPWH) has also built 4 semi-permeable structures in Demak in 2017, to work with us on testing structure designs, a requirement for uptake by the Ministry. They also secured funds for impact monitoring and are in the process of producing a national guideline on Hybrid Engineering.

NO.	DISTRICT/CITY	PROVINCE	LENGTH (METRE)
	YEAR 2015		**14.160**
1	Cirebon District	West Java Province	2.910
2	Brebes District	Central Java Province	910
3	Semarang City	Central Java Province	3.145
4	Demak District	Central Java Province	915
5	Jepara District	Central Java Province	3.140
6	Pati District	Central Java Province	3.140
	YEAR 2017		**7.450**
1	Cirebon District	West Java Province	1.850
2	Demak District	Central Java Province	3.300
3	Rembang District	Central Java Province	1.100
4	Gresik District	East Java Province	1.200
	YEAR 2019		**1.900**
1	East Lombok District	Nusa Tenggara Barat Province	200
2	Bombana District	Southeast Sulawesi Province	1.100
3	Bone District	South Sulawesi Province	600
		TOTAL	**23.510**

Table 1: Mainstreaming of permeable structures by MMAF since 2015



“The Permeable structures have stopped erosion. That is a massive achievement given the high rate of subsidence. It is very promising for all the millions of people that may be affected by erosion along Northern Java’s delta shorelines.”

FEMKE TONNEIJCK, WETLANDS INTERNATIONAL

Permeable structures built by MMAF in Lombok Timur
Photo: Indonesian ministry of Marine Affairs and Fisheries (MMAF)



Permeable structures built by MMAF in Lombok Timur
Photo: Indonesian ministry of Marine Affairs and Fisheries (MMAF)

2.2 Converting ponds to grow mangrove greenbelts

In coastlines where erosion is less severe, we have endeavoured to create a restored greenbelt of mangroves by encouraging villagers to reconnect abandoned, degraded and unproductive aquaculture ponds with the ocean. The aim is to allow sediment to enter these basins, along with water containing mangrove seeds. In some places we have replanted specific species of mangroves, but otherwise we have allowed natural regeneration.

Villagers agreed to devote some of their, mostly non-functional ponds, and to protect the new mangrove basins from those wanting to return them to aquaculture. Sometimes they did this in exchange for financial and other assistance to rent ponds outside the green-belt area or start alternative livelihoods, which we discuss later.

Among the ten community groups involved in Building with Nature, more than two dozen farmers gave up almost 80 hectares of ponds to green-belt recovery. This exceeded the programme target. However, the farmers find it challenging to maintain the basins' hydrological connectivity with the sea, and as a result so far there is limited mangrove recovery, leaving these areas at continued risk of erosion. There are several reasons for this: there is limited space available for such work, and in absolute numbers there is a too limited number of farmers participating in this work, causing limited connection with neighbouring ponds and existing mangrove forests. In addition, the ponds located in the original green belt are relatively deep (lower than mean sea level) which makes it challenging for natural mangrove recruitment.

Lessons learned

- Mangrove restoration with permeable structures and through pond conversion is low-tech, but requires a sophisticated design based on comprehensive understanding of coastal processes, and continuous monitoring and adaptive management. The effort is worth it, however. Our innovative approaches can be replicated and adapted widely.

  Technology and system knowledge

- Sustainable solutions require a combination of technical and socio-economic measures that address the root causes of the problem. Although the interrelatedness of measures challenged the design process, in the end it led to a more resilient outcome. The comprehensive solution developed at the start of the project is presented in the design and engineering plan.

  Technology and system knowledge

- Permeable structures are a temporary measure to allow mangroves to recolonise. But, depending on the durability of available materials and the exposure of the structures to extreme weather, they may suffer damage. So, they require regular maintenance. Further research on material durability and structural design matters should help perfect the approach in future. Also, under unfavourable conditions -- such as significant land subsidence or reduced sediment input -- their effectiveness decreases. Such local factors need to be taken into account when deciding where and how to use them.

  Management, monitoring and maintenance

- The key to success is collaboration across disciplines and sectors. To be effective, mangrove restoration needs to be part of integrated coastal management and to be supported by policy, planning and strong local governance. Community involvement is also required. The programme showed that farmers will give up ponds for mangrove restoration, if there is intensive stakeholder engagement and improvement of production in new ponds.

  Multi-stakeholder approach

- Local involvement in mainstreaming has sometimes been hindered by regional laws that transfer the authority to manage the coastal zone to the provincial government. Therefore, the national ministry must work closely with the local and provincial governments to ensure that programmes can run in harmony.

  Multi-stakeholder approach



Fegi Nurhabni

Ministry of Marine Affairs and Fisheries

Indonesia's Ministry of Marine Affairs and Fisheries has since 2012 been supporting the idea of permeable structures in holding back coastal erosion. Fegi Nurhabni, the ministry's deputy director for disaster mitigation and climate change adaptation, says they have potential for upscaling for beyond the shores of Java.

Q: How big is the problem of coastal erosion in Indonesia?

A: Erosion is one of Indonesia's biggest problems, because we have so many islands and so much coastline. It is especially important in northern Java, where some of our biggest cities are. The cities' development has often not been properly planned. They rely on pumping underground water, which causes land subsidence. Also, the island's alluvial coastline is not stable and easily erodes. Moreover, as in many places, most of the mangroves were cut down during the 1980s when villagers replaced them with fish ponds, exposing the coast to the power of waves and tides. Putting these three things together was a bad combination. And nowhere has suffered more than Demak.

Q: But the government is fighting back.

A: In the past five years, we have had a programme to protect the north coast of Java, and also an active national programme to restore 50,000 hectares of mangroves by 2024. That is ambitious. To protect and restore some of these coastlines is a long shot, to be honest. But we are trying.

The government has adopted the idea of permeable structures from the Building with Nature initiative. This hybrid engineering is cheaper than conventional hard structures, and uses local materials. Altogether we have placed 23.5 kilometres of permeable structures. They work well. They trap sediment, and this allows natural mangroves to regrow along the coast. We can speed up the growth by planting.

The structures are not practical everywhere. For instance, the poles that hold the brushwood structures need foundations in a solid foreshore. We wanted to build them in eastern Sumatra, but the mud is too deep there: more than five metres. And successful installation requires support from local communities. The government approach at first focussed only on engineering. But we learned that that is not enough. The structures are fragile and require constant maintenance. For that, you have to involve the local communities, which did not happen at the start.

Community engagement takes time and effort. You have to raise awareness about the value of the structures. After all, villagers have a legal right to their land and we are asking them to give up some of their ponds for a collective benefit. Every village has its own society and values. To achieve engagement, we have to fit in with those values.

That is what makes the Building with Nature approach special. It emphasises engagement with local communities, and its comprehensive approach offers economic benefits such as better yields from aquaculture in return for the sacrifices of land and labour to protect the coastline. It found a balance between environmental and economic value, at the same time restoring the ecosystem, protecting the coastline and making fish ponds more productive.

Q: Can that approach be replicated?

A: Yes, though it will not always be easy. Our government has been experimenting with what we call coastal resilient villages, where we spend some of the budget for coastal restoration on community empowerment. We have been doing this in eastern Lombok, and Bombana in southeast Sulawesi. There is no standard blueprint. Upscaling has to recognise that. But Building with Nature is going to be the answer to coastal protection in many places. What we have been pioneering in Indonesia can certainly be replicated successfully elsewhere.



Yus Rusila Noor

Wetlands International

As head of programme for Wetlands International Indonesia, Yus Rusila Noor has been on the front line of turning the theory of Building with Nature into action by communities on the ground. What went right?

Q: Did you find local administrations keen to engage?

A: Yes. Village governments were especially supportive of Building with Nature, as the project directly tackled problems for their communities. And because we spent a long time listening to them about what the problems were. This gave a good indication to them that we wanted to solve the problems together, and to do it for them. Their ideas were accommodated and that built up trust.

Q: Did they see it as an economic opportunity as well as an environmental one?

A: Of course, communities see economic and environmental issues as closely linked. And we built on that with our Bio-rights approach. Building with Nature is not a one-time planting programme; it requires a comprehensive approach: combining hydraulic engineering with the environment, economic planning and social development as well as associated budget planning and governance.

The government side can create challenges. For instance, governments have budget planning horizons that may be different from the needs of the work. And sometimes budgets allow for construction, but not for necessary maintenance, even though everybody agrees the permeable structures require regular maintenance.

Q: Can the success be replicated elsewhere?

A: We hope so. The main challenge for scaling up and replication is not to do it blindly. Every project must be place-specific. It is important to learn general lessons about what works and what does not, but at the same time it is essential to recognise that every environment and every community is different. So, replication is always an adaptive, learning process. That is what makes success, but that is also what makes it interesting and exciting to work on.

Resources:

→ 3. Wilms, T., Van Wesenbeeck, B.K., & Tonneijck, F. Permeable Structures; Building with Nature to restore eroding tropical muddy coasts. Wetlands International and Ecoshape. 2020

→ 10. Cado van der Lelij, C., Van Rees, F., De Lucas Pardo, M., Van Wesenbeeck, B. Ecological mangrove restoration with permeable structures. Monitoring report. Deltares. 2021

→ 14. Gijón Mancheño, A., Jansen, J., Winterwerp, H., Uijttewaal, W. Predictive model of bulk drag coefficient for a nature-based structure exposed to currents. Nature Scientific Reports. 2021

→ 38. Winterwerp, J., Albers, T., Anthony, E., Friess, D., Gijón Mancheño, A., Mosely, K., Muhari, A., Tas, S., Tonneijck, F. Naipal, S., Noordermeer, J., Wilms, T., Saengsupavanich, C., Van Eijk, P., Van Lavieren, E., Van Wesenbeeck, B. Managing erosion of mangrove-mud coasts with permeable dams – lessons learned. Ecological Engineering. 2020



Photo: Yus Rusila Noor, Wetlands International

3. Boosting community prosperity

The coastal communities of Demak have in recent decades generated considerable income through aquaculture in ponds created by sacrificing mangroves. But yields and financial returns have declined. By 2015, the western part of Demak had lost most of its aquaculture ponds to coastal erosion. Further east, ponds remained, but productivity was reduced by erosion, flooding and pollution. Income from aquaculture in Demak had decreased by 60-80 per cent.

A typical pragmatic response was to maintain income by converting yet more mangroves to ponds, exacerbating the problems. But there is potential to do better, and restored mangroves can be a key part of this. For instance, restored mangroves can protect the ponds from waves, and filter sea-borne toxins such as industrial waste. In addition, they can deliver firewood and fertiliser, and provide nursery and feeding grounds for wild fish. So, rather than being competing land uses, mangroves and aquaculture can be complementary.

The key to breaking the damaging cycle of declining pond yields and further mangrove destruction has been to realise these potential gains. We did this by introducing coastal field schools to train villagers in better aquaculture techniques and appreciation of the value of mangroves, and by providing incentives through Bio-rights, a financial system that reconciles livelihoods with environmental conservation and restoration.

3.1 Coastal field schools

Coastal field schools train small-scale pond farmers in good practices to advance their livelihoods and sustain coastal ecosystems. Led by local facilitators from the Indonesian NGO Blue Forests and the Faculty of Fisheries and Marine Science of the Diponegory University, Demak farmers learned about the ecology of coastal waters, the functions of mangroves, and pond ecology and management.

The coastal field schools taught a system known as ‘low external input sustainable aquaculture’, based on principles developed for land-based agriculture and considered suitable for resource poor farmers. This system optimises the use of locally available natural resources and inputs, such as organic fertiliser, solid and liquid compost and fermented waste to enhance pond fertility by adding energy, minerals and micro-organisms. This stimulates the growth of natural feed for the tiger shrimps, white legged shrimps, milkfish and tilapia that fetch high market prices locally. These species can be cultivated together to enhance resilience. The approach also reduces or eliminates the use of external inputs such as synthetic chemicals, so minimising pest resistance and destruction of the soil ecosystems, while reducing costs.

Farmers used that knowledge to debate with their colleagues about best practice, design aquaculture production systems, and make informed decisions about management of their own ponds. Thus, besides gaining knowledge, they acquired “soft” skills in critical thinking about adapting to changing environments, and learned to have more confidence in making decisions and public speaking. The trained villagers passed on their insights through new training in other villages.
Over 80 per cent of the field-school participants in Demak subsequently adopted aspects of the LEISA system in 464 hectares of ponds, with sometimes spectacular success for their livelihoods. Milkfish yields reportedly rose threefold, and average shrimp yields sixfold. Profit margins were typically three times higher.

The gains might have been even greater but for land subsidence, which lowered water levels in many ponds, causing flood damage to the surrounding bunds, especially during storms, damaged water quality, and washed away fish and prawns. For this reason, we supported bund heightening and explored alternatives such as netted aquaculture and ponds in freshwater basins. We also supported the introduction of early warning systems, so that farmers can harvest their ponds before storms.





Woro Yuniati and Ratnawaty Fadilah

Blue Forests

Blue Forests, an Indonesian NGO dedicated to ecological mangrove restoration, has been central to motivating the fish farmers of Demak to adopt more sustainable methods that protect their coastline and boost their incomes. Woro Yuniati and Ratnawaty Fadilah explain how.

Q: Tell us about Blue Forests and your role in Building with Nature?

W: We have been going since 2000, educating people in mangrove areas about how to improve their livelihoods sustainably, while allowing the mangroves to recover. We concentrate on organic systems for aquaculture. We are based in South Sulawesi and have worked all over Indonesia, from Papua to Sumatra. Between 2015 and 2019, we set up and operated coastal field schools to train aquaculture farmers in Demak as part of Building with Nature. I was the programme manager and Ratna devised the curriculum.

R: The coastal field schools took place in the villages. They were centred on the experiences and needs of the learners, on their ponds as agroecosystems, and on collective decision-making and actions. The farmers met once a week over four to five months, a full cropping season. We encouraged them to adopt organic fertilisers and compost, to reduce the use of chemicals and to take a more scientific approach to preparing the land and improving water quality in the ponds, as well as to restore mangroves.

Q: Did the farmers take to your methods?

R: Yes, even while they were still attending the courses, some were already applying them, and adapting them to their own needs. They began to make their own liquid fertiliser from domestic waste. They introduced local algae and other microorganisms to the ponds to improve water quality. We taught them how to monitor pH, salinity and other parameters every day using modern measuring devices, and to use the readings to inform their pond management. Before, they never did anything like this. But now they understand its importance for improving their yields.

Q: What about the flooding? Can you help them cope with that?

W: Yes, in Demak the main issue for the farmers is flooding of their ponds by the sea. We have been able to help them by implementing associated mangrove aquaculture. By restoring mangroves at the front of their ponds, they can dampen the effect of the waves. But it takes time for mangroves to grow, so we adapted our curriculum to teach them about what they can grow in ponds that have been inundated, and where their regular crops of prawns and milkfish cannot grow. We found that green mussels and blood cockles grow well in the permanently inundated ponds.

While we promote organic methods and the restoration of mangroves, every place we go has its own problems and priorities. We make sure that the coastal field schools reflect that.



Abdul Ghofur

Community Member of Jaya Bhakti Group

Unsatisfied with the output of his fish ponds using conventional chemical inputs, Abdul Ghofur of Tambakbulusan village in Demak enrolled with the coastal field school to learn some better methods. Now he is a champion of organic fish-farming that brings higher productivity and protects his village by reviving the coastal mangroves.

Q: Why did you join the field school?

A: Before I joined, I used chemicals in my ponds. But the results were not good. The milkfish died of disease after four to six weeks. So, I had to harvest them when they were very small. I decided to attend the school to learn new methods, using environmentally friendly materials. I went to 25 weekly meetings.

I learned to replace chemical fertiliser with organic compost and to improve the water quality with klekap, a mixture of algae and cyanobacteria that grow naturally on local sediment. These were cheaper and better than chemicals. Now the fish don't die and I can harvest them after ten weeks, when they are much bigger. It works every time.

