Frontiers of Change

How Nature-Based Solutions in Coastal Areas can Help Address Global Crises

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Executive Summary

Ecosystem services provided by nature are a hugely under-rated asset. Coastal ecosystems in particular provide a wide range of benefits for our planet and humankind – natural capital – which remain undervalued. Seagrass meadows, for example, are a more powerful carbon sink than terrestrial forests. Mangroves and oyster beds are sources of food and fuel and act as natural buffers against storm surges and cyclones, which are becoming fiercer with climate change. Coral reefs are the most productive habitat in the marine realm, supporting more than 25% of all marine species,[1] and also sustain many jobs in tourism.

Ultimately, nature is priceless. However, it is not valueless. Estimates of the total value of the world's ecosystem services amount to twice as much as global GDP – as much as US$125 - 145 trillion per year.[2]

And yet, because our financial and national accounting systems do not assign a monetary value to the services provided by nature, natural habitats[3] are overexploited and degraded. The world has lost 85% of oyster reef habitats in the past century and half of the world's mangrove forests in the past 50 years. Coral reefs face extinction within the next few decades.[4] The planet may be losing 7% of its seagrass cover every year and this rate is likely accelerating.[5]

The loss of these natural habitats endangers biodiversity, accelerates climate change and impoverishes livelihoods. Protecting and regenerating coastal ecosystems is therefore of vital importance.

This report centres on the benefits of coastal regeneration for countries in Africa, East Asia and the Gulf Cooperation Council (GCC). All three regions have large coastal areas that support many livelihoods but are vulnerable to the impacts of climate change.

Nature-based Solutions (NbS) are regenerative interventions that seek to work with nature to reverse the damage caused to our natural environment. If implemented cohesively and in an integrated manner, NbS have the potential to address multiple overlapping challenges simultaneously. They can help mitigate climate change, reverse biodiversity loss, help prevent future pandemics and support economic development.

Furthermore, NbS are low-tech, affordable and have the potential to create lots of jobs, which means they are particularly suited to the developing world, where the impact of global warming and environmental degradation is more acutely felt.

The International Labour Organisation estimates 17 green jobs can be created per million dollars spent on coastal habitat protection.[6]

There is now an unprecedented opportunity for governments in East Asia, Africa and the GCC to embrace NbS as part of efforts to rebuild economies and address their overlapping climate, environmental and economic challenges. With the right policies, enabling conditions and relatively modest investment, governments can unlock the full potential of NbS.

By including NbS in national development plans and climate strategies, governments also add to their toolbox for meeting their international commitments to the UN Social Development Goals and the Paris Climate Agreement.

However, by their very nature, NbS are long-term projects. To ensure success, governments must begin to value natural capital; they must set aside long-term funding to allow NbS projects to reach maturity; and they must recruit a diverse group of stakeholders to win community support, assist with monitoring and enforcement, and share the benefits widely.

Our human, environmental and economic health are inextricably linked. By including NbS within green growth recovery strategies, governments will be securing a more resilient and sustainable future for their people and the planet.

Chapter 1

Working with Nature

Working with Nature

Nature-based Solutions can help the world address multiple overlapping crises, including climate change, loss of biodiversity, pandemics and economic shocks

Nature-based Solutions (NbS) is the name given to a suite of environmental interventions that have a powerful regenerative effect on natural ecosystems. If implemented cohesively and in an integrated manner, NbS can help mitigate climate change, reverse biodiversity loss, help prevent future pandemics and support economic development.

The International Union for Conservation of Nature (IUCN) defines NbS as "actions that address key societal challenges through the protection, sustainable management and restoration of both natural and modified ecosystems, benefiting both biodiversity and human wellbeing".[7]

Effective and affordable

The IUCN estimates NbS have the potential to supply up to 37% of our carbon abatement needs.[8]

Coastal ecosystems such as seagrass meadows, salt marshes and mangrove forests, for example, are much more effective at absorbing CO2 than tropical rainforests. They cover less than 2% of ocean areas but absorb about 50% of the total carbon sequestered by oceans.[9]

NbS can also reduce the harm caused by extreme weather events and help build resilience to climate change. Mangroves alone, if healthy and sustainably managed, provide a natural buffer against storm surges, cyclones and rising sea levels – threats that have become more serious with global warming. Restoring mangrove forests could reduce annual flooding for more than 18 million people globally, says the IUCN, and avoid $57 billion of economic losses in China, India, Mexico, the US and Vietnam each year.[10]

NbS are low-tech and affordable interventions, yet are often overlooked in policy-making. Only recently, with the acceleration of our climate crisis, have governments looked anew at the potential of working with nature to address multiple overlapping challenges simultaneously.

The value of 'natural capital'

Central to the environmental, social and economic value of NbS is the concept of 'natural capital'. This is the sum of natural assets, including geology, soil, air, water and all living things, that make human life possible.[11]

Natural capital includes the food we eat, the water we drink and the plant materials we use for fuel, building materials and medicines. There are also many less visible ecosystem services such as the climate regulation and natural flood defences provided by forests, the billions of tonnes of carbon stored by peatlands or the pollination of crops by insects. Even less tangible are cultural ecosystem services such as the wellbeing we derive from wildlife or a walk in the woods.

Destruction of natural capital – depleting aquifers, denuding forests, overfishing – can trigger local, regional or even global ecosystem collapse. Poorly managed natural capital is not only an ecological liability, but a social and economic liability too. Overexploiting natural capital can be catastrophic not just in terms of biodiversity loss, but also for humans. It makes it more difficult for communities to sustain themselves, particularly in already stressed ecosystems, potentially leading to starvation, conflict over resource scarcity and migration.

There are many studies that have calculated natural capital's value in financial terms. For example, street trees in California provide $1 billion per year in ecosystem services, through atmospheric regulation and flood prevention.[12] Mexico's mangrove forests provide an annual $70 billion to the economy through storm protection, fisheries support and eco-tourism.[13] Estimates of the total value of the world's ecosystem services amounted to twice as much as global aggregate GDP – as much as $125-145 trillion per year.[14]

The destruction of natural capital therefore brings associated costs. Scientists warn we are in the midst of the sixth mass extinction of species,[15] with an estimated 68% of vertebrate populations lost since 1972.