Q: Now you have become a local champion for these methods?

A: Yes. When I saw these methods worked on my ponds, I started to teach them to my farmers' group. Now we make our own compost. We also decided that we could get a better harvest if we planted mangroves between the sea and our ponds. The water here contains chemical waste from factories in Semarang, so we constructed a tandon, a reservoir that holds the water among the mangroves, which filters the pollution before the water goes to the ponds.

Now we are sharing our success with other groups in Demak. I tell my fellow fish-farmers: Let's not be lazy; let's not be hesitant; the proof is here.



Farmer Abdul Ghofur, Member of Jaya Bhakti Group, Tambakbulusan village who participated in the coastal field schools showing his catch
Photo: Blue Forests

Resources:

→ 5. Bosma, R.H., Rejeki, S., Ariyati, R.W., Widowati, L.L., Fadila, R., Yuniati, W. Building Sustainable Aquaculture through Coastal Field Schools Building with Nature to restore eroding tropical muddy coasts. Wetlands International and Ecoshape. 2021

→ 30. Widowati, L., Rejeki, S., Ariyati, R., Bosma, R. The impact of aquaculture field school on the shrimp and milkfish yield and income of farmers in Demak, Central Java. World Aquaculture Society 52: 362-377. 2021



Participants of a post-field school planning workshop for greenbelt recovery.
Photo: Boskalis



Farmers working together to realign the dyke of the associated mangrove aquaculture system.
Photo: Wetlands International

3.2 Associated mangrove aquaculture

During the project, we introduced those farmers with aquaculture ponds situated along rivers and creeks to the novel 'associated mangrove aquaculture' system, in which part of the pond is given up to make space for riverine mangroves. The system involves the creation of a double line of bunds along the river, with sluice gates operated to encourage natural sedimentation between the two lines. The newly sedimented areas create a new habitat where mangroves will recruit naturally. Eventually, the bund line along the river may be abandoned once the mangrove forest has matured.

The associated mangrove aquaculture system differs from more conventional ways to combine mangroves with aquaculture, the so-called silvo-fisheries. Conventional silvo-fisheries involve growing mangroves inside the ponds or on the pond bunds. Our novel associated mangrove aquaculture system avoids the problem of mangroves hampering pond maintenance or reducing productivity by creating litter and shade. By placing the mangrove buffers outside of the pond they can protect the bunds against erosion, purify incoming water and reduce the spread of disease agents. A downside is that farmers need to give up part of their pond area. However, in practice this is compensated with improvements in yields from the smaller ponds, especially when applying techniques learned at coastal field schools. One farmer can practise the approach alone, but to improve the landscape, ideally all farmers along a river or canal will adopt it.

The associated mangrove aquaculture system became very popular and many graduates of the field schools took it up. It was successfully introduced in no less than 167 hectares of ponds along rivers. Typically, farmers converted around 10 percent of their pond into mangrove habitat. New sediment accumulated at a rate of 10 centimetres per year, and in most locations natural mangrove seedlings regrew within one year. The success rate of mangrove recovery was around 75%. When the original pond depth exceeded 40 cm, mangrove recovery became more difficult.

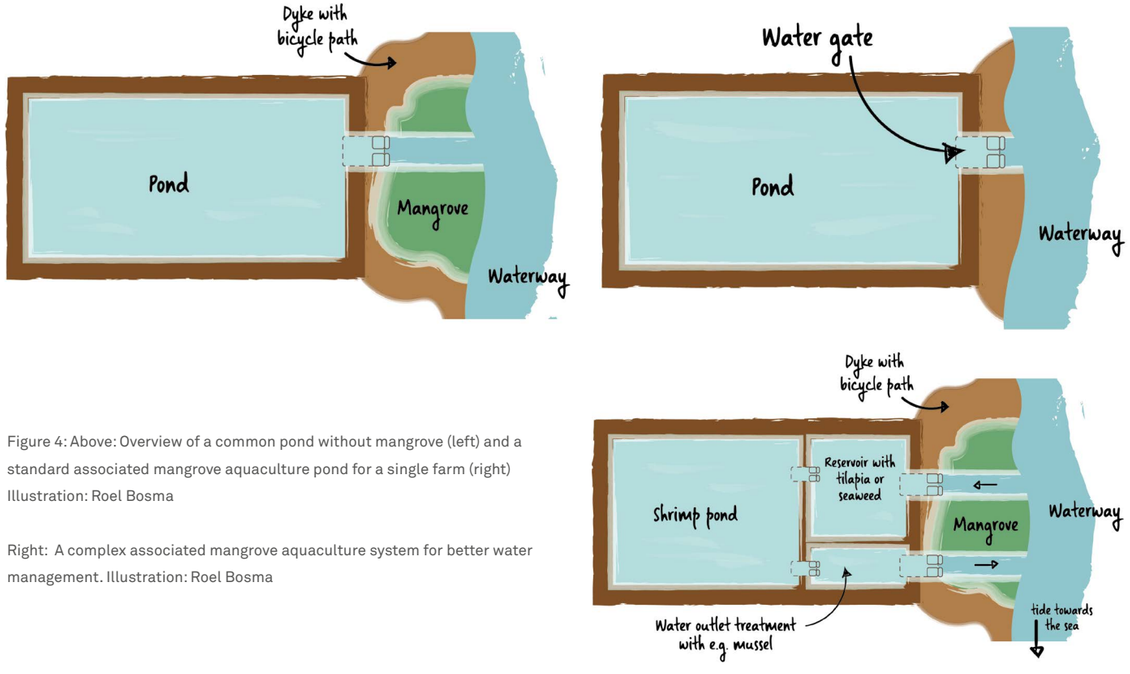


Figure 4: Above: Overview of a common pond without mangrove (left) and a standard associated mangrove aquaculture pond for a single farm (right) Illustration: Roel Bosma

Right: A complex associated mangrove aquaculture system for better water management. Illustration: Roel Bosma



Kasmudi facing his grow-out pond with its clear water and the dark shadows of the seaweed visible at the bottom, with his nursery ponds in the background.
Photo: Roel Bosma



The remains after soil-subsidence and some storms of the most common silvo-fisheries system in Indonesia demonstrate the limited function of such systems for coastal protection.
Photo: Roel Bosma

Resources:

- → 4. Bosma, R.H, Debrot, D., Rejeki, S., Tonneijck, F., Yuniati, A., W. & Sihombing, W. Associated Mangrove Aquaculture Farms; Building with Nature to restore eroding tropical muddy coasts. Wetlands International and Ecoshape. 2021
- → 32. Wardani, I., Cado van der Lely, A., Massa, Y. Monitoring of Mixed Mangrove Aquaculture. New method for restoring aquaculture farms in Indonesia. Deltares. 2021
- → 39. Yuniati, W., Fadilah, R., Rejeki, S., Widowati, L., Ariyati, R.W., Astra, A., Bosma, R. Aquaculture field schools supporting mangroves for climate change adaptation of Indonesian milkfish-shrimp farmers. Aquaculture Asia. 2021



Roel Bosma

Wageningen University & Research, on sustainable aquaculture

Coastal aquaculture in the tropics has a bad reputation. Almost everywhere, ponds for raising prawns replace mangroves, destroying biodiversity as rich as rainforests and exposing coastlines to rising tides, worsening storms and tsunamis. For some, the idea of sustainable aquaculture is an oxymoron. But Roel Bosma of Wageningen University and Research, says it can be achieved through associated mangrove-aquaculture systems. The coastline of Demak is becoming a testbed.

Q: Isn't aquaculture in the tropics just bad news?

A: You can call it bad if you like. But people need to make a living. The problem is that in some places, there are too many people or they get too greedy. They open up the mangroves, and that is when the problems start. But it can be done better. We need to show that keeping sufficient mangroves can increase the output of ponds as well as protect the coastline.

Q: What is associated mangrove aquaculture?

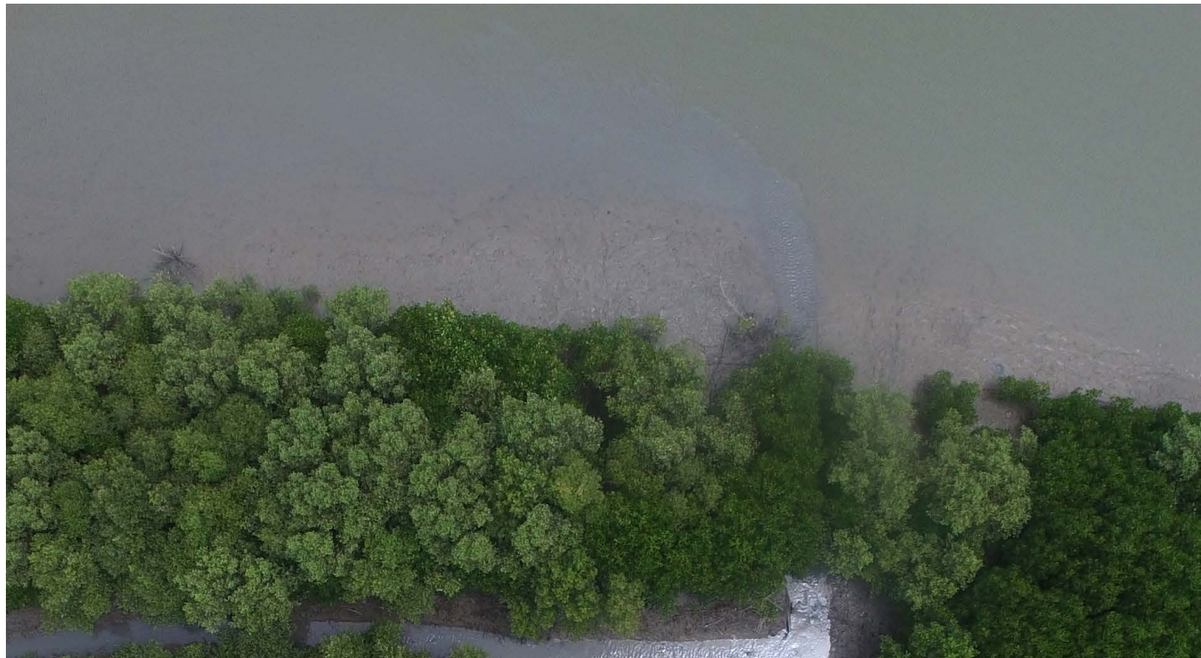
A: The idea, as the name suggests, is to integrate the benefits of mangroves to improve pond yields. But it is different from traditional mixed systems that plant mangroves within the ponds or on the bunds around them. The idea here is to have mangroves as the intermediaries between open water and the ponds. That way, the mangroves provide extra benefits for the ponds, as well as other ecosystem services such as nursery grounds for fish and coastal protection. The new system works where ponds are close to rivers to supply them with water. In Demak, we set the ponds back from the rivers, to make space for open ponds containing mangroves. Ideally, a strip of more than 20 metres wide. The water then passes first through the mangrove ponds, which filter the water, cleaning up pollution and often reducing disease agents.

Q: Did farmers need persuading this was a good idea?

A: Yes. They usually see mangroves as a waste of space, full of snakes. But we have shown that even though they reduce the area left for ponds, they increase pond yields. Demak is the first place where this system of mangroves outside fish ponds has been tested in Asia.

As part of Building with Nature, we trained 414 farmers at the project's coastal field schools, and around a hundred have tried associated mangrove aquaculture. Not all farmers had a pond along a river. They often combined it with other methods of cleaning the river water, which is often polluted. These methods include adding wet compost made from fruit and vegetable waste, and culturing some kinds of seaweed. Together, they have tripled yields of prawns and milkfish in the ponds, while adding to protection of the coastline against erosion.

BUILDING WITH NATURE IN DEMAK | UPSCALING IN INDONESIA AND ASIA | FROM A SMALL PROJECT TO LANDSCAPE SCALE IMPLEMENTATION | GUIDANCE AND PUBLICATIONS



Associated mangrove aquaculture pond in Timbulsloko showing natural mangrove restoration. *Photo: Blue Forests*

3.3 Bio-rights and alternative livelihoods

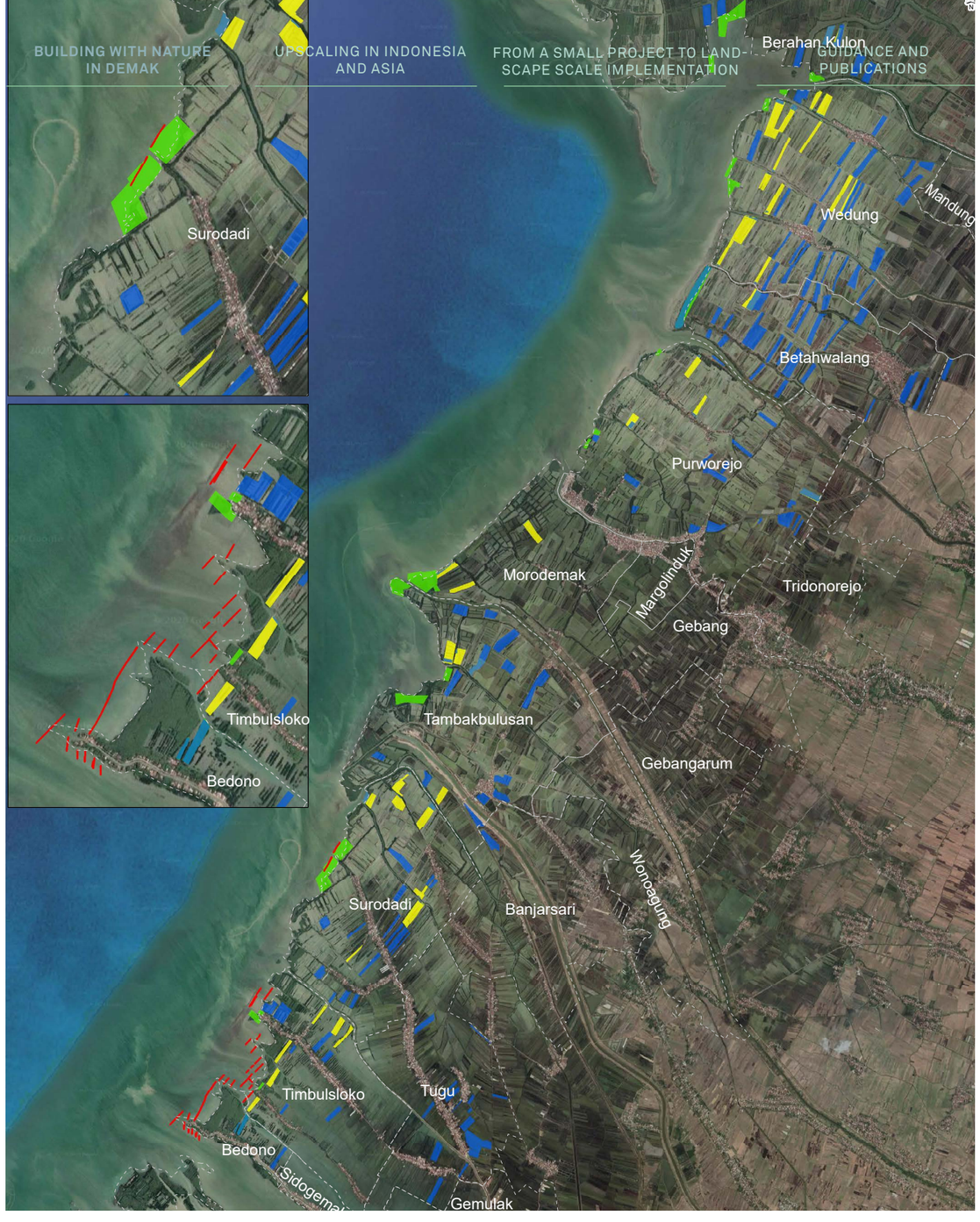
Bio-rights is an innovative system for giving communities financial and technical support to develop more sustainable livelihoods, in return for their active engagement in conservation and restoration. In this case, the payments are made where farmers agree to change aquaculture methods in order to restore rather than destroy mangroves. An important feature of Bio-rights agreements is that they are conditional. The payments are loans that are written off only if and when more sustainable aquaculture approaches have been adopted and restoration efforts have been successfully demonstrated. The aim is both to be more effective and to encourage community insights into the purposes and benefits of the work undertaken.

Overall, 268 people from the ten community groups engaged in Building with Nature along the Demak coast participated in Bio-rights. They were supported by field facilitators who lived in the district throughout the landscape restoration process. Each group set aside areas for coastal and riverine greenbelt restoration as well as for the revitalisation of aquaculture. We paid Bio-rights funds to them in return for such tasks as constructing, maintaining, guarding and inspecting permeable structures, and converting degraded ponds into sediment-catching basins.

The communities spent the funds on improving aquaculture or creating alternative livelihoods and other projects of benefit to communities. Some bought equipment to make fish food or fertiliser for their ponds from organic waste such as straw and leaves. Others purchased livestock, created vegetable gardens, produced flour from crab shells, installed water pumps, bought boats for rental and harvested non-timber forest products to make handicrafts and honey. Still others explored ways to cultivate green mussels on the permeable structures. Thanks to one Bio-rights investment, the regent of Demak opened a 350-metre boardwalk through new mangroves in Bedono village, earmarked for enjoyment by tourists, and for educational purposes and local meetings. We have also supported farmers with equipment to harvest wild fish from in and around the resurgent mangroves.

Subsequent research has confirmed the sustainability of these alternative livelihoods. More than 80 per cent of fishers report better near-shore catches, with incomes now as good as those from aquaculture. A study of nearshore catches associated with mangrove restoration in eastern Demak, carried out by Wageningen and Diponegoro universities, found both a clear recovery in fish populations and rapid increases in fish catches. An assessment of non-timber forest products that used Demak as an example found that mangroves provided products ranging from medicines to textiles and firewood to foods such as leaf chips, chutneys and fruit drinks. They were a major but largely untapped business opportunity for local communities, and the assessment called for further investment.
Over time, the participants in field schools and Bio-rights projects have learned to manage their ponds in ways that contribute to mangrove restoration, coastal protection and biodiversity. Having previously regarded regular flooding and low pond productivity as inevitable, communities are now much more optimistic, creative in their thinking and collaborative in making strategic decisions to improve their lives and sustain their surroundings.

This is seen perhaps most clearly in the way that the ten community groups have organised themselves into a Community Group Forum, called Bina Noto Segoro (BINTORO), which is Javanese for “to manage the sea”. BINTORO now plans and implements the restoration and livelihood measures begun under the project. It also represents the communities to local government and other external parties and has released its own independent assessments of the coastal situation in Demak, which called for further action to address land subsidence. This statement was also used in Water Dialogues on land subsidence for Semarang and Demak.



Overview of the implemented measures in Demak.
Image: Witteveen+Bos

Meeting Community Ocean Forum BINTORO (Bina Noto Segoro: To manage the Sea).
Photo: Kuswantoro, Wetlands International





Apri Susanto Astra and Eko Budi Priyanto

Wetlands International

They have built boardwalks for tourists to explore the mangroves; they have made organic fertiliser for their shrimp ponds from dead fish and household waste. Community groups in the villages of Demak have come up with numerous economic ventures, all funded by loans from Wetlands' International's pioneering Bio-rights programme. Under the programme, the loans are written off if the environmental endeavour -- in this case, erecting structures to capture coastal silt to restore mangroves along the district's shoreline – is achieved. Apri Susanto Astra and Eko Budi Priyanto of Wetlands International Indonesia explain how the scheme works and why the success rate is so high.

Q: Many development projects fail. So what has Bio-rights got right?

A: Eko: First, we are not handing out aid. We are reaching deals with community groups created within the villages. Under the agreements, the groups erect and maintain the permeable structures to hold the silt along the coastline and rehabilitate mangroves, in return for receiving loans to carry out a package of agreed activities, either connected with improving village lives or to stimulate alternative livelihoods. If the groups achieve the environmental targets, then the loans are turned into grants that do not have to be repaid. If not, then they will have to be repaid.

Second, we take our time. When the work began in 2015, we spent almost a year living and working in the nine villages involved, learning about their problems and hopes, and about their village development plans. And we discussed with them the ideal of electing village groups to carry out activities. Only when the groups had been established did we begin negotiating the package of activities and the terms of the loans, and setting up training programmes to help them achieve their aims.

Q: What kind of activities did they embark on?

A: Eko: All kinds. There are ten groups involving around 260 members. They shared around $300,000 in loans. There were some common aims, such as rehabilitating mangroves and improving the productivity of their shrimp and fish ponds. Switching to organic inputs produced better yields by preventing the spread of diseases that chemicals could not counter. Mixing mangrove cultivation with aquaculture was also popular.

A: Apri: A group of women in one village set up a business to make fertilizer pellets for their ponds from crabs and cassava flour. Others wanted to invest in tourist attractions. Two villages built boardwalks through mangroves. One of the boardwalks has a bamboo entrance gate modelled on the Eiffel Tower. Elsewhere, they have set up fishing trips for tourists.

Q: Once the contracts have been fulfilled and the loans written off, do the groups continue?

A: Apri: We encourage them to continue with the programme by themselves. Most have reached their targets, though a few have not yet achieved the changes to village regulations that were agreed. But so far the groups have continued, and we meet them every month. They have a life of their own. For instance, they have formed a forum of community groups, known as the BINTORO Forum, that speaks with one voice to local authorities such as district officials.

Some groups are now receiving direct support from the district, such as funding for maintaining the permeable structures and boardwalks, and seeds for aquaculture and mangrove planting around their ponds. Of course there is a turnover of people in the groups. Some members leave the area, others die or cease to be involved. Right now, we are encouraging them to hold elections for new members.

Q: So all is going well?

A: Apri: We are very pleased with how the activities have worked out, and the progress of trapping silt. But there are always external forces. A big problem is land subsidence, caused by groundwater pumping by industry in and around the nearby city of Semarang. In many places, this is causing the coastline to subside faster than the structures can raise it. So the mangroves are not returning as hoped for.

In early June, there were big tidal floods in central Java, made worse in Demak by the local subsidence. The sea flooded many fish ponds. It was a big setback. So now we plan to extend our work for another year to use unspent money on supporting community efforts to repair dykes, put up nets to retain fish. Whatever the future brings, we want to invest in these communities.



BINTORO in action during World Wetlands Day 2020 to train students about the importance of mangrove conservation.
Photo: Kuswantoro, Wetlands International



Maskur, BINTORO

Wetlands International

The community groups that have erected and maintained the permeable structures along the coast of Demak have formed their own representative forum, Bina Noto Segoro, which is Javanese for "to manage the sea". In short, referred to as BINTORO, its task is to network with the government, receive funding for future Building with Nature activities, and advocate for protection of their coastline, says leading member Maskur.

Q: How do you see the environmental problems in coastal Demak?

A: They are complex. First is the damage to the mangroves caused by opening up fish ponds and erosion. But there is also land subsidence, which results in tidal waters rising into residential and farming areas, and other issues such as fishing gear that is not environmentally friendly, and excessive use of chemicals on farms.

Q: What is BINTORO's role?

A: The forum was formed in July 2019 by members of the community groups active in coastal parts of Demak in Central Java. We represent the groups, as well as exchanging information, generating ideas, compiling environmental programmes and influencing government policies on the environment. We aim to be a permanent Forum, and we already have good relationships with district and village governments. For instance, on our advice, several villages have issued their own regulations on the environment and mangrove restoration.

Q: What benefits do you see for your communities from Building with Nature?

A: So far, the success of Building with Nature is good. The changes from coastal restoration and benefits of Bio-rights can be felt, especially by people living along the coast. But its studies have also shown that excessive groundwater extraction is causing land subsidence. So, we now know that successful mangrove restoration will be difficult without stopping the subsidence.

Lessons learned

- Best aquaculture practices required less investment and boosted aquaculture productivity and income and became very popular. As a consequence of successful aquaculture revitalisation, farmers along rivers were willing to give up part of their pond to create a riverine greenbelt which provided additional benefits in the form of wild fish catch. The financial incentive provided by Bio-Rights provided the push community members needed to also dedicate areas for coastal greenbelt restoration.

Business Case

- The coastal field schools were critical to both mangrove restoration and increasing production from sustainable aquaculture. The investment in the training was cost-efficient. The trained villagers passed on their insights through new training in other villages, giving a multiplier effect. Participants also acquired soft skills that enabled them to be more creative in adapting to change and empowered them in policy dialogues.

Capacity building

- Throughout the programme, achieving gender balance was a challenge due to local customs. In the last year the project's female trainers therefore recruited a women's group for two coastal field schools. In the future, gender analysis should be an integral part of programme design, and a gender strategy should be developed in the early stages.

Multi-stakeholder approach

- The Bio-rights programme required a significant investment in preparation, planning, and capacity and trust building. These were programme strengths. Government involvement will be necessary for upscaling of Bio-rights. At present, rigid sectoral planning and budgetary processes within government do not match the holistic and adaptive approach of Building with Nature. Getting around this may require public-private partnerships, with each partner adopting the roles and responsibilities that best suit their planning and budgetary processes.

Institutional embedding

Woman picking mangrove fruits. *Photo: Nanang Sujana*



Siti Amanah
from Wedung village on the experience of the women with the project

“The project has helped us set up a business to make pellets out of dead fish and cassava flour that we sell locally and use as fertiliser in our own fish ponds. With chemical fertilisers, it takes four months to get a harvest. With the pellets it is only two months, and they are cheaper. The idea came from the field school. Before, our husbands mostly ran the fish ponds, but now women are much more involved. The men work for us, harvesting the ponds. Each member of our group of women has their own pond, and we also have a common pond, where profits go into a community savings fund. Since learning the new techniques, we have tripled our incomes.”



Coastal field school session amidst ponds.
Photo: Restiana Wisnoe

BUILDING WITH NATURE IN DEMAK | UPSCALING IN INDONESIA AND ASIA | FROM A SMALL PROJECT TO LANDSCAPE SCALE IMPLEMENTATION | GUIDANCE AND PUBLICATIONS



Sifatul Khoiriyah
in Timbulsloko on her hopes for the future

“Building with Nature is improving our village economy and protecting our environment. I am a teacher and an organiser. I get money from Bio-rights, which I use to support my husband and son, buying nets and a small boat for their fishing, and gear to catch crabs. I save some of the income from selling the crabs to enlarge the business. I don’t go out in boats. My obligations to the village are mainly to prepare the proposals for maintaining the structures and other projects. I organise village planning meetings, and write and present our proposals to local governments. I am also pressing the government to do something about the pumping of underground water in Semarang, which is lowering the land here and causing more flooding. If we can achieve that, we can have a good future here.”

Resources:

- → 6. Assessment of the Biorights mechanism in Demak: A community incentive for sustainable development and mangrove conservation. Final report. Lestari Sustainable Development Consultants Inc. 2021
- → 13. Debrot, A.O., Veldhuizen, A., Van Den Burg, S., Klapwijk, C., Islam, N., Alam, L, Ahzan, M, Ahmed, M., Hasan, S., Fadilah, R., Noor, Y., Pribadi, R., Rejeki, S., Damastuti, E., Koopmanschap, E., Reinhard, S., Terwisscha Van Scheltinga, C., Verburg, C., Poelman, M. Non-Timber Forest Product Livelihood-Focused Interventions in Support of Mangrove Restoration: A Call to Action. Forests. 2020
- → 20. Rejeki, S., Debrot, A.O., Van den Brink, A., Ariyati, R.W., Widowati, L.L. Increased production of green mussels (Perna viridis) using longline culture and an economic comparison with stake culture on the north coast of Java, Indonesia. Aquaculture Research. 2020
- → 27. Van Eijk, P. & Kumar, R. Bio-rights in theory and practice. A financing mechanism for linking poverty alleviation and environmental conservation. Wetlands International, Wageningen, Netherlands. 2009

4. Social costs and benefits

Our experience in Demak has bolstered a business case for Building with Nature, by showing the wide range of avoided costs and co-benefits from taking this approach to tackling problems. But we also encountered difficulties in quantifying many potentially large benefits, especially those associated with the varying dynamics of natural systems, including the emerging effects of climate change.

To demonstrate that the investments in coastal protection, mangrove restoration and revitalisation of aquaculture ponds that we have outlined in this report are economically sound and beneficial to society, we developed a Social Cost Benefit Analysis (SCBA). The SCBA assesses future scenarios for two different coastal zones: Coast 0, reaching from Surodadi to Wulan Delta, where a coherent coastal greenbelt is lacking. Instead there are aquaculture ponds present up to the seafront, and Coast I/II closer to Semarang, from Bedono to Surodadi. A coherent greenbelt is also lacking here and in addition to this, erosion has taken hundreds of meters of aquaculture ponds. The future scenarios that were assessed range from continuing business as usual (do nothing) to a full building with nature landscape (continuation of our project's work, including stopping subsidence by 2030. The SCBA for Demak shows that the benefits of coastal protection measures using the BwN approach significantly outweigh the costs. The direct benefit is the creation of sustainable and productive land which in this case is used for aquaculture in Coast 0 and a mangrove and fisheries parks in Coast I/II. If no investments are made in coastal protection, it will result in the loss of productive aquaculture land and the consequences are dramatic as shown by the results of the Business as Usual scenario for both coasts. Besides the direct benefit of protecting productive land, the Building with Nature measures result in several additional income generating benefits, such as increased wild catch, increased tourism and recreation possibilities, production of timber and non-timber products, carbon sequestration and increase of biodiversity.

It is found that the value of all these benefits increases when the measures are maintained. But that requires government support. At a minimum, this should provide: restoration and conservation of the mangrove green belt, and financing mechanisms to support a continued transition from traditional to low external input aquaculture systems and associated mangrove aquaculture systems.

The SCBA does not consider the costs of subsidence. However, we can already today witness the losses of infrastructure and productive land. Continued success also hinges on government measures to halt land subsidence as soon as possible. An assessment of the economic consequences under different subsidence scenarios, conducted by Deltares [25] showed that some places are likely to sink by as much as two metres in the coming two decades, with expected economic damage of 4.9 billion Euros in Semarang and 1.8 billion Euros in Demak. Cutting the rate of subsidence by three-quarters would reduce economic damage by 80 per cent and 37 per cent respectively. Potential measures to achieve these benefits all involve reducing extraction of groundwater in and around Semarang. The measures include reducing water demand, recycling water, obtaining water from new sources and recharging the groundwaters.