Government subsidies[16] that drive loss of nature are extensive, at around $4-6 trillion per year.[17]

The link between human, environmental and economic health

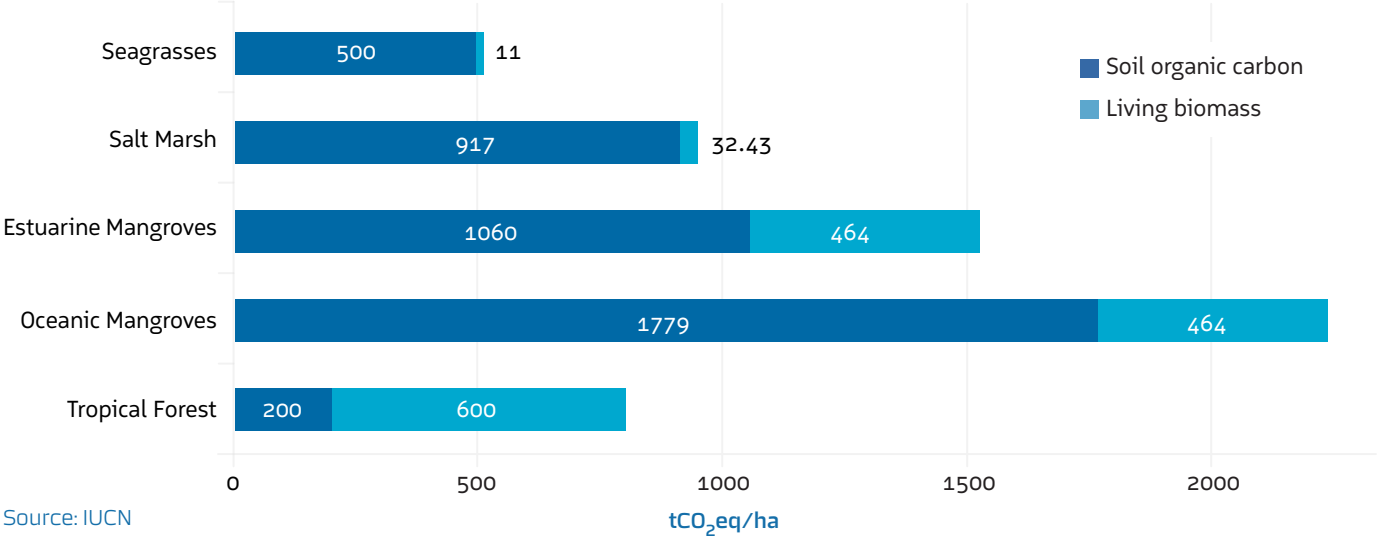
Our human, environmental and economic health are inextricably linked, which is why the destruction of natural capital can have devastating consequences.

While the origin of the Sars-CoV-2 virus that triggered the COVID-19 outbreak is still a matter of conjecture, one theory is that it originated in a horseshoe bat. Human encroachment on its habitat, or wildlife trade and consumption, may have caused the virus to jump species and infect humans.[18] Almost all known pandemics (influenza, HIV/AIDS, COVID-19) and 70% of new diseases, such as Ebola, Zika and Nipah encephalitis, are caused by microbes of animal origin that spread due to contact among wildlife, livestock and people.[19] Climate change has also been implicated in disease emergence and will likely cause substantial future pandemic risk by driving the movement of people and wildlife, resulting in the spread of pathogens.[20]

Containing climate change will require global greenhouse gas (GHG) emissions to decline to net zero by the middle of this century.[21] This requires unprecedented efforts to reduce reliance on fossil fuels and solutions to enhance carbon sinks and remove emissions from the atmosphere.

Nature-based Solutions (NbS), such as forests, mangroves and seagrasses, have the potential to store atmospheric carbon emissions (Figure 1).

Figure 1: Carbon sequestration per hectare of coastal ecosystems and tropical forests



Source: IUCN

Social and economic benefits

Estimates of the value of NbS to the economy, job creation and human wellbeing include:

- 'Natural capital' contributes more than twice as much to human well being as GDP, offering global services worth an estimated $125-145 trillion annually.[22]
- An estimated 1.2 billion jobs in sectors such as farming, fisheries, forestry and tourism are dependent on the effective management and sustainability of healthy ecosystems.[23]
- 17 green jobs can be created per million dollars spent for coastal habitat protection, similar to conservation of parks and land, and much higher than industries including coal, gas and nuclear power (ILO & WWF 2020).[24]
- NbS provide the highest job intensities per million dollars invested (see Figure 2).

Figure 2 [25]:

Activities integral to implementation of NbS	Types of jobs	Total direct job (FTE)/ US$ million
Afforestation, reforestation and desertification control	Environmental science jobs (forester), farmers, lawyers, administrative positions	275 to 625
Watershed improvement	Urban planners, environmental science jobs (hydrologists), construction workers	166 to 500
Indigenous forest management	Administrative positions	200 to 400
Agroforestry including conversion of land	Farmers, pastoralists, agronomists, environmental science jobs	500 to 750
Creation and management of urban green spaces	Gardening, landscaping, horticulture, environmental science jobs, administrative jobs, tourist guides	24 to 250
Fire management	Environmental science jobs, foresters, fire fighters	200 to 250

Dr Vanessa Perez, Former Deputy Lead, Global Climate & Energy Practice, WWF International

"This is not just an environmental crisis, it's an economic and humanitarian crisis too. The world's economies, businesses and our own wellbeing all depend on nature – the natural assets, such as thriving ecosystems and species, water resources and stable atmosphere."

Focus on East Asia, Africa and the GCC

This paper aims to spark interest and debate on the relevance of NbS to countries in East Asia, Africa and the Gulf Cooperation Council (GCC). It will show how NbS can be supported and scaled up to generate sustainable value. These regions have been selected because they are especially vulnerable to the impacts of climate change and also because they have not focussed as much on NbS as, for example, Europe and North America.

East Asia faces worsening pollution and the degradation of ecosystems caused by rapid population growth and economic development. Africa has a young and growing population and depends on natural resources to improve livelihoods. The countries of the GCC are major exporters of fossil fuels, with the associated GHG emissions, and face a future of acute water scarcity as a result of climate change. NbS are an opportunity for these regions to address their challenges, create jobs and diversify their economies as part of the energy transition.

All three regions have large coastal areas that are vulnerable to the impacts of climate change and support many livelihoods. This paper therefore focuses on NbS for coastal areas and how they can be scaled up. Each chapter will examine one natural habitat, chosen for its potential to meet multiple sustainability objectives. Mangroves, seagrass meadows, coral reefs and oyster reefs will be discussed in turn, with case studies, lessons learnt and key messages for policy-makers.

Chapter 2

Mangroves

Mangroves

A Nature-based Solution for climate adaptation

Mangrove forests are among the most productive ecosystems on earth. They are a rich source of biodiversity, food, timber and economic activities such as shrimp farming, and they are efficient carbon sinks, capable of storing three to four times more CO2 than inland tropical forests. They also prevent coastal erosion and protect coastal communities from rising tides and storm surges, making them the first line of defence against hurricanes and cyclones, which are increasing in frequency and intensity with climate change.