Common sandpiper on mangrove roots.
Photo: Yus Rusila Noor, Wetlands International

Investment	Benefits	Value	Conclusion
€8 million (provided by bilateral funding and by EcoShape Foundation and its members, excluding research and Indonesian government funding) These costs must be weighed against the benefits of the Building with Nature approach in comparison with a business-as-usual scenario, which assumes that most threatened land is lost and incomes from aquaculture stop entirely.	Revitalisation of aquaculture	300 hectares of aquaculture ponds was projected to yield a net profit of €5,000 per hectare per year = €1,5 million Net present value of this yield 20 million EUR (7.5% over an infinite period of time).	Breakeven is attained after about five years. While the landscape restoration in Demak was financed by the Indonesian government and foreign donors, the quick-scan cost-benefit analysis shows that such a project could pay for itself if up-front investments can be financed, for instance via mild-conditioned loans. A mechanism for cost and benefit sharing within the landscape would then need to be developed. Disclaimer: This is only possible if land subsidence is effectively addressed.
	Coastal protection	Not calculated in the quick scan. The ecosystem services provided by mangrove forests, including coastal protection, have been valued at US$ 70,000 per ha/yr [27]	
	Other societal benefits, including mangrove forest products such as fruits and timber, near-shore fisheries, potential carbon values, avoided damage and avoided costs of relocating people.	Not calculated	

"The Building with Nature Indonesia programme offers a triple win: for nature, communities and economies. It meets local needs, while boosting benefits such as fisheries, carbon sequestration, recreation and biodiversity,"

YUS RUSILA NOOR, WETLANDS INTERNATIONAL

Resources

→ 16. Mahya, M., Kok, S., Cado van der Lely, A. Economic assessment of subsidence in Semarang and Demak, Indonesia. Deltares, 2021

→ 17. Nieuwkamer, R., Tonneijck, F., Van der Goot, F., Debrot, D., Social Cost Benefit Analysis; Building with Nature to restore eroding tropical muddy coasts. Wetlands International and Ecoshape. 2021

→ 25. Van Eekelen, E., Kok, S., De Kok, M., Gauderus, J., Jansen B., Gleijm, A. Paving the way for scaling up investment in nature-based solutions along coasts and rivers. EcoShape White Paper. 2021

BUILDING WITH NATURE IN DEMAK | UPSCALING IN INDONESIA AND ASIA | FROM A SMALL PROJECT TO LAND-SCAPE SCALE IMPLEMENTATION | GUIDANCE AND PUBLICATIONS

Lessons learned

→ Co-benefits do not necessarily translate into revenue streams, and if they do, additional efforts are needed to bring these revenue streams such as from carbon, ecotourism, fisheries or non-timber products into the project structure. Quantification of all social costs and benefits arising from Building with Nature requires new methods beyond traditional financial accounting.

Business Case

→ For long term implementation of BwN (future scenarios), innovative procurement models (such as short term versus. long term, performance-based) and multi-party integrated delivery agreements may apply to share risks. Pilots, like the BwN Indonesia project, in applying innovative procurement or other risk sharing models, allow learning and further development of such models.

Business Case

→ Ensuring long term benefits requires ongoing support from the government, notably in addressing land subsidence. The implementation of BwN measures requires the support of a governance structure which is typically provided by the national, provincial or local government for the protection of public goods such as mangrove forests. This governance structure should at least provide:

- Restoration and conservation of the mangrove green belt;
- A financing mechanism to support a transition from traditional to sustainable (associated mangrove) aquaculture;
- A financing mechanism to support a transition from unproductive aquaculture to mangrove fisheries park.

International embedding

→ Active community engagement is the way to create a local social-economic structure that could facilitate an integrated landscape transition. The Bio-Rights mechanism provides means to make the transition from traditional aquaculture to sustainable aquaculture as well as restoration and subsequent protection of the mangrove green belt.

Multi-stakeholder approach

→ To help reduce uncertainty and risks associated with the dynamic behaviour of BwN, consultants and the science community can support asset managers of BwN infrastructure by providing tools and advice for adaptive management practices which fit the dynamic character of BwN.

Management, monitoring and maintenance

Typical mangrove fruit flower.
Photo: Yus Rusila Noor, Wetlands International

5. Adaptive management

Building with Nature relies on a system of management that is able to adapt to the dynamic environment that it seeks to harness, including under changing climatic conditions. In Demak, we measured both biophysical and socio-economic indicators, ranging from rates of sedimentation and mangrove re-establishment to increases in pond harvest rates and incomes. Monitoring and evaluation was used by the project team to inform project management and has resulted in adaptive management, seizing opportunities and addressing risks. Detailed and regular monitoring and evaluation was also conducted by local communities, to inform their aquaculture and mangrove management decisions. Lastly, two research programmes have generated insight into coastal dynamics and aquaculture production systems.

To integrate this monitoring into project decision taking, we adopted an annual cycle, shown in figure 5. The monsoon months, when natural changes were most dynamic, last from November to February and are indicated with dark blue circles. After the monsoon, monitoring data are processed and analysed as input to updated design of both coastal safety and socio-economic measures. To enable alignment with the government funding and decision-making timetables, a draft design is available in April, and the final design by the end of May. In June and July, further project monitoring and evaluation takes place to make adjustments to coastal safety systems ahead of the next monsoon season. Implementation of socio-economic measures follows the rhythm of the aquaculture systems, which can vary widely and are not captured in the planning cycle. In August the preparations are made for the implementation of the coastal safety measures in September and October to be in place before the monsoon starts.

The importance of adaptive management has been underlined by the discovery, in mid-project, of the severity of land subsidence. We had always recognised that subsidence was an issue, but its extent was not obvious at the start. We found that pumping groundwater in cities and industry around Semarang affects land levels 20 kilometres or more away, and locally reaches eight centimetres or more per year. It has become evident that safeguarding the future of Demak requires groundwater extraction to decrease drastically. Otherwise, a threshold will be reached beyond which coastal restoration is no longer feasible. Our systems for adaptive management allowed us to raise awareness of the issue locally and to initiate dialogues with stakeholders at both local and national levels. It also empowered communities to join the dialogues. This approach resulted in the appointment of a Presidential Task Force, and the adoption in 2019 of a national “roadmap” for mitigating and adapting to subsidence, covering 132 districts and cities in 21 provinces. In Central Java, which includes Demak and Semarang, we translated this national initiative into a provincial roadmap. These roadmaps have adopted our Building with Nature approach and we hope will result in curtailing subsidence through a mixture of better water management and nature-based coastal protection.

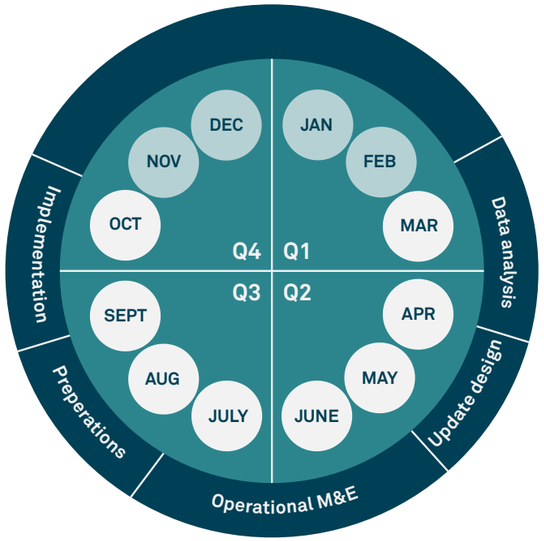


Figure 5: Annual cycle Building with Nature measures.



Community group of Berkah Alam from Surodadi Village conducting monitoring of mangrove growth and water quality in their associated mangrove aquaculture pond.
Photo: Netherlands Enterprise Agency on behalf of the Dutch Ministry of Foreign Affairs

Box 1: Research programmes

Building with Nature projects can be very locally specific, but a key characteristic is that their success requires fundamental knowledge about the functioning and interrelations of physical, ecological and societal systems that can have wide applicability. Our work inspired two spin-off research programmes that supported project implementation through their independent perspective and provided fundamental knowledge that gave confidence in the effectiveness of the measures:

BioManCO: "Bio-morphodynamic modelling of mangrove-mud coasts" (BioManCO) is a research programme run by three Netherlands-based PhDs that studies what drives the evolution of mangrove coastlines. It builds a numerical model that could help plan restoration efforts in a range of settings. Partners: TUDelft, Royal Netherlands Institute for Sea Research (NIOZ) and Diponegoro University (UNDIP, Indonesia). Website: http://www.biomanco.org/about-biomanco/

PASMI: "Project Aquaculture Supporting Mangrove restoration Indonesia" (PASMI) is a research programme developed at Wageningen and Diponegoro universities to design environmentally friendly alternatives to aquaculture ponds. It has analysed the potential for farming blue swimming crabs, a local inter-tidal species, and for integrated cultivation of shrimps, fish, seaweed, green mussels and blood cockles. Website: https://www.wur.nl/en/project/PASMI-BwN-Indonesia-.htm

MUMACO: "Mussels as mangrove facilitators for coastal defence" (MUMACO), by TUDelft, Wageningen University and the University of Diponegoro, funded by NOW is a follow- up research project to the BwN Indonesia project, with contributions from Deltares, Wetlands International, Ecoshape, Wageningen Marine Research and Witteveen+Bos. From 2021-2024 it will investigate how to optimally combine coastal restoration using vertical poles with new livelihood provision using mussel culture, to make a viable business case for environmental and socio-economic revitalization of the affected area.

Fisherman in Demak with riverine mangroves.
Photo: Joost Noordermeer

Lessons learned

- Continuous monitoring and research has increased our technology and system understanding which allowed us to respond to the natural dynamics of coastal systems with changes in materials used for the structures, innovations in design and changes to budget allocations to make the necessary adjustments.
- Community ownership has similarly been essential for adaptive management, because permeable structures need continuous maintenance in the face of storms and other wear and tear. This will continue until the mangroves behind the structures are sufficiently developed to take over their function.
- Directly addressing rapid land subsidence caused by groundwater pumping in and around Semarang was beyond the scope of the project. Nonetheless, our systems for adaptive management allowed us to raise awareness of the issue locally and to initiate dialogues with stakeholders at both local and national levels. This resulted in the uptake of a national roadmap to address land subsidence, safeguarding 132 districts and cities in 21 provinces.



Technology and system knowledge



Management, monitoring and maintenance



International embedding

Resources:

- 2. Van Wesenbeeck, B.K., Van Rees, F.F., Tonneijck, F., Cronin, K., Winterwerp, H. System Understanding; Building with Nature to restore eroding tropical muddy coasts. Wetlands International and Ecoshape. 2021
- 9. Cado van der Lely, A., Van Eekelen E., Honingh D., Leenders J., McEvoy S., Penning, E., Sterk, M., Voskamp, I., Warren, A., Van Zelst, V. Building with Nature: a future proof strategy for coping with a changing and uncertain world. Ecoshape White Paper. 2021
- 22. Smits, B., De Lucas Pardo, M., Van Wesenbeeck, B. Effectiveness of ecosystem-based adaptation measures subject to sea level rise and land subsidence. Modelling report of 'Ecosystem-based Adaptation at Scale Through Building with Nature Towards Resilient Coasts in Indonesia' project in Demak. Deltares. 2020

6. Enabling environment

It is often a challenge to secure sustainability beyond project lifetime. To ensure our gains are sustained, we have focussed extensively on raising awareness about the principles behind Building with Nature and on supporting the creation of a receptive policy environment. Community players, who are on the front line of the problem, are vital to this. Through the field schools and Bio-rights incentives, we have aimed to give community groups and their individual members the knowledge, skills and authority to engage in policy dialogues in their villages and with government officials at district and other levels. We have encouraged their participation to embed Building with Nature into coastal planning and the development of a new spatial plan for Demak district. Both government ministries involved in the project have supported the creation of this enabling institutional environment, and for its mainstreaming nationwide. In total 9 (inter-) national policies and plans better enable ecosystem-based solutions, nature based solutions or ecosystem restoration.

As a result of this work, appreciation of mangroves and the services they provide has increased enormously. We see this locally in community efforts at mangrove restoration outside the project itself, in the enactment by villages of new regulations that protect mangroves, and in commitments to give up aquaculture ponds for mangrove rehabilitation. Village development plans and associated land-use regulations incorporating Building with Nature have been adopted by communities and formalised within the local government of the 9 villages involved. These developments have received government support and resulted in enhanced funding for the maintenance of permeable structures, mangrove rehabilitation and improved aquaculture.

But continued success is not guaranteed. Despite the plans, there has been growing pressure to zone land in severely eroded areas of Demak for industrial development. Speculators have bought up land from villagers suffering from flooding. Industrial developments will likely involve heavy investment in hard structures to prevent flooding. While such investment might be cost-effective for the developer, it would damage the wider environment and communities by extracting more groundwater, accelerating subsidence, and increasing land loss and flooding along the coast of Demak.

In 2021, a Roadmap towards Adapting and Mitigating Land Subsidence in Central Java province was released as input from the Building with Nature Indonesia consortium to the Central Java Province government [27]. The Roadmap is based on the Water Dialogues involving all actors in the watershed, including water-using industries in and around Semarang and technical expertise, including an assessment of the economic consequences under different subsidence scenarios [22]. The overall aim is to mitigate subsidence in Semarang and Demak's coastal zone by 2030, by reducing groundwater extraction, recharging aquifers and optimising surface water use and recycling.

Lessons learned

- We have shown that muddy mangrove coasts are recoverable in the right conditions, but the process takes many years and requires constant adaptation to changing conditions. So those efforts need a legal and political framework that is conducive to long-term integrated planning.
- Combining bottom up empowerment of local communities and government with top down engagement from the national government turned out to be quite effective. Policies and plans at different levels enabled nature based solutions and resulted in budget allocations for measures on the ground.
- Awareness of the Building with Nature concept is still limited. The concept therefore needs further awareness raising, institutional embedding, capacity building and additional landscape scale implementation.



International embedding



Multi-stakeholder approach



Capacity building



H.M. Natsir

Head of Demak district (Bupati, 2016-2021)

Demak has suffered some of the worst flooding in northern Java and has been the focus of Building with Nature. As head of the district from 2016-2021, H.M. Natsir, describes progress.

Q: Flooding was bad again in 2020 in Demak. How bad was it?

A: Yes, the tides were very high. Floods covered approximately 5,133 hectares, including 6,372 houses in four sub-districts, Sayung, Karangtangah, Bonang and Wetuk. The main causes of the flooding are the rise of sea level due to global warming and the excessive groundwater extraction from many industries in the area, which is resulting in land subsidence of 10-12 centimetres per year, according to local university researchers.

Q: Can Building with Nature be the solution?

A: It is very helpful. The permeable structures capture sediment in several locations, and where that happens we have seen mangroves coming back. But in other places the waves are too high, because of the land subsidence. To finally control the problem, we will need alternative water supplies for industry, such as the Jragung and Dolok dams now under construction on rivers in the district.

Our regional government also wants the central government to build tidal embankments along the northern coast of Java. This plan is currently being investigated. With all these initiatives, we hope that in future flooding and erosion will be ended on our coast, which will allow the economies of coastal communities to grow.

Q: Meanwhile, you need to keep the structures maintained. How is that going?

A: We collaborate extensively with village governments and coastal community groups for the maintenance of the structures. It works well. We hope that this participation can be maintained and enhanced, because the structures will be needed for as long as the erosion continues. We are also supportive of the community groups forum, BINTORO, which has been very active in educating the communities about the different types of mangroves, and teaching them to rehabilitate and look after mangroves on the beaches.

Resources:

- 16. Mahya, M., Kok, S., Cado van der Lely, A. Economic assessment of subsidence in Semarang and Demak, Indonesia. Deltares, 2021
- 18. Noor. Y., Astra, A., Hoffmann, F., Andreas H., Handayani, W., Anggraeni, M., Hidayani, R., Saputra, H., Angger, N., Beagen, B., Cado van der Lelij, M., Muthia, M., Noordermeer, J. Assessment and Roadmap: Towards Adapting and Mitigating Land Subsidence in Central Java Province. 2021

“The Building with Nature project in Demak has given hope to the community that through working together and working hard, there is still a possibility to improve the situation and people’s livelihoods.”