Some estimates put the value of ecosystem services provided by mangrove forests at $2.7 trillion.[26]

Every year, they absorb the carbon emissions of some 50 million cars.[27]

In flood prevention alone, mangroves protect more than 18 million people around the globe and avert up to $57 billion in flood damage every year across China, India, Mexico, the US and Vietnam.[28]

And yet, despite the incredible value that mangroves provide, some 50% of the world's mangroves have been lost in the past half century. They now cover only 157,000 km², just twice the land area of the United Arab Emirates.[29] If current trends continue, the remaining mangroves could be gone by the end of this century.

As a result, policy-makers face two urgent tasks: protect existing mangroves from further destruction and embark on mangrove restoration projects to build resilience against climate threats, increase biodiversity and provide new economic activities for coastal communities.

The International Union for Conservation of Nature, the University of Cambridge and The Nature Conservancy estimate that 8,120 km² of lost or degraded mangrove areas show potential for restoration, with 5,000 km² considered highly restorable.[30]

Mangrove restoration – success factors

The best places to restore mangrove forests are where there is a large tidal range, good sediment supply and where nearby mangroves could help protect, re-seed and nurture recovery. Restoration is unlikely to be successful in built-up areas or where the coast is severely eroded and has been fully inundated by the sea.

The map below shows the potential for mangrove restoration across Asia, Africa and the GCC region (Figure 3).

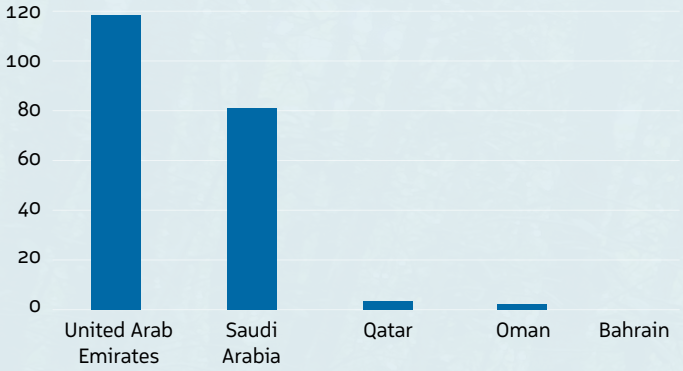
Figure 3: Key restorable area of mangroves

Source: http://maps.oceanwealth.org/mangrove-restoration/

Case Study 1
GCC region: public-private partnerships and drone technology for mangrove restoration

Mangroves are found in the coastal areas of the Arabian Gulf and Red Sea, particularly in the United Arab Emirates (UAE) and Saudi Arabia (Figure 4). As economies in the region seek to diversify away from oil, mangrove restoration has the potential to create new jobs, especially in eco-tourism. For example, mangrove areas in Abu Dhabi have been estimated to provide ecosystem services worth $141 million a year to 15 hotels.[31]

Figure 4: Mangroves extent (km^2) in GCC



Source: https://gma-panda.opendata.arcgis.com/grove-restoration/

Public-private initiatives

An innovative public-private partnership in the UAE, bringing together Environment Agency – Abu Dhabi (EAD), French utility ENGIE and Distant Imagery Solutions, a drone company, is piloting a mangrove-planting project near the site of the Al Mirfa power station,[32] which is operated by ENGIE.

The project is planting 4,000 mangrove seedlings and using custom-made drones to monitor their growth at the Al Mirfa lagoon. The early stages of the project reportedly show outstanding results. Furthermore, ENGIE's 20-plus-year contract to operate and manage the power station matches the length of time the mangrove seedlings will take to grow into mature trees, allowing the utility to remain engaged with the restoration project.

The project is an example of how the goals of different partners can be integrated into a common vision and approach. EAD fulfils its mission to conserve biodiversity; ENGIE implements a project to meet its carbon abatement and biodiversity targets; and Distant Imagery Solutions, a local start-up, gets a chance to test its technology, generating income and employment.

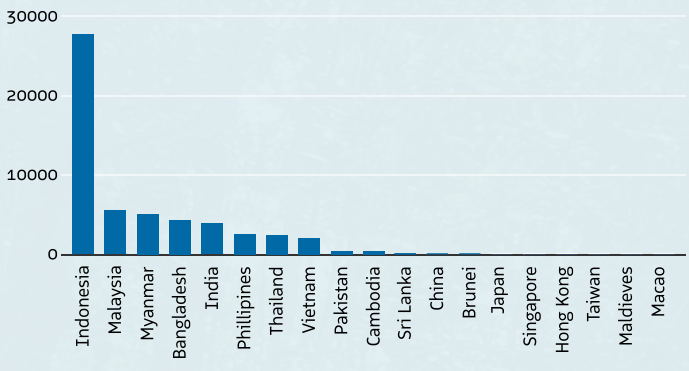
In Saudi Arabia, NEOM – a new zero-carbon city – is being built and 95% of its terrestrial and marine habitats will be protected conservation areas.[33] In addition to making the city sustainable, the Kingdom aims to generate revenues from eco-tourism ventures in its protected parks, including areas of mangrove along the Red Sea coast.

In a separate initiative, the national oil company, Saudi Aramco, is planting two million mangrove seedlings with support from thousands of company and community volunteers[34] as part of an ambitious programme to restore lost mangrove habitats in the Kingdom's Eastern Province.

Case Study 2
East Asia: protecting coastlines and boosting incomes in Indonesia and the Philippines

Mangroves in Asia (Figure 5) face severe pressure from agriculture, logging, urban development and climate change. The loss of mangroves adds new pressures on food security and increases the risks of flooding and coastal erosion during storms. The loss of protective cover and biodiversity provided by mangroves has also impoverished local fishermen, leading many to migrate elsewhere for work.

Figure 5: Mangroves extent (km^2) in Asia



Source: https://gma-panda.opendata.arcgis.com/

In the Indonesian village of Paremas on the island of Lombok,[35] for example, demand for firewood led to a significant decline in mangrove acreage. However the large mangrove forest had been shielding the coastline from storm surges and deposits of plastic waste. About a decade ago, the local government and environmental NGOs began to raise awareness in the local community about the importance of restoring the mangroves. This led to a replanting project with positive results and multiple benefits. The women of Paremas, for example, launched a bakery business using mangrove flour, which tripled their incomes. The restored mangrove forest has also helped absorb the impact of large ocean swells and stopped waste plastic from piling up on the beach.