MR. H.M. NATSIR, HEAD OF DEMAK DISTRICT, ROTTERDAM 2019

Handover the Building with Nature technical guidelines book to Demak government. From left to right: Dr. Singgih Setyono, Secretary of Demak District, Maskur, head of Forum Bintoro, Joost Noordermeer, Witteveen+Bos, Yus Rusila Noor and Apri Susanto Astra, Wetlands International Indonesia.
Photo: Wetlands International

Upscaling in Indonesia and Asia

Inspiring Action at Scale



Children are playing on the connecting bridge in the village area which has been submerged by sea water.
Photo: Netherlands Enterprise Agency on behalf of the Dutch Ministry of Foreign Affairs

The challenges in Demak are typical for many low-lying muddy coasts in Indonesia and across Asia along which mangroves have been converted into aquaculture ponds. Such coasts often face severe erosion and catastrophic floods that leave millions of people at risk of losing their houses, land, roads and income. For many such places, Building with Nature is a feasible, replicable and scalable solution. But it requires the right conditions, including the presence of involved and committed stakeholders from different sectors and disciplines, and a favourable and well-understood bio-physical environment. The principles of Building with Nature are universal. They can be applied in other environments besides muddy mangroves coasts. They have potential wherever decision makers face challenges to deliver infrastructure that protects land and water resources, while also benefiting nature and human activities and insuring landscapes against environmental shifts fuelled by climate change. Sandy beaches, river floodplains, lake shores and watersides in cities and ports can all benefit from combining hard and soft nature-based engineering solutions.

Indonesia has been a trail-blazer in mainstreaming of the success of Demak. Following the collaboration in Demak, the Indonesian Ministry of Marine Affairs and Fisheries (MMAF) altogether installed 23.5 kilometres of structures in 13 districts between 2015 and 2019 across Indonesia (see Table 1). PusAir, the research department of the Indonesian Ministry of Public Works and Housing, has developed and tested new semi-permeable structure designs, and is producing technical guidelines on their use that are being accepted nationally. The country's current mid-term development plan adopts Building with Nature as an innovative approach to the design of water infrastructure and coastal protection. The ministry also published a report in collaboration with Deltares and the Asian Development Bank (ADB) to draw up guidelines for river management that include nature-based solutions. It presents a step-by-step methodological approach to assist ADB project teams in incorporating natural river management approaches into the water sector investments in a systematic manner [36].

Despite our successes, however, many actors are still unaware of the benefits of Building with Nature. So, we continue to campaign to raise awareness amongst policy makers, planners, investors and engineers about both the advantages of a nature-based approach and the environmental downsides of hard infrastructure. We do this through local, national, regional and international events, online news updates, field visits, videos, discussion papers, technical guidelines and reports and scientific publications.

Demak has become a lighthouse example for the Global Center of Excellence on Climate Adaptation, an international body funded by the Dutch government. It also won two prestigious awards: the 2020 Flood and Coast Excellence Award from the British government's Environment Agency, and the 2016 Vernufteling Award from the Dutch Royal Institute of Engineers for innovative engineering.

7. Landscape propositions

To stimulate Building with Nature implementation in different parts of Indonesia suffering from water related problems we developed a series of landscape "propositions" in coastal and riverine landscapes that are vulnerable to climate change due to the decline of vital ecosystems. Landscape propositions are formulated together with national and local actors and experts. For each site biophysical and socio-economic stresses and conditions are analysed and root causes of the problems are defined. Through the participative process an integral approach to address the identified challenges is proposed, following Building with Nature principles, leading to high level project definitions. The Building with Nature solutions can vary depending on local settings, and can involve different combinations of hard and nature-based solutions, ranging from sediment capture by revegetating shorelines and restoring mangroves to nourishment of sand on beaches. Ultimately, the aim is to create a pipeline of projects to nurture investment in selected landscape propositions and support their implementation.

BUILDING WITH NATURE IN DEMAK | UPSCALING IN INDONESIA AND ASIA | FROM A SMALL PROJECT TO LAND-SCAPE SCALE IMPLEMENTATION | GUIDANCE AND PUBLICATIONS

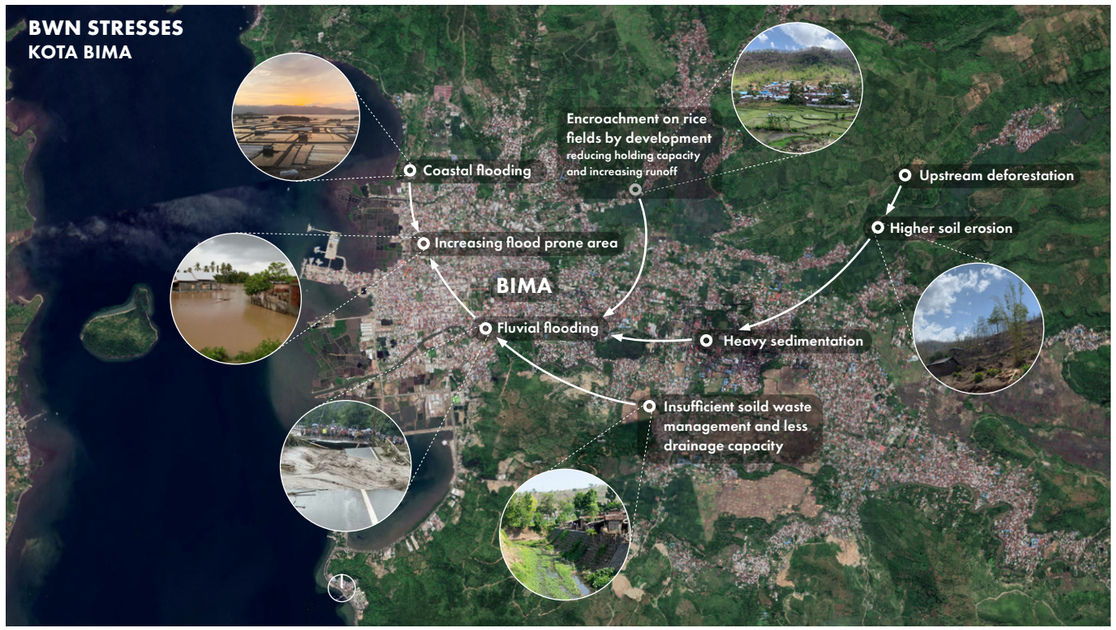


Landscape proposition showing potential Building with Nature solutions in and around Semarang to mitigate and adapt to subsidence. Showing links between Demak and Semarang's coastal zone. *Image: One Resilient team for the Water as Leverage Initiative*

The first landscape proposition was developed in 2018 as part of efforts to address land subsidence in Semarang and Demak, caused by unsustainable groundwater extraction. The Water as Leverage for Resilient Cities Initiative called for innovative, bankable and implementable designs to solve the challenges. Our partners helped develop tangible green-grey solutions in and around Semarang to address subsidence that have been very well received and will be further explored, see image above. Water as Leverage now provides funding for pre-feasibility studies to compare a traditional hard-engineering solution using a combined seawall and toll road with our proposed Building with Nature solution.

Further landscapes propositions are developed for Kota Bima, a city on the eastern coast of the island of Sumbawa in central Indonesia 's province West Nusa Tenggara, Lombok Timur at the coastline of East Lombok that suffers from severe erosion and coastal flooding and The Welang River, a first order river in East Java with 21 tributaries.

Below example from Kota Bima shows some of the visuals developed by One Architecture, Wetlands International and EcoShape resulting from the process of identifying stresses and conditions as well as Building with Nature solutions across the landscape.



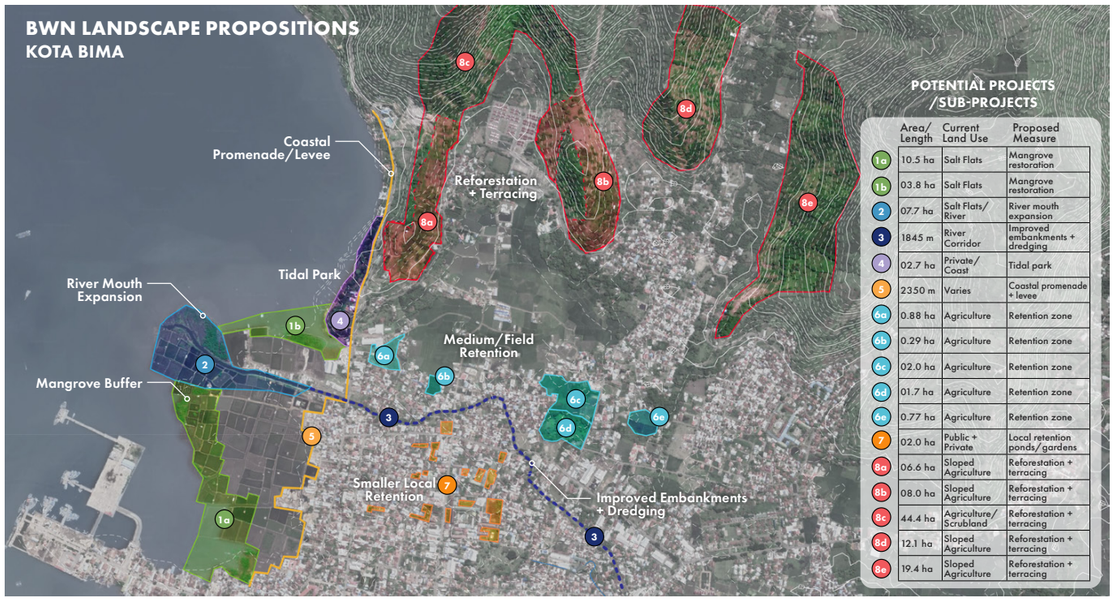


Images: One Architecture & Urbanism on behalf of the Building with Nature Asia initiative



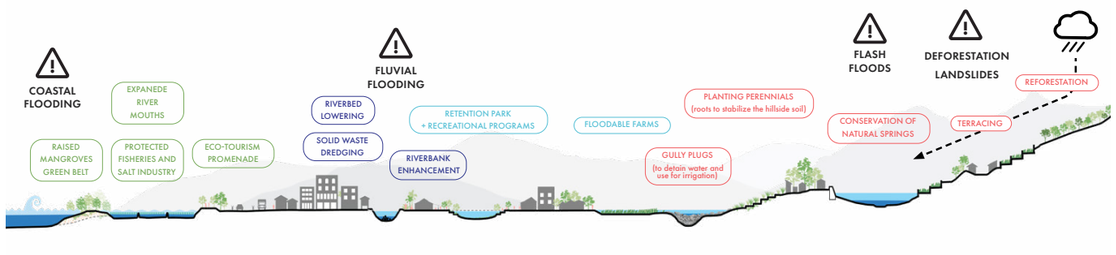


Images: One Architecture & Urbanism on behalf of the Building with Nature Asia initiative



	Area/ Length	Current Land Use	Proposed Measure
1a	10.5 ha	Salt Flats	Mangrove restoration
1b	03.8 ha	Salt Flats	Mangrove restoration
2	07.7 ha	Salt Flats/ River	River mouth expansion
3	1845 m	River Corridor	Improved embankments + dredging
4	02.7 ha	Private/ Coast	Tidal park
5	2350 m	Varies	Coastal promenade + levee
6a	0.88 ha	Agriculture	Retention zone
6b	0.29 ha	Agriculture	Retention zone
6c	02.0 ha	Agriculture	Retention zone
6d	01.7 ha	Agriculture	Retention zone
6e	0.77 ha	Agriculture	Retention zone
7	02.0 ha	Public + Private	Local retention ponds/gardens
8a	06.6 ha	Sloped Agriculture	Reforestation + terracing
8b	08.0 ha	Sloped Agriculture	Reforestation + terracing
8c	44.4 ha	Agriculture/ Scrubland	Reforestation + terracing
8d	12.1 ha	Sloped Agriculture	Reforestation + terracing
8e	19.4 ha	Sloped Agriculture	Reforestation + terracing



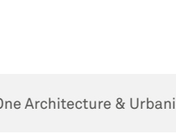


Images: One Architecture & Urbanism on behalf of the Building with Nature Asia initiative



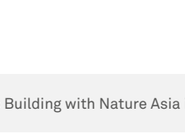
Mixed mangroves aquaculture practice

- withstand stormsurge and SLR
- trap sediment thus raise land to resist sea level rise and erosion
- support local fisheries



Expanding river mouths

- increase flood capacity
- decrease flood risk for the communities by the river
- plant floodable wetland species along river mouth to create recreational opportunities and habitat



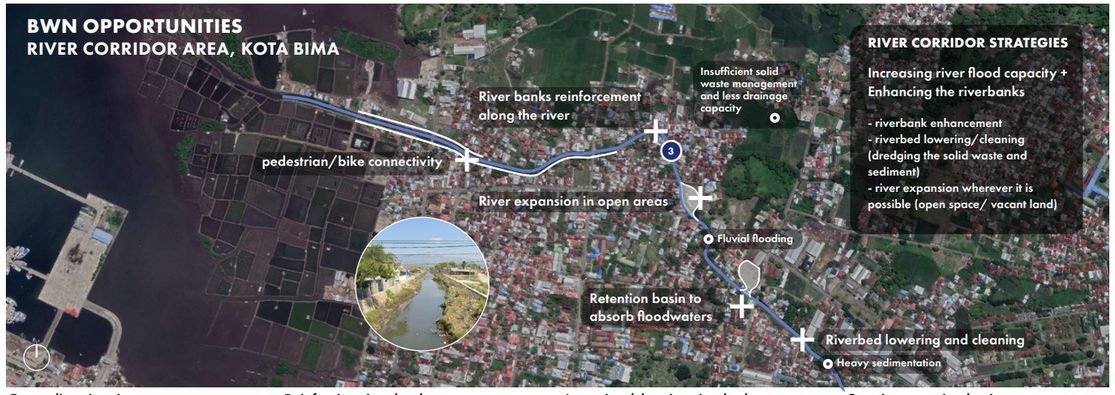
Vegetated shorefores + raised promenades

- protect low-lying land from sea level rise
- trap sediment to form soil thus strengthen the levee and increase seepage length
- attenuate waves
- create habitat
- create recreational destinations

Creating tidal parks

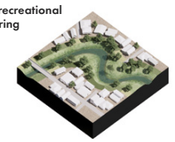
- trap sediment and filter polluted water
- regulate microclimates
- create recreational destinations
- create habitat





Expanding river in open areas

- green riverbanks and expand into available open space
- provide the recreational functions during dry season



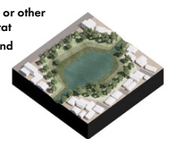
Reinforcing river banks

- normalize river banks
- offer pedestrian/bike connectivity along the rivers



Lowering/cleaning riverbed

- dredge the solid waste and sediment
- lower the riverbed
- restore wetland or other ecological haibtat
- trap sediment and pollutants

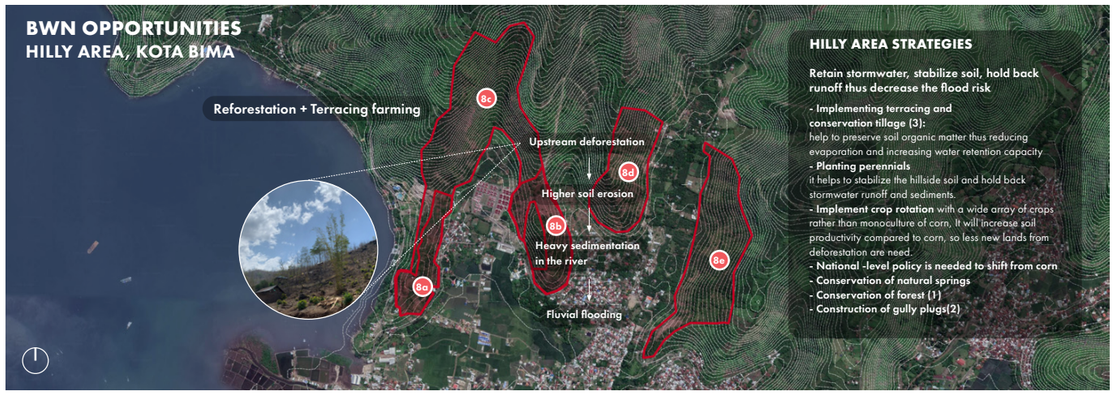


Creating retention basins

- expand river in open areas
- offer recreational programming during dry conditions for communities