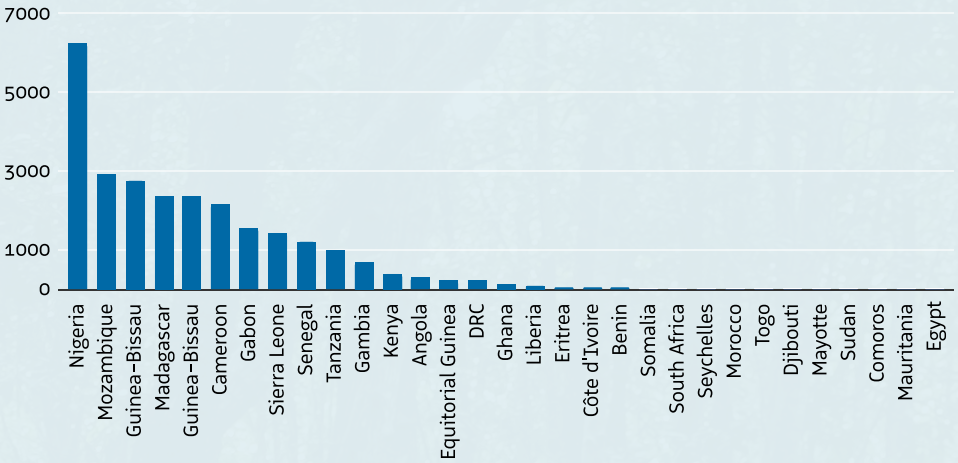
The Philippines, a country regularly ravaged by typhoons, has lost half of its mangrove cover in the past century. Fishpond aquaculture is mainly to blame. Commercial fishponds are often built to the shoreline despite laws mandating 50-100 metres of mangrove greenbelt. In Panay Island, efforts have been made to convert abandoned fishponds back into mangroves, providing climate mitigation and adaptation benefits and supporting improved livelihoods for local communities.[36]

Case Study 3
Africa: natural regeneration in Guinea-Bissau, Senegal and Tanzania

West Africa's coast has some of the highest and most rapidly growing populations in the region. Many communities rely on mangrove wood as a primary fuel source. Mangroves also play an essential role in West Africa's coastal fisheries, which contribute $400 million annually to the regional economy, according to USAID.

The need for fuel and the pressures of urbanisation and agriculture have caused West Africa to lose 5% of its mangrove cover since 1975, a net loss of 984 km². Nigeria, which has the biggest mangrove cover on the continent (Figure 6) accounts for almost half of that loss.[37]

Figure 6: Mangroves extent (km²) in Africa



Source: https://gma-panda.opendata.arcgis.com/

However, there are some local examples of mangrove restoration that show potential to be scaled up.

In Guinea-Bissau, Tanzania and Senegal, Community-Based Ecological Mangrove Restoration (CBEMR) projects have proved successful.[38] Rather than relying on tree planting, these projects create the conditions for natural recovery. This is achieved through measures that restore hydrology, sediment dynamics and soil conditions, with planting used only when necessary. This approach also considers socio-economic factors that can endanger mangrove restoration, given that successful restoration can take decades.

Wetlands International applied this approach in Cacheu National Park, Guinea-Bissau, where some 200 hectares (2 km²) of mangroves were set aside for regeneration.

The same approach was applied to the Rufiji Delta in Tanzania, where 7,000 hectares (70 km²) were lost between 1991 and 2015 to rice farming. Wetlands International cleared grass cover, removed invasive species and dug channels to increase water flow.

In Senegal, the regenerative approach has been applied to the Saloum Delta, where 1,248 km² of mangrove forest extend along approximately one-third of the country's 866 km coastline. Progress is being monitored through Global Mangrove Watch's digital platform and remote sensing tools.[39]

Takeaways for policy-makers

Benefits

- Mangroves provide multiple benefits: carbon sequestration, flood protection, fisheries enhancement, wildlife and eco-tourism opportunities and water quality enhancement, which all benefit livelihoods.
- Economic benefits include increased incomes for fishermen from fisheries, local communities generating new income and jobs through eco-tourism ventures.
- Application of new technologies (e.g. drones) to facilitate mapping, planting and regeneration monitoring.

Considerations for implementation

- A long-term outlook is needed as it takes at least 20 years for mangrove seedlings to grow to maturity.
- Include local communities in defining the project goals and monitor their attitudes over time.
- Adopt a Community-Based Ecological Mangrove Restoration (CBEMR) approach to rehabilitate environmental conditions that promote natural regeneration, with planting as a supplemental activity.
- Select mangrove species that are normally prevalent in the local or regional area.
- Water and sediment quality need to be of a sufficient standard.
- If there has been any historical growth of mangroves in the area then it is more likely to be successful.

Role of government checklist:

Enabling

- [ ] Encourage partnerships among government, businesses, NGOs and local communities to find common goals that can be delivered by projects.
- [ ] Invest in research to gather data about the value provided by NbS and promote knowledge sharing.
- [ ] Ensure local community engagement as a critical part of the process.

Regulation, implementation, monitoring and evaluation

- [ ] Set clear policies and objectives to protect and enhance mangrove coverage in the knowledge of the value they provide to biodiversity, economies and societies.
- [ ] Integrate mangrove restoration into national development planning and international policy commitments.
- [ ] Develop regulations and implementation mechanisms that are transparent and well resourced.
- [ ] Provide funding to monitor and evaluate programmes, learn lessons and share.
- [ ] Take a long-term view: NbS need time to deliver potential benefits in full.

Chapter 3

Oyster reefs

Oyster reefs

A Nature-based Solution to protect coastlines

Oyster reef restoration projects are a regenerative, nature-based alternative to seawalls and breakwaters for island states and coastal communities that are threatened with sea-level rise and storm surges, particularly in the context of climate change. And yet, the world has lost an estimated 85% of oyster reef habitats[40] in the past century. Over-harvesting, dredging, coastal development, contaminated waters and disease have all played a role in the degradation of oyster habitats.

Oyster reefs provide a range of important ecosystem services beyond the provision of food. They bind sediment, prevent erosion and provide a physical barrier against storm surges. They improve water quality, which in turn creates more favourable conditions for other sea creatures and economic activities like fishing. A pristine environment teaming with biodiversity in turn increases the potential for eco-tourism. The value of oyster reef ecosystem services has been estimated at $99,000 per hectare of reef per year.[4]

In this chapter, we look at the range of policies governments can adopt to protect the oyster reefs that remain and restore those that have been lost.

Oyster reef restoration as a NbS

Early efforts to restore oyster reefs were focused on increasing productivity for the shell-fishing industry. With the acceleration of climate change, reef restoration today is centred on creating living breakwaters that are able to reduce the force of storm surges, protect shorelines and prevent erosion – which are all effects of global warming. A number of projects[42] indicate that

> shoreline retreat has been reduced by 40% or more thanks to artificial reef structures seeded with newly translocated oysters.[43]

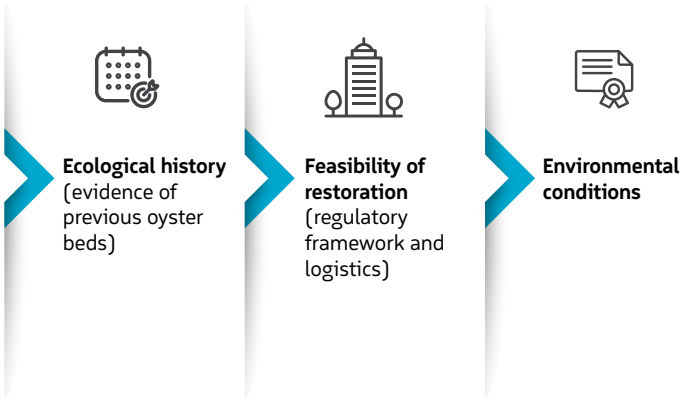
The creation of sanctuary sites to allow time for oyster populations to recover can also amplify the ecosystem benefits of restoration projects. This requires careful monitoring and policing to deter poachers.

When harvesting is allowed to resume, it is important to determine the maximum sustainable yield of an oyster reef by taking into account all the ecosystem benefits and not just the reproductive capacity of the oyster population. This is the best way to ensure ecosystem services will not be affected by oyster harvesting quotas.

While shell-fishing bans during the creation of sanctuary sites may cause temporary economic losses, over time a restored reef may provide more sustainable fishing incomes. During restoration projects, jobs are created in the construction of the artificial reef, in raising and seeding oyster spat (larvae that have become attached to a surface), monitoring reef health and progress and enforcing fishing bans.

Site selection has also proved critical for the success of restoration projects.

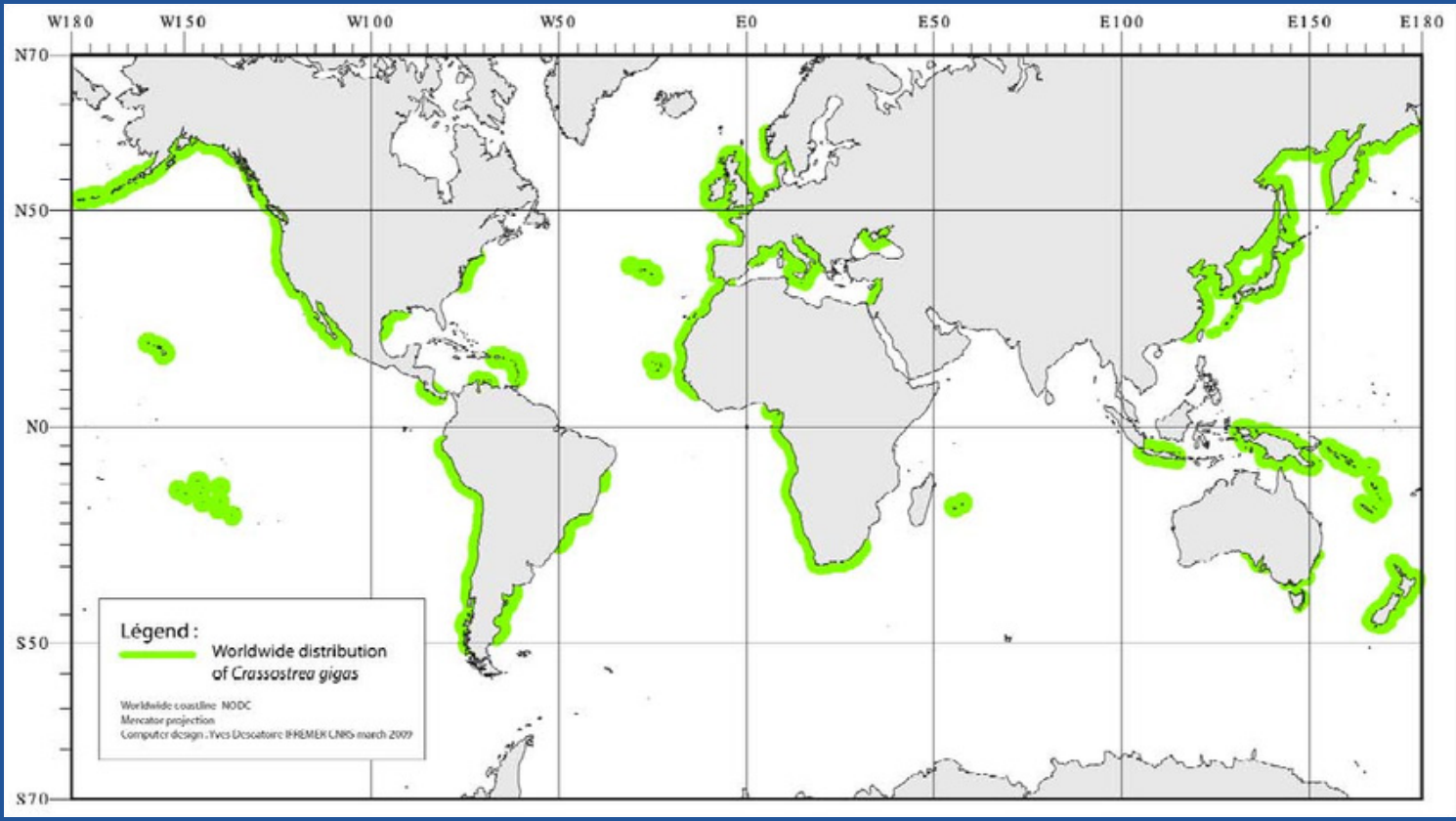
Three factors should drive selection criteria:



The distribution of Crassostrea gigas, the Pacific oyster, one of the most commercially important species, is shown in the following map (Figure 7). This suggests that much of coastal South America, Western Africa, East Asia and Indonesia would additionally benefit from applying oyster reef restoration. The Pacific oyster does not grow in the GCC region, but there are efforts to cultivate edible oysters in Dibba Bay, UAE, for restaurants and supermarkets.[44]

Several studies have been conducted to examine the health of oyster reefs and the potential for restorative work in East Asia. Indonesia, where many islands are at high risk from sea-level rise, flooding, tsunamis and storm surges, is a prime candidate for oyster reef restoration as an NbS. Government involvement, community engagement and private partnerships could point the way forward.

Figure 7: Worldwide distribution of Crassostrea gigas



Source: https://www.researchgate.net/figure/1-Worldwide-distribution-of-the-Pacific-oyster-Crassostrea-gigas_fig5_40229531

Contamination and poaching

Oyster reef restoration is sometimes proposed for heavily contaminated sites. However, oysters grown in these locations are not suitable for human consumption and the risk is that poachers will infringe harvesting bans and sell them to unsuspecting consumers. Policing and enforcing harvesting bans is therefore crucial to ensure that public health and safety is not compromised by restoration projects in such areas.

Recycled shells: pros and cons

The use of recycled oyster shells as a substrate for reef restoration is cost-effective, and there is a positive example in our Chesapeake Bay study below, but one such programme[45] provides a cautionary tale.