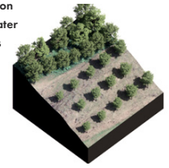


Images: One Architecture & Urbanism on behalf of the Building with Nature Asia initiative



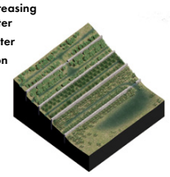
Reforestation on the hillsides

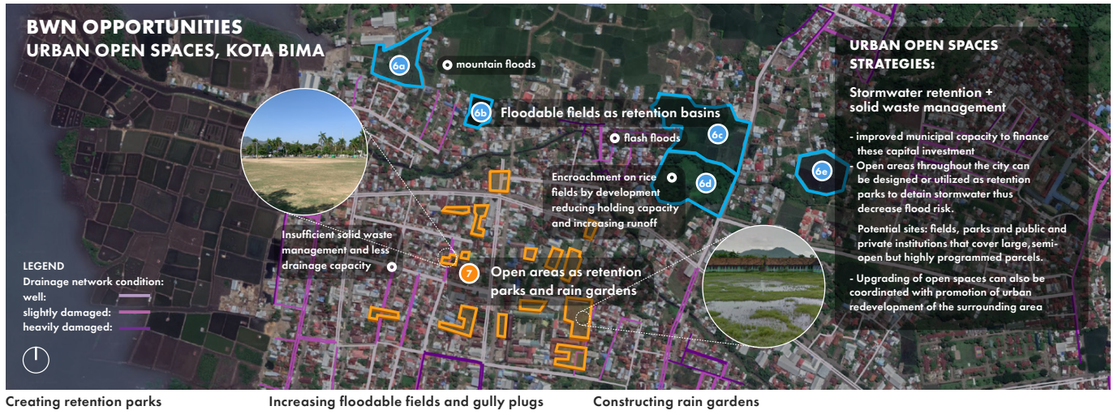
- stabilize hillside
- prevent soil erosion
- slow the stormwater runoff of hillsides



Engineered terracing

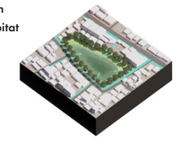
- more effective farming, decreasing irrigation water
- retain rainwater
- control erosion





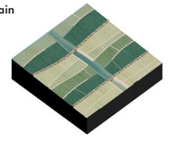
Creating retention parks

- detain stormwater
- increase infiltration
- create a recreational destination
- create habitat



Increasing floodable fields and gully plugs

- gully plugs help to store water for irrigation
- raise the edge of farmlands to retain stormwater
- control erosion



Constructing rain gardens

- offer public programming in dry conditions
- retain stormwater
- create habitat



Images: One Architecture & Urbanism on behalf of the Building with Nature Asia initiative

The need for BwN solutions is great. For example, a risk assessment of flooding on the north coast of Java, conducted by Deltares [37], found that 2.5 million people – a fifth of the population -- live in hotspots where subsidence of up to a metre could cause widespread flooding during storm surges. But the assessment concluded that the conservation of mangroves in rural areas would be a more effective approach than embankments, especially if combined with limiting groundwater extraction. In urban areas with less potential for mangrove cover, it found that hybrid strategies combining hard engineering and natural regeneration might work best. The risk assessment informs a new bilateral Memorandum of Understanding on water being agreed by the governments of Indonesia and the Netherlands, which stresses continuing existing collaboration on enhancing coastal resilience in Java. Scaling up Building with Nature will hopefully be a key part of the strategy.

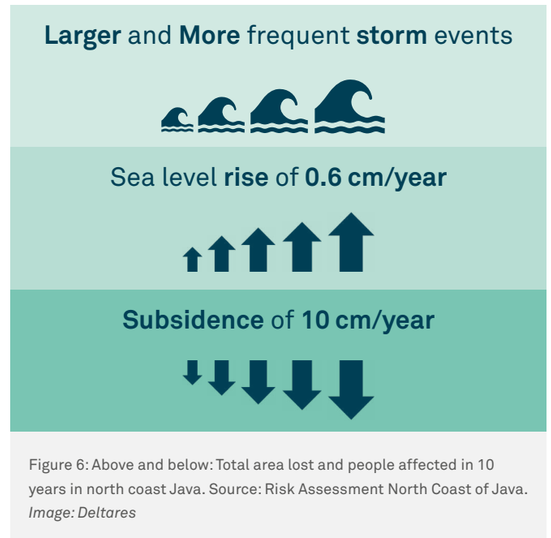


Figure 6: Above and below: Total area lost and people affected in 10 years in north coast Java. Source: Risk Assessment North Coast of Java. *Image: Deltares*



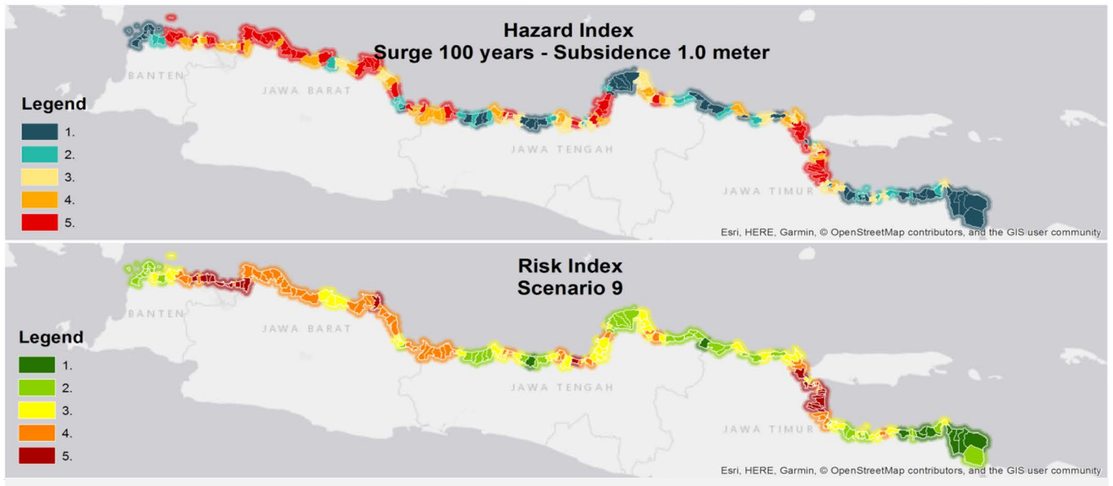


Figure 7: Risk index of the north coast of java. The top plot shows the hazard index for a scenario of subsidence of 1.0m, surge with a return period of 100 year. The risk index (bottom panel) combines the exposure and hazard index with large numbers (red) indicating a large exposure, hazard and/or risk. *Source: Risk Assessment North Coast of Java. Image: Deltares*

8. Capacity building and training

Among our biggest successes in Demak was the way that coastal field schools empowered community members to engage in policy dialogues. But our capacity building has extended much more widely, among universities, policy makers, water and coastal zone managers and engineers. Collaboration between our public and private partners has resulted in education, training, and knowledge-sharing programmes targeting a wide variety of stakeholders and sectors. The Building with Nature Massive Open Online Course, developed by TU Delft, has served as an entry point for professionals and now includes Asian examples, most notably Demak. It has already educated more than 750 engineers and ecologists to work with nature rather than against it [41].

We have rolled out a Training of Trainers (ToT) programme, specifically adjusted for the Indonesian and South East Asian context, geared towards building a new pool of instructors. The curriculum covers all stages of Building with Nature implementation from the analysis, design and evaluation of solutions in the physical environment, to understanding government institutions, stakeholders and financing. Over four years, 62 trainers participated in four ToT events. As of the beginning of 2020, they had reached over 2500 students and agreed to repeat this annually.

Building with Nature training programmes were embedded in the curricula of eight universities across Indonesia, namely Faculty of Marine and Fisheries, Universitas Diponegoro (UNDIP), Faculty of Engineering, Universitas Brawijaya (UNBRAW), Faculty of Civil Engineering and Environment, Institut Teknologi Bandung (ITB), Faculty of Engineering, Institut Teknologi Sepuluh November (ITS), Faculty of Civil Engineering and Regional Planning, Institut Teknologi Sumatera (ITERA), Faculty of Engineering, Universitas Jember (UNEJ), Faculty of Engineering, Universitas Udayana (UNUD), Faculty of Civil Engineering and Planning, Institut Teknologi Kalimantan (ITK). Five Ministries and associated Research departments participated in the Training of Trainers programme, namely the Ministry of Marine Affairs and Fisheries, Environment & Forestry, Public Works & Housing, Planning and the Coordinating Ministry for Maritime Affairs and Investment Affairs, including e.g. the Center for Research and Development of Water Resources (PusAir) and the Hydrodynamic Institute of Technology.

Finally, we found exchange visits especially valuable to inspire upscaling. We organised an exchange trip for officials from PusAir and MMAF to Vietnam to study various coastal nature-based solutions, and facilitated field visits to Demak and the Netherlands for high-level government officials, stakeholders and Indonesian and international university students.



Filming and interview with pak Rudhi in Bali for the new BwN MOOC.
Photo: Amrit Cado van der Lelij, Deltares



Hendra Yusran Siry

Secretary of Directorate General of Marine Spatial Management at the Ministry of Marine Affairs and Fisheries

Indonesia’s Ministry of Marine Affairs and Fisheries (MMAF) chose the coastline of Demak district, where around 70,000 people have suffered flooding, to try out permeable structures. Hendra Yusran Siry, now its Secretary of Directorate General of Marine Spatial Management, was in charge of implementation of Building with Nature in Demak and its upscaling around Indonesia.

Q: What have been the critical factors behind the success of Building with Nature in Demak?

A: Most important has been the political will and financial support of the MMAF, combined with the willingness of the provincial and local governments to participate and to align it with their development priorities. It was a joint effort from all three levels of government.

Q: One of the original objectives was to show that the approach worked and learn lessons for upscaling elsewhere in Indonesia and beyond. Did you achieve that?

A: Yes. The MMAF has already applied the principles we learned in Demak to several other areas along the north coast of Java and elsewhere Indonesia, for instance Sulawesi and Lombok. Altogether, some 30 million people at risk of losing their houses, roads, land and livelihoods to coastal flooding, stand to benefit. I have seen similar practices in Vietnam. So, I am sure Building with Nature can be applied to other Asian countries too, and beyond. Across the world, thousands of kilometres of tropical mud coasts are suffering dramatic erosion from lost mangroves. We can help. Indonesia, as the world’s biggest archipelago and a leader in mainstreaming oceans policy, has the potential and experience to take a leading role.

Q: What was your most interesting experience during the project?

A: Of course, the big picture of upscaling is vital, but my most enjoyable experience during the project has been to see the enthusiasm of the communities working on the project to safeguard their futures.



Construction of permeable structures, 2015.
Photo: Nanang Sujana



Jan Paul van Aken

Senior advisor Netherlands Enterprise Agency

Protecting the coast of northern Java with permeable structures is a flagship project of the Dutch government's Sustainable Water Fund, says Jan Paul van Aken, project advisor at the Netherlands Enterprise Agency. And its potential for replication on other threatened shores is massive.

Q: How did your agency become involved in Building with Nature in Demak?

A: Indonesia has a big problem with coastal erosion and tidal inundation along the north coast of Java. In some areas, they have a simple choice: do something major to address the problem or abandon the land to the ocean. Partial abandonment was being actively discussed, especially because hard engineering with sea walls was protecting some places but making things worse in others. But instead, the Indonesian government wanted to work with Dutch companies who have expertise from back home in using natural processes to build shorelines. It came to us for funding.

Q: How has it worked out from your perspective?

A: It has been a challenge. From the start we were experimenting with what kind of permeable structures would work best to trap mud and allow mangroves to regrow. Anything permeable to the waves and tides is subject to damage. So, the trick has been to make the structures rigid without being impermeable. Though a lot of maintenance has been required, and the design has changed quite a lot, we have achieved that. And while we often have to help, mangroves do regrow. Also, the stakeholder engagement has been very effective, right from ministries to the communities that do all the construction and repair.

Q: What is the potential for upscaling and replication?

A: There is a very large potential, in the first instance all along the northern shore of Java. Some places will probably still need hard engineering, but our task is to integrate mangrove restoration using permeable structures with that, to benefit the whole coastline. For instance, Jakarta Bay may require hard structures, but permeable structures could be very effective around the edges of the Bay. We are discussing that now with the government, the Asian Development Bank and others.

Replication is not simple. One size does not fit all. The essentials for success are fine-tuning the design of the structures to the local geomorphology, ensuring community participation and finding ways to make projects financially sustainable by leveraging public-private finance. Bio-rights have been important at the village scale, leveraging gains for aquaculture farmers. There needs to be continued public funding for further construction and the maintenance of structures that are now under community ownership.

But we have shown the huge potential of permeable structures to allow the restoration of mangroves, and to protect and restore coastlines.



Aerial picture of Demak village with permeable structures in front of the coastline. *Photo: Boskalis*

9. Building with Nature Asia

Several international regulations and agreements support the ideas that underlie Building with Nature. So, we have been able to make inputs to their work. This includes ecosystem-based adaptation under the Paris Agreement; nature-based solutions under the Sendai Framework for Disaster Risk Reduction; as well as the work of the Convention on Biological Diversity, the Ramsar Convention on Wetlands, development banks, the EU's Green Infrastructure and Biodiversity Strategy and the UN's Decade of Ecosystem Restoration.

Support for natural solutions to engineering problems has increased especially rapidly in Asia. Indonesia -- the world's largest archipelago, - some 80,000 kilometres coastline – is seen across the continent as a test case for using Building with Nature to protect coastlines from erosion. MMAF has raised the ambition to support its international adoption. Wetlands International teamed up with the Global Center on Climate Adaptation, MMAF and EcoShape to initiate a joint commitment, Accelerating Adaptation through Building with Nature in Asia, announced at the UN Climate Summit in New York in 2019.

But while there is funding available, proposals that tackle issues in an integrated manner remain in short supply. To address this, we are working with political partners and stakeholders in Malaysia, the Philippines, China, Indonesia and India, to develop large-scale projects to replicate Indonesia's success.

Singgih Setyono, Secretary of Demak district sharing his experience at a Building with Nature Asia workshop in Rotterdam, 2019.
Photo: Studio Dijkgraaf



Image: One Architecture & Urbanism



Keizrul Abdullah

Wetlands International Malaysia and regional coordinator for Building with Nature Asia

Building with Nature is a key part of a global effort to harness natural processes in adapting to the threats posed by climate change. But engineers remain hesitant, until the techniques are proven to work better than concrete, says Keizrul Abdullah, chairperson of the Council of Wetlands International Malaysia, who is the regional coordinator for upscaling Building with Nature across Asia.

Q: Is Indonesia just the start?

A: Yes indeed. Indonesia is the only Asian country to have rolled out Building with Nature at scale so far. So we depend a lot on its experience, and our Indonesian counterparts are keen to share it. After an expert workshop in 2019, four other nations expressed a strong interest in joining -- Malaysia, the Philippines, China and India – along with the Asian Development Bank. The aim is to include more countries. In each, we propose identifying one site for landscape scale restoration, so we can show stakeholders it is viable, cost-effective and acceptable to local communities. But after that, we are looking to scale up quickly to more projects in each country. Our ambition is to benefit 10 million people in the coming decade, by integrating the services nature provides into civil engineering practice.

Q: How far have you got?

A: Our approach is to hold a national consultation in each country to introduce Building with Nature and assemble a coalition of supporters. Covid-19 has held things up, but we had a workshop in Malaysia in February 2020, just before lockdown, where stakeholders identified four potential sites for landscape scale restoration across the country, three suffering from coastal erosion and one on a lagoon. Malaysia has a tradition of using hard engineering to solve hydraulic and erosion problems. I am an engineer; I have been part of that. But hard engineering is expensive, not very aesthetic and often environmentally unfriendly, so we are looking for better ways. The national consultation established a core of key stakeholders -- comprising Wetlands International, three government departments, three universities and with input from the hands-on experience of the Dutch design and planning company One Architecture -- that will soon decide on the final landscape to restore.