Oyster spat grown on recycled shells and tied into bundles were attached to a breakwater at a site with choppy seas. Before the natural oyster cementation process could take place, the reef structure collapsed. And although the oysters were not killed, and contributed to an increase in biodiversity and water quality, the collapsed structure failed as a natural barrier against storm surges. It was suggested that more rigid structures are needed in areas with rough seas to provide supplementary support while oyster cementation takes place.

The following case studies have been selected to highlight the successes and challenges of oyster reef restoration across the globe.

Case Study 1
Successful restoration of degraded reefs in Chesapeake Bay, US

First recorded in the 1700s, less than 1% of the original area of oyster beds remains in Chesapeake Bay, on the east coast of the United States. In 2014, the six states that border the bay's watershed and the Environmental Protection Agency signed the Chesapeake Bay Watershed Agreement to restore healthy, functioning oyster reefs in five main rivers by 2025.

As of 2019, reef rehabilitation had been completed in two of the five rivers. Methods utilised include:

- stray' the reef with oyster spat.
- Local restaurants save used oyster shells for recycling to help build the reef.
- Artificial 'reef balls' used as hard substrate for oyster spat to grow on.
- Local waterfront homeowners engaged to volunteer to grow oyster spat off their piers.

Results: The rebuilt sanctuary reefs show a measurable increase in biodiversity and improved water quality. The programme has also flagged the importance of obtaining adequate materials for reef building – ideally, older shells – as well as raising oyster spat. All in all, the programme is on target to reach its goal by 2025 and enjoys continued support from local governments, NGOs, academic institutions and communities.

Case Study 2
Pilot study on preventing erosion in Bangladesh

The Bengal Delta, spanning Bangladesh and West Bengal in India, is the largest and most fertile delta in the world. However, climate change has made it vulnerable to sea-level rise and the infiltration of saline water, which kills crops. Fiercer and more frequent cyclones, another consequence of global warming, are also eroding the coast. Many hard engineering structures have been erected to protect communities from cyclone damage, but these man-made structures repulse rather than absorb the impact of storms, causing erosion and further storm damage elsewhere.

A 2012-14 pilot study by Wageningen University and consultancy Royal Haskoning of the Netherlands with the University of Chittagong in Bangladesh[46] found that oyster spat readily settled on a variety of structures, but were prone to mortality when transplanted on open substrates. A follow-up study deployed pre-cast concrete rings and found the approach successful, with good oyster growth on the rings. A further study was undertaken to assess coastal protection afforded by 'oyster reef rings' and their impact on biodiversity and adjacent habitats.

Results: The deployment of concrete rings with oysters was successful. The study found that oyster breakwater reefs reduce erosion and trap sediment, thereby promoting mudflat stability and saltmarsh growth. It also established that the reefs supported greater biomass and biodiversity.

Case Study 3
Restoring oyster beds in the Pearl River Delta

Oyster farming is a traditional activity in the Pearl River Delta and recent research[47] points to the high potential for restoring degraded oyster reefs. Furthermore, due to the existence of oyster farms, restoration can be met without the need for hatchery-raised oyster spat.

Inspired by the success of Staten Island's "Billions of Oysters" programme in New York, Hong Kong's City University launched "Oysters Save Our Seas (SOS)"[48] in 2021, aiming to add five to 10 million oysters to traditional oyster beds in the initial years of the project.

Results: The project starts with the advantage of being able to rely upon the expertise of Hong Kong's oyster farmers. Further knowledge was gained from a study tour of the oyster restoration projects in Chesapeake Bay, organised by The Nature Conservancy, an NGO. This included restorative aquaculture and reef-restoration research and partnerships, highlighting the benefits of information sharing and exchanges.

Takeaways for policy-makers

Benefits

- Restored reefs can provide coastal protection while enhancing biodiversity, water quality and supporting fisheries.
- Economic benefits include new skills and jobs for local communities including reef building, monitoring and enforcement of fishing bans.
- Secondary economic benefits include value added from ecosystem services and increased oyster production.

Considerations for implementation

- Scaling of operations are limited by materials needed for reef construction and raising oyster spat.
- Appropriate site selection is paramount to self-sustaining reef success.
- Careful design is required to ensure structural integrity of engineered reefs.
- For areas where restored reef will be used for aquaculture, it is essential to establish beforehand the maximum sustainable yield of the ecosystem.

Role of government checklist:

Enabling

- ☐ Oyster reef restoration requires regulatory support and funding, which could be provided via PPPs with local fishery organisations.
- ☐ Oyster reef restoration is relatively uncommon and many programmes are in a pilot phase. Knowledge sharing between sectors and regions will contribute to the success and efficiency of reaching project goals. Summits or conferences may provide an ideal platform.
- ☐ There may be technology applications which could allow faster progress on large-scale restoration projects. Funding R&D may spur restoration progress globally.

Regulation, implementation, monitoring and evaluation

- ☐ Harvesting bans must be enforced to allow sanctuary sites to establish themselves and provide more comprehensive ecosystem services than over-harvested sites.
- ☐ In contaminated waters, harvesting bans must be enforced to prevent poachers selling oysters that are unfit for human consumption.
- ☐ Coordination and setting targets help. Chesapeake restoration efforts would not be as successful without the agreement between the six states bordering the waterway.
- ☐ Long-term monitoring and measurement of project impact will strengthen the case for NbS as preferable to traditional grey infrastructure.

Chapter 4

Seagrass meadows

Seagrass meadows

A Nature-based Solution for climate action

Seagrass meadows are highly effective carbon sinks. It is estimated that one hectare of seagrass can absorb CO2 up to 40 times faster than a hectare of terrestrial forest.[49]

In addition to acting as carbon sinks, seagrass meadows provide many ecosystem services: they support fisheries and biodiversity, dampen waves and control erosion, recycle nutrients and reduce the prevalence of pathogens.

This makes seagrass one of mankind's best natural allies in the fight against climate change. As the GHG emissions that cause global warming continue to rise, carbon sequestration – removing CO2 from the atmosphere – will become increasingly important for containing emissions to manageable levels.[50] And yet, scientists estimate that the planet may be losing 7% of its seagrass cover every year, and that this rate is likely accelerating.[51] This decline has been linked to pollution, overfishing, dredging and sudden marine heatwaves, which cause mass die-offs of delicate marine ecosystems such as coral reefs and seagrass beds and are becoming a more common occurrence as a result of global warming.

Even more worrying, the death of seagrass meadows may release large, ancient stores of CO2 into the atmosphere, accelerating rather than holding back our looming climate catastrophe. As a result, protecting and restoring this critical habitat has become vitally important for a multitude of species, including the human race.

Early restoration projects show promise

Since 1999, one of the earliest large-scale restoration efforts was undertaken in Atlantic Bay, USA, where a slime mould disease and a hurricane wiped out the seagrass population.[52] Secondary impacts followed: the Brant goose (a popular game fowl) disappeared, scallop fishery collapsed and industries that used seagrass for fertiliser production, insulation and packing materials also suffered.

Years later, small seagrass patches began to appear. But natural growth rates were too slow to repopulate the entire area. A large-scale seeding effort was extremely successful, with seagrass proliferating naturally far beyond the initial restored plots. And while the restoration objectives in Atlantic Bay were commercial – to support its traditional industries – the full ecosystem benefits of seagrass restoration also became apparent. These included erosion control, shoreline protection, pathogen reduction, nutrient recycling, carbon sequestration and the provision of sheltered nurseries for invertebrates and juvenile fish.

In addition, a modern NbS approach that relies on local community engagement can also create jobs as manpower is required to seed, translocate, monitor and enforce protection of seagrass restoration plots.

Defining long-term success

The ultimate goal of any seagrass restoration project is a successful establishment of seagrass. This can take several decades. Dense growth might be achievable in a few years, but the target is to ensure resiliency and viability of the habitat long-term. Thus monitoring efforts should carry on for at least 10 years to capture data on self-sufficiency of restored meadows.

While growth and health of seagrass are the primary success metric, the restoration of wider ecosystem services, such as water quality, nutrient uptake and overall biodiversity, should not be overlooked.

Jurisdiction difficulties

Jurisdiction of marine environments is complicated, which makes the restoration of marine systems a particular challenge. Multiple actors often have access to the same open-water areas and marine ecosystems might extend across political boundaries. This leads to difficulty in determining the ability to restore specific sites as well as in delineating responsibility for enforcement, upkeep and monitoring. To ensure success, seagrass restoration projects must involve multiple stakeholders and determine the best approach for sharing responsibility.

Cost and effort

Seagrass restoration is often deemed costly as it is high in manpower requirements, requires long-term commitment and often needs a trial-and-error approach with heavy initial losses. It is imperative to ensure budgets foresee these eventualities and are not made on the basis of only one initial planting scheme.

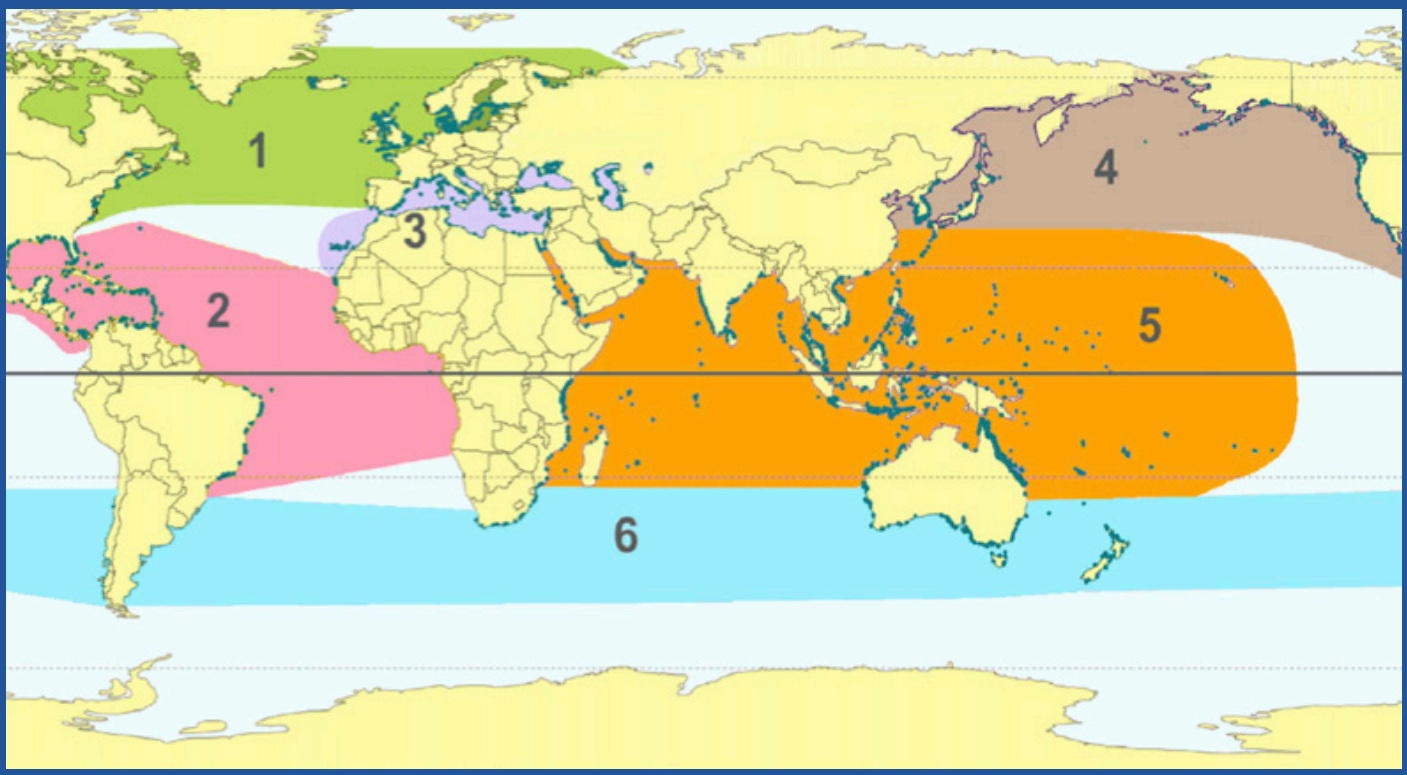
Relevance for East Asia, Africa and GCC regions

The tropical waters of the Indo-Pacific have the highest diversity of seagrasses (Figure 8), pointing to a long evolutionary history that took advantage of the region's optimal growing conditions. Seagrass ecosystems are historically under-studied in the region; most research and restoration projects are focused in the Americas, Europe and Australia. The following case studies will look at some of the restoration efforts that have been undertaken within the Indo-Pacific region.

Future resilience

Assuring high genetic diversity is also paramount to the future health and viability of restored meadows. Translocations or seeding from a single source could increase vulnerability to pathogens, pollution and other impacts. To avoid this, mixing seeds from multiple sources and selecting those most likely to adapt to a warming climate will increase chances of success. There are more than 70 known species of seagrass which are adapted to a wide range of marine environments.

Figure 8: Map showing highest diversity of seagrasses worldwide. Orange section indicates the Indo-Pacific region covering GCC, Asia and East Africa. Blue dots are the seagrass distribution points.