Q: Will the methods be the same as in Indonesia?

A: It is indeed an option to apply in Malaysia various elements from Indonesia, such as replicating the success with permeable structures to combat coastal erosion. However, Building with Nature extends beyond that. In the Philippines, for instance, tackling problems along rivers will require different ways of harnessing natural processes. So we will pioneer other solutions. There are no one-size-fits-all solutions. Every solution will be site specific.

Resources:

→ 45. Building with Nature Asia: www.buildingwithnatureasia.org





Building with Nature Asia workshop, Rotterdam, 2019
Photo: Studio Dijkgraaf

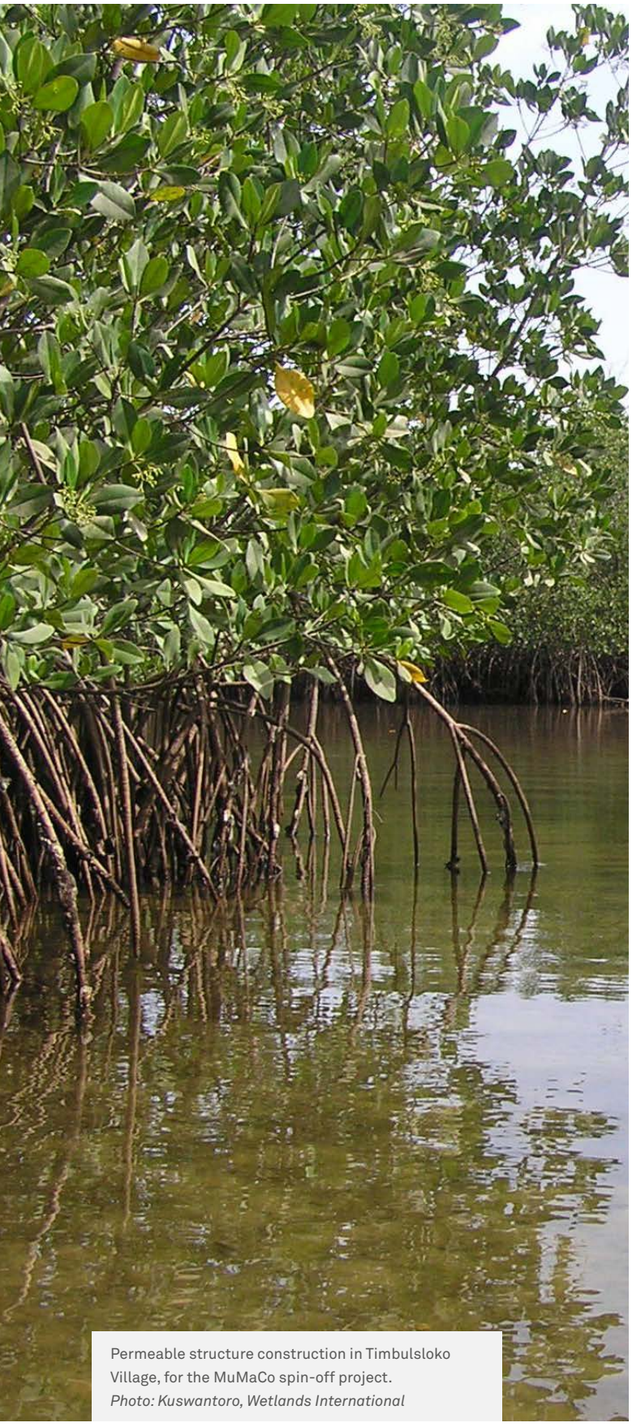
From a small-scale project to landscape scale implementation

BUILDING WITH NATURE IN DEMAK | UPSCALING IN INDONESIA AND ASIA | FROM A SMALL PROJECT TO LANDSCAPE SCALE IMPLEMENTATION | GUIDANCE AND PUBLICATIONS



Milky stork.
Photo: Rusila Noor, Wetlands International

In Demak we turned a small experiment in one village into rehabilitation of 20km of mangrove coast in 7 years' time, as an alternative to failed efforts to build breakwaters and replant mangroves. The project, managed through a multi-disciplinary initiative and enabled through public private funding has been widely hailed a success. The Demak case is now used as a lighthouse example to inform the way Nature-based Solutions are planned, designed and financed. Its design and collaboration approaches and its engineering and social methods are being taught into Indonesian universities and mainstreamed by the Indonesian government elsewhere. The cost-benefit analysis that was conducted demonstrates the financial viability of the project which is necessary to generate further support and financing for replication of this particular Building with Nature application. While the project formally ends in 2021, its methods and ideas are set for replication across the Indonesian archipelago and more widely through Asia.



Permeable structure construction in Timbulsloko Village, for the MuMaCo spin-off project.
Photo: Kuswantoro, Wetlands International

10. Timeline

2012

Small scale pilot starts in Timbulsloko village

2015

- → Project scales up to 20 km coastline through a multi-disciplinary partnership
- → Mainstreaming: MMAF constructs 14,2 kms of permeable structures (of which 3,3 km in Demak

2016

- → 45 Centimetres of sedimentation monitored behind first series of permeable structures
- → Indonesia and the Netherlands sign Letter of Intent to enhance coastal restoration in Central Java.
- → German funding leveraged to stimulate sound replication and upscaling of Building with Nature.
- → First Coastal Field Schools starts
- → Building with Nature Indonesia wins the Vernufteling Award

2017

- → Bio-rights contracts signed with 10 villages
- → Mainstreaming: MMAF constructs 7,4 kms of permeable structures in Demak
- → Partners raise the alert on rapid subsidence rates and related flooding across Demak district
- → MMAF raises its ambition to mainstream the Building with Nature approach in Indonesia

2018

- → Training and Awareness programme kicks off. MoU signed with 8 universities and knowledge institutes. 2500 students trained.
- → Partners join design solutions for sinking and flooding challenges in Semarang city adjacent to Demak
- → National workshop on land subsidence
- → Start of Water Dialogues with all actors in the watershed in and around Semarang
- → Transfer of ownership and maintenance of permeable structures to Demak communities

2019

- → Mainstreaming: MMAF constructs 2 more km of permeable structures
- → Risk Assessment North Coast Java shows replication potential approaches applied in Demak

2020

- → Building with Nature Master Open Online Course with BwN Indonesia project case
- → BINTORO Ocean management forum launched by the 10 community groups of Demak
- → Building with Nature Indonesia wins international Flood & Coast Excellence award

2021

- → Technical guidelines released
- → Launch of Roadmap on land subsidence Central Java
- → Development of landscape propositions to scope and stimulate new Building with Nature projects in Indonesia and wider Asia

2015-2021

Institutional embedding of Building with Nature in policies and planning at district and (sub)national levels

2012

A small scale experiment starts in one village

In 2012, we convened a group of NGOs and knowledge institutes to discuss how to restore degraded mangrove coastlines in Indonesia. Benefitting from a million-Euro philanthropic donation, Wetlands International, Deltares and The Nature Conservancy draw attention to the role of mangroves for coastal safety and develop a novel way to restore mangroves in settings with severe erosion. Equipped with this knowledge, we assessed opportunities with the Indonesian government.

The government had already tried various strategies to mitigate the land loss. It had placed concrete sea walls along the shore of Demak, but these had collapsed in the soft mud and blocked sediment transport inland, further exacerbating erosion. Efforts to plant mangroves, meanwhile, had also failed, because the water along the shore had become too deep. A new approach was needed.

In the Netherlands, EcoShape had been experimenting with Building with Nature concepts to harness the forces of nature to benefit the environment, economy and society. The Indonesian government asked to investigate the potential of our novel approach in the Demak village of Timbulsloko. The local communities, who had lost valuable land and homes to the waves, welcomed these efforts, and the project began.

Funding: 1.3M by Waterloo Foundation, Stichting Otterfonds, Nationale Postcode Loterij, anonymous donor.

2015

Scaling up

The experiment in Timbulsloko was proving successful, so in 2015 our partnership was expanded through EcoShape to include private-sector partners. Ecoshape members jointly pledged two million Euros, which was subsequently augmented with three million Euros from the Dutch Government. The aim now was to rehabilitate 20 kilometres of coastline in the Demak district. What started as a small scale experiment developed into a landscape-scale implementation project.

Funding: 2M (Ecoshape partners), 3M (Sustainable Water Fund, Dutch Ministry of Foreign Affairs), 1.1M (NWO, TKI, Research programmes Dutch government)

2016

Funding leveraged

The German government extended our project with three million Euros to enhance climate and water resilience and stimulate sound replication through training and the development of landscape propositions for other settings.

Funding: 3M, The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) as part of the International Climate Initiative (IKI).

A Dutch trade mission to Indonesia, featuring a field visit to Demak and resulting in a Letter of Intent signed by Minister Schultz (Dutch Ministry of Transport, Public Works and Water Management) and Minister Susi (Indonesian Ministry of Marine Affairs and Fisheries) on coastal restoration in Central Java.

The project also won the prestigious Vernufteling engineering award, and received high-level backing when the Dutch Prime Minister Mark Rutte and the minister of Marine Affairs and Fisheries in Indonesia referred to it as cutting-edge innovation during a trade mission. This political buy-in resulted in mainstreaming by the Indonesian government in 13 sites elsewhere in the country. Meanwhile PusAir secured 1.1 million Euros for research to monitor and further enhance the approach

2017

Building with Nature Forum

MMAF took the initiative to set up a Building with Nature Forum, to disseminate the approach through practical training and support in Indonesia and wider Asia, and by embedding Building with Nature principles into government policy. The ambition was to become a Centre of Excellence that engages government, private sector, knowledge institutes and civil society to initiate new landscape-scale restoration in different settings, and to cement a paradigm shift in Indonesia towards sustainable hydraulic engineering.

2018

Capacity building
We initiated a Training and Awareness programme for the public and private sector that resulted in eight universities and knowledge institutes adopting Building with Nature in their curriculums. The aim is to create a workforce of future policy makers and practitioners fluent in its principles and the practices.

Land subsidence
The Coordinating Ministry for Maritime Affairs and Investment Affairs, Wetlands International, Partners for Resilience organise the first national workshop on land subsidence.

Water as Leverage Semarang
Partners join Water as Leverage Initiative design teams to develop solutions for sinking and flooding challenges in Semarang, the city adjacent to Demak.

2018 - 2021

Water dialogues

By 2018, the threat posed by land subsidence was becoming increasingly clear. The programme organised a symposium in 2018 and developed with MMAF a national Roadmap on the issue. In 2019 we organised ‘Water Dialogues’, involving all actors in the watershed, including water-using industries in and around Semarang. The overall aim is to mitigate subsidence in Semarang and Demak’s coastal zone by 2030, by reducing groundwater extraction, recharging aquifers and optimising surface water use and recycling. In 2021, a customised roadmap towards Adapting and Mitigating Land Subsidence in Central Java province was released as input from the Building with Nature Indonesia consortium to the Central Java Province government, based on the Water Dialogues and technical expertise, including a an assessment of the economic consequences under different subsidence scenarios.

2020-2021

Landscape propositions for Indonesia

To scope and stimulate new Building with Nature implementation in different parts of Indonesia, we began work with MMAF to develop a series of landscape propositions for areas suffering from water related problems.

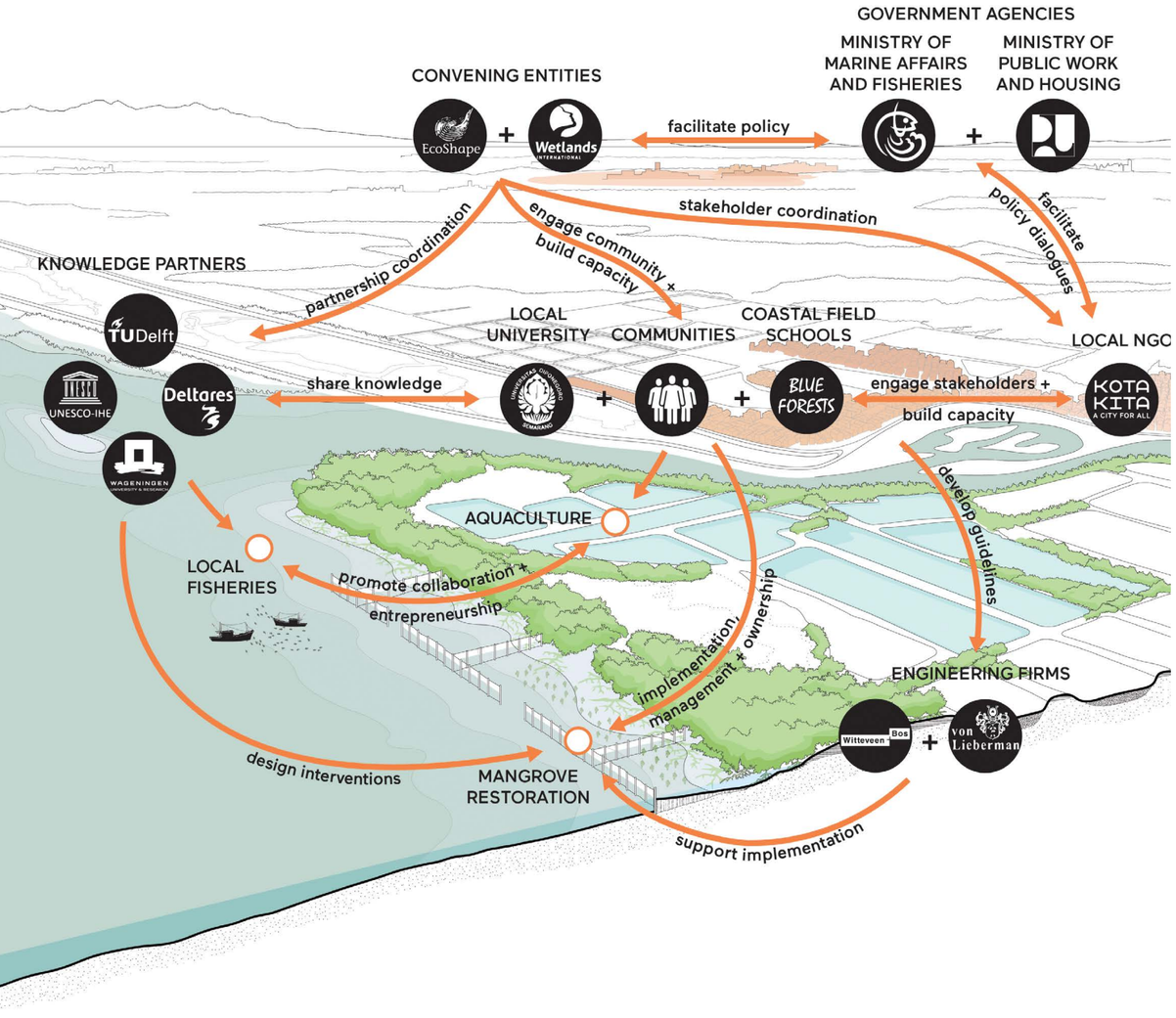
2021

Building with Nature Asia

Wetlands International, in collaboration with MMAF, EcoShape and One Architecture, initiate the Building with Nature Asia programme to mainstream nature-based solutions in water and marine engineering practice across Asia. Working with political partners and stakeholders in five Asian countries, the initiative builds political commitment; develops work packages at regional and national levels to overcome barriers in awareness, knowledge, capacity, institutional environment and finance; and identifies potential sites for the development of large-scale projects across 5 Asian countries.



Photo: Netherlands Enterprise Agency on behalf of the Dutch Ministry of Foreign Affairs



Organisation chart of the Building with Nature Indonesia project.
Illustration: One Architecture & Urbanism

11. Partnership

Building with Nature Indonesia was implemented through a public private partnership under leadership of the Indonesian government, Wetlands International and Ecoshape. This partnership connected international expertise and experience with local knowledge on engineering, aquaculture, ecosystems, capacity building and governance. Such interdisciplinary collaboration has been essential to our success, with each partner bringing specific knowledge, experience and skills. Partners include government agencies, not-for-profit organisations, knowledge institutes, the private sector and local communities in Demak.

Government agencies

Building with Nature aims to fit into local institutional norms and regulations to help develop the necessary partnerships and ensure funding. Planning and implementation in Demak took place in alignment with field programmes of the Indonesian Ministry of Marine Affairs and Fisheries, the government body responsible for management of coastal and marine resources, and the research centre for water resources at the Indonesian Ministry of Public Works and Housing, which is responsible for large water-safety infrastructure. We worked closely with the government at village, district, province and national level, facilitating horizontal and vertical collaboration between agencies.

Not-for-profit organisations

Wetlands International, the global NGO dedicated to maintaining and restoring wetlands for nature and people, managed the overall public-private partnership, led the implementation and coordination of the partnership, budget and work programme and coordinated outreach and field based activities, empowered local communities, facilitated policy and stakeholder dialogue and contributed ecological expertise. EcoShape acted as liaison with the Dutch Building with Nature community, bringing together public and private organisations. It partially financed the programme and co-managed the partnership with Wetlands International. Blue Forest, an Indonesian NGO dedicated to community based mangrove conservation and restoration, organised coastal field schools for communities in Demak. Kota Kita, an Indonesian NGO with expertise in urban planning and citizen participation, contributed to the Water Dialogues to address groundwater extraction, the primary cause of land subsidence in Semarang and Demak.

Knowledge institutes

Monitoring the local ecological, social and physical systems is essential for any Building with Nature intervention to work, as is disseminating this knowledge. Deltares and Wageningen University & Research and the Aquaculture Department of the University of Diponegoro shared their knowledge on coastal ecology and geomorphology, aquaculture and alternative livelihoods. They designed and monitored the Building with Nature interventions undertaken in Demak district. Deltares also coordinated training, together with the international water education facility UNESCO-IHE. The University of Diponegoro in Semarang contributed local knowledge to the design and supported on-the-ground monitoring and implementation. Additionally, Delft University and Wageningen University in collaboration with University of Diponegoro performed independent scientific research on the coastal dynamics and aquaculture systems, contributing to our system understanding. We further collaborated closely with the research department of the Ministry of Marine Affairs and Fisheries and Ministry of Public Works and Housing (PUSAIR).

Private sector

Building with Nature's designs are intended to be dynamic, able to respond to changing climatic conditions. This adaptive approach requires innovative engineering and contracting practices. Consultancy and engineering firm Witteveen+Bos was responsible for the implementation of coastal engineering by Indonesian contractors and communities, and prepared the overall social cost-benefit analysis. Through the engineering company Von Liebermann, we exchanged ideas with stakeholders in Vietnam that were implementing similar landscape restoration interventions. Two dredging and maritime engineering contractors, Boskalis and Van Oord, contributed via the EcoShape consortium. Dutch design and planning company One Architecture supported the development of landscape propositions inspiring upscaling in Indonesia and Asia.

Communities:

Last but far from least, design, implementation and maintenance of Building with Nature measures was carried out as much as possible with and by local communities, through Bio-rights agreements, field schools and individual enthusiasm. The small-scale experiment began in Timbulsloko village, extended to ten community groups in nine villages and actively involved a total of 260 people.



Interdisciplinary collaboration.
Photo: Yus Rusila Noor, Wetlands International

“I grew up in the 1960s when the sea was more than a mile away. Life was good. Food was cheap. Then the waves got bigger. The flooding began. It became worse in the 1990s. The water in our fields became salty, and our houses were lower in the water.

I got involved in the Building with Nature approach because I believed we had to do something. Many people were moving, if they had money. But this is our home and, God willing, we plan to stay. I hope the landscape restoration can save us. We are putting back the mangroves. If everyone did their job it would be OK. I feel new hope.”

SLAMET IN TIMBULSLOKO ON HIS MOTIVATION FOR BEING INVOLVED



Guidance and publications

The Building with Nature Initiative has produced various materials that may be of use for others, notably leaflets, technical guidelines, technical reports and scientific publications. These materials are listed here, along with a few key references that informed our work and may inform the work of others. Note that this list is by no means conclusive.

Leaflets

- Building with nature for coastal resilience. Wetlands International. 2013
- Building with Nature Indonesia - reaching scale for coastal resilience. Wetlands International and EcoShape. 2015
- Building with Nature Indonesia: meet the partners. Wetlands International and EcoShape. 2016
- Design Summary Water as Leverage for Semarang to integrate risk reduction with ecological restoration, economic growth and a fostering of social resilience with communities. One Architecture. 2019
- Landscape scale disaster risk reduction: public private sector collaboration in Java. Wetlands International. 2017
- Mangrove restoration: to plant or not to plant? (available in 10 languages). Wetlands International. 2016
- Policy brief: Sustainable Technologies and Aquaculture Field Schools to increase Indonesian's Shrimp and Milkfish Production. PASMI. 2020

Series of Technical guidelines

1. Wilms, T., Van der Goot, F., Tonneijck, F., Nurhabni, F., Sembiring, L. Building with Nature Approach; Building with Nature to restore eroding tropical muddy coasts. Wetlands International and Ecoshape. 2021
2. Van Wesenbeeck, B.K., Van Rees, F.F., Tonneijck, F., Cronin, K., Winterwerp, H. System Understanding; Building with Nature to restore eroding tropical muddy coasts. Wetlands International and Ecoshape. 2021
3. Wilms, T., Van Wesenbeeck, B.K., & Tonneijck, F. Permeable Structures; Building with Nature to restore eroding tropical muddy coasts. Wetlands International and Ecoshape. 2020
4. Bosma, R.H, Debrot, D., Rejeki, S., Tonneijck, F., Yuniati, A., W. & Sihombing, W. Associated Mangrove Aquaculture Farms; Building with Nature to restore eroding tropical muddy coasts. Wetlands International and Ecoshape. 2021
5. Bosma, R.H., Rejeki, S., Ariyati, R.W., Widowati, L.L., Fadila, R., Yuniati, W. Building Sustainable Aquaculture through Coastal Field Schools Building with Nature to restore eroding tropical muddy coasts. Wetlands International and Ecoshape. 2021

Reports and publications

6. Assessment of the Biorights mechanism in Demak: A community incentive for sustainable development and mangrove conservation. Final report. Lestari Sustainable Development Consultants Inc. 2021
7. Bosma. R.H., Nguyen, T.H., Siahainenia, A.J., Tran, H.T.P., Tran, H.N. Shrimp-based livelihoods in mangrove silvo-aquaculture farming systems. Aquaculture. 2014
8. Bouw, M. & Van Eekelen E. Building with Nature - Creating, implementing and upscaling Nature-based Solutions. Nai Publishers. 2020
9. Cado van der Lely, A., Van Eekelen E., Honingh D., Leenders J., McEvoy S., Penning, E., Sterk, M., Voskamp, I., Warren, A., Van Zelst, V. Building with Nature: a future proof strategy for coping with a changing and uncertain world. Ecoshape White Paper. 2021
10. Cado van der Lely, C., Van Rees, F., De Lucas Pardo, M., Van Wesenbeeck, B. Ecological mangrove restoration with permeable structures. Monitoring report. Deltares. 2021
11. Damastuti, E., De Groot, G., Debrot A.O., Silvius, M. Effectiveness of community-based mangrove management for biodiversity conservation: A case study from Central Java, Indonesia. Trees, Forests and People. 2022
12. Debrot, A.O., Plas, A., Boesono, H., Prihantoko, K., Baptist, M.J., Murk, A.J., Tonneijck, F.H. Early increases in artisanal shore-based fisheries in a nature-based solutions mangrove rehabilitation project on the north coast of Java. Estuarine, Coastal and Shelf Science. 2022
13. Debrot, A.O., Veldhuizen, A., Van Den Burg, S., Klapwijk, C., Islam, N., Alam, L, Ahzan, M, Ahmed, M., Hasan, S., Fadilah, R., Noor, Y., Pribadi, R., Rejeki, S., Damastuti, E., Koopmanschap, E., Reinhard, S., Terwisscha Van Scheltinga, C., Verburg, C., Poelman, M. Non-Timber Forest Product Livelihood-Focused Interventions in Support of Mangrove Restoration: A Call to Action. Forests. 2020
14. Gijón Mancheño, A., Jansen, J., Winterwerp, H., Uijttewaal, W. Predictive model of bulk drag coefficient for a nature-based structure exposed to currents. Nature Scientific Reports. 2021
15. Kodikara K., Mukherjee N., Pulukkuttige, J., Dahdouh-Guebas F., Koedam N. Have mangrove restoration projects worked? An in depth study in Sri Lanka. Restoration Ecology. 2017
16. Mahya, M., Kok, S., Cado van der Lely, A. Economic assessment of subsidence in Semarang and Demak, Indonesia. Deltares, 2021
17. Nieuwkamer, R., Tonneijck, F., Van der Goot, F., Debrot, D., Social Cost Benefit Analysis; Building with Nature to restore eroding tropical muddy coasts. Wetlands International and Ecoshape. 2021
18. Noor. Y., Astra, A., Hoffmann, F., Andreas H., Handayani, W., Anggraeni, M., Hidayani, R., Saputra, H., Angger, N., Beagen, B., Cado van der Lelij, M., Muthia, M., Noordermeer, J. Assessment and Roadmap: Towards Adapting and Mitigating Land Subsidence in Central Java Province. 2021
19. Primavera, J., Esteban, J. A review of mangrove rehabilitation in the Philippines: successes, failures and future prospects. Wetlands Ecology and Management volume 16, pages 345–35. 2008
20. Rejeki, S., Debrot, A.O., Van den Brink, A., Ariyati, R.W., Widowati, L.L. Increased production of green mussels (Perna viridis) using longline culture and an economic comparison with stake culture on the north coast of Java, Indonesia. Aquaculture Research. 2020
21. Russi, D., Ten Brink, P., Farmer, A., Badura, T., Coates, D., Förster J., Kumar R. and Davidson N. The Economics of Ecosystems and Biodiversity for Water and Wetlands. IEEP: London and Brussels; Ramsar Secretariat: Gland. 2013
22. Smits, B., De Lucas Pardo, M., Van Wesenbeeck, B. Effectiveness of ecosystem-based adaptation measures subject to sea level rise and land subsidence. Modelling report of 'Ecosystem-based Adaptation at Scale Through Building with Nature Towards Resilient Coasts in Indonesia' project in Demak. Deltares. 2020
23. Spalding M, McIvor A, Tonneijck F., Tol S and Van Eijk P. Mangroves for coastal defence. Guidelines for coastal managers & policy makers. Published by Wetlands International and The Nature Conservancy. 2014
24. Taufai, A., De Lucas Pardo, M., Van Wesenbeeck, B. Ecosystem-based adaptation at scale through Building with Nature: towards Resilient Coasts in Indonesia. Exploratory Integrated Water Resources Management (IWRM) Study in Demak Coastal Area: Water Availability and Water Users. Deltares. 2018
25. Van Eekelen, E., Kok, S., De Kok, M., Gauderus, J., Jansen B., Gleijm, A. Paving the way for scaling up investment in nature-based solutions along coasts and rivers. EcoShape White Paper. 2021
26. Tonneijck, F., Winterwerp, H., Van Wesenbeeck, B., Bosma, R., Debrot, D., Rusila Noor, Y., Wilms, T. 2015. Building with Nature Indonesia Securing Eroding Delta Coastlines: Design and Engineering Plan. Ecoshape Foundation, Dordrecht, The Netherlands. 65 pp. 2015
27. Van Eijk, P. & Kumar, R. Bio-rights in theory and practice. A financing mechanism for linking poverty alleviation and environmental conservation. Wetlands International, Wageningen, Netherlands. 2009
28. Van Eijk, P., Van der Goot, F., Tol, S., Van Wesenbeeck, B., Wilms, T. Coastal protection by means of natural mangrove recovery: experiences from Demak. H2O-Water Matters. 2018.
29. Van Wesenbeeck, B., Van IJzendoorn, C., Nunez Sanchez, A., 2019. Regional: Protecting and Investing in Natural Capital in Asia and the Pacific. Guidelines for mainstreaming natural river management in ADB Water Sector Investments. Asian Development Bank. 2019
30. Widowati, L., Rejeki, S., Ariyati, R., Bosma, R. The impact of aquaculture field school on the shrimp and milkfish yield and income of farmers in Demak, Central Java. World Aquaculture Society 52: 362-377. 2021
31. Willemsen, P., Cado van der Lely, C., Van Wesenbeeck, B. Risk Assessment North Coast Java. Deltares. 2019
32. Wardani, I., Cado van der Lely, A., Massa, Y. Monitoring of Mixed Mangrove Aquaculture. New method for restoring aquaculture farms in Indonesia. Deltares. 2021
33. Wilms. T., Van der Goot, F., Debrot, A.O. Building with Nature - an integrated approach for coastal zone solutions using natural, socio-economic and institutional processes. Paper presented at: Coasts & Ports 2017 Conference – Cairns, 7pp. 21-23 June 2017
34. Wilms, T., Van der Goot, F., Debrot, A.O. Building with Nature - an integrated approach for coastal zone solutions using natural, socio-economic and institutional processes. PIANC Coasts & Ports Conference. 2017
35. Wilms, T., Prusina, I., Van der Goot, F.. Building with Nature: Restoring mangrove coast. E-proceedings of the 38th IAHR World Congress nr 367 6 pages. 2019
36. Winterwerp, J.C., Wilms, T., Van Wesenbeeck, B.K . Building with Nature – Indonesia; Towards A Sustainable Protection of Mangrove Coasts. HATHI seminar Bali. 2015
37. Winterwerp, H., Wilms, T., Siri, H.Y., Van Thiel de Vries., J., Noor, Y.R., Van Wesenbeeck, B., Cronin, K., Van Eijk, P., Tonneijck, F. Building with Nature: Sustainable Protection of Mangrove Coasts. Terra et Aqua. 2016
38. Winterwerp, J., Albers, T., Anthony, E., Friess, D., Gijón Mancheño, A., Mosely, K., Muhari, A., Tas, S., Tonneijck, F. Naipal, S., Noordermeer, J., Wilms, T., Saengsupavanich, C., Van Eijk, P., Van Lavieren, E., Van Wesenbeeck, B. Managing erosion of mangrove-mud coasts with permeable dams – lessons learned. Ecological Engineering. 2020
39. Yuniati, W., Fadilah, R., Rejeki, S., Widowati, L., Ariyati, R.W., Astra, A., Bosma, R. Aquaculture field schools supporting mangroves for climate change adaptation of Indonesian milkfish-shrimp farmers. Aquaculture Asia. 2021
40. Van Bijsterveldt, C.E.J., Debrot, A.O., Bouma, T.J., Maulana, M.B., Pribadi, R., Schop, J., Tonneijck, F. To Plant or Not to Plant: When can Planting Facilitate Mangrove Restoration? Frontiers in Environmental Science, section Interdisciplinary Climate Studies. 2022

Online sources:

41. Master Open Online Courses (MOOC) on Building with Nature:
    - https://www.edx.org/course/engineering-building-with-nature
    - https://www.edx.org/course/beyond-engineering-building-with-nature
42. Building with Nature approach: www.ecoshape.org
43. Building with Nature Indonesia: www.indonesia.buildingwithnature.nl
44. The 4 Returns Framework for landscape proposition 2021-2030, Commonland, Landscape Finance Lab and Wetlands International, 2021
45. Building with Nature Asia: www.buildingwithnatureasia.org

Thanks to our partners:





























Building with Nature in Indonesia

Restoring an eroding coastline and inspiring action at scale

2015-2021