01 Temperate North Atlantic **02** Tropical Atlantic **03** Mediterranean **04** Temperate North Pacific

05 Tropical Indo-Pacific **06** Temperate Southern Oceans

Source: https://india.mongabay.com/2019/06/seagrass-explainer-what-is-seagrass-where-are-seagrasses-found/

Case Study 1
Seagrass restoration in Kenya

Twelve species of seagrass cover more than 300km² of the coastline in Kenya. This diverse marine life is now under threat from an explosion in the population of sea urchins, which graze on seagrass. As a result, Watamu and Malindi are estimated to be losing 4.6% of their seagrass cover every year.[53]

The Kenya Marine and Fisheries Research Institute has carried out trials for seagrass restoration, recolonising areas that have lost seagrass and increasing existing meadows. One successful method involved planting seagrass seedlings in "punched holes in large bags" on the ocean floor.

Results: Kenya's programme helped develop seagrass restoration guidelines for the Western Indian Ocean region, supported by the UN Environment Programme.

Case Study 2
Protecting livelihoods in Mozambique

The fishing communities of Maputo Bay and Inhambane, further north, have long depended on seagrass for their livelihoods. These harbour shrimp, sea cucumbers, clams and crabs, which are a source of food and income. But destructive shellfish harvesting, flooding and sedimentation from rivers has caused a rapid decline of seagrass cover, with an estimated loss of 86% of seagrass acreage in Maputo Bay alone.[54]

Eduardo Mondlane University, supported by the government of Mozambique, is identifying sites and implementing restoration projects in both bays. Educating fishermen in sustainable fishing practices is key to the effort. Another goal is to protect species that depend on seagrass. Dugongs – marine mammals similar to manatees – are a critically endangered species that frequent the waters of Mozambique. Seagrass meadows are a vital habitat for this species and restoration efforts are anticipated to enhance local populations.

The project is funded by the Nairobi Convention, a platform for governments, civil society and the private sector that promotes the sustainable management of the Indian Ocean's marine and coastal ecosystems.

Case Study 3
Seagrass conservation from the Gulf

Seagrass species that thrive in the Arabian Gulf have the ability to withstand extreme environmental conditions, including major seasonal variations in water temperature and salinity.[55] While seagrass communities elsewhere may have 10 or more species, only three species currently thrive in the Arabian Gulf waters. These particular species may prove to be more resilient to impending climatic changes and as a result are of even more importance to conserve. There is much promise in seagrass restoration and conservation in the Arabian Gulf, which may not only increase ecosystem resilience in the region but act as a genetic reservoir for future seagrass donors in the event that cooler-climate species suffer from changes in climatic conditions. Seagrass restoration could act as a carbon sink for a region that has some of the highest per capita carbon emissions in the world. Restoration could also protect critically endangered species, including the hawksbill turtle and dugongs, that rely on seagrass habitats. Below are some successful examples of seagrass conservation efforts in the Gulf.

The Dugong and Seagrass Conservation Project[56]

- Executed by the Mohamed bin Zayed Species Conservation Fund in Abu Dhabi, UAE, this project focuses on the conservation dugongs and their associated seagrass habitats throughout the Indo-Pacific region.
- There are 38 national projects located in Indonesia, Madagascar, Malaysia, Mozambique, Sri Lanka, Solomon Islands, Timor-Leste and Vanuatu, managed by 26 local partners. The Project focuses on education and awareness, citizen engagement, policy development, and scientific study.
- This is an example of the important role played by the UAE in 'conservation diplomacy', where it is facilitating funding and executing international partnerships for seagrass conservation.
- Implementation of protected areas with restricted fishing and other disruptive activities has seen an increase in seagrass health in several programs run by the project.

Regeneration of seagrass in the Gulf

- Studies have shown that seagrass in the Gulf was able to quickly regenerate healthy meadows within one year after catastrophic incidents such as major oil spills.[57]
- A remote sensing exercise found a direct correlation after the banning of shrimp trawling in the UAE and the growth and area of seagrass in affected areas.[58]
- Further studies have found that large areas in the Gulf are suitable for seagrass restoration based on a review of environmental conditions such as water depth and flow rates.[59]

Case Study 4
Seagrass transplants in Cape Bolinao, Philippines

The survival of seagrass transplants has been tested in Cape Bolinao, Pangasinan, in the northwest of the Philippines.[60] Five species were transplanted; pioneering species performed well, but climax species did poorly. Pioneer species are fast-growing colonisers. They allow other species to move in and become established. Climax species are those that are only present when an ecosystem reaches its full stage of development, called a climax community.

Results: The trial shows that the selection of species for transplant and the establishment of successive populations must be considered in regeneration trials.

Takeaways for policy-makers

Benefits

- Seagrass acts as a powerful carbon sink and provides many ecosystem services.
- Seagrass restoration should be investigated as a potential NbS for improving water quality, reducing coastal erosion, carbon sequestration and increasing local biodiversity.
- Economic benefits include provision of resources for coastal communities as well as creation of jobs and directing funding into the local economy.

Considerations for implementation

- Initiatives to date have been mostly small-scale, but large-scale initiatives have had high success rates. Scaling up is feasible, but requires a dedicated budget, a long timeframe and manpower.
- Minimum environmental conditions must be met for seagrass restoration to be successful; that is, to allow the seagrass meadows to proliferate beyond the restoration plots and remain healthy in the future.
- Seagrass restoration projects must involve multiple stakeholders to navigate the complex jurisdiction of marine areas.
- Local community engagement is also important where harmful fishing practices are a factor in seagrass degradation. The economic benefits of regeneration must be made clear and long-term restoration must be managed by the community itself.
- Species selection and sourcing is important for the long-term success and resilience of regeneration projects.

Role of government checklist:

Enabling

- [ ] Seagrass restoration requires funding. To help achieve SDGs, government may allocate budget for restoration projects carried out by NGOs, corporations and academic institutions.
- [ ] Cross-boundary management agreements are important as coastal waters often cross political jurisdictions.
- [ ] Funding for technology development and seagrass ecosystem research will further boost understanding of seagrass ecology and help choose the best restoration methods for each habitat.
- [ ] Knowledge sharing of failure as well as successes furthers progress. Platforms for information exchange include regional conferences and global databases.

Regulation, implementation, monitoring and evaluation

- [ ] Seagrass restoration initiatives have to look at the causes of initial decline. If destructive shipping and harvesting practices have caused loss of habitat, enforcing bans on these activities is key to a restoration programme.
- [ ] Monitoring and evaluation require establishment of standard metrics. This should be done at a regional level (inter-governmental) to ensure that monitoring results are comparable over time and across projects.

Chapter 5

Coral reefs

Coral reefs

A Nature-based Solution for tourism revival

Coral reefs are the most productive habitat in the marine realm, supporting more than 25% of all marine species,[61] yet they face extinction within the next few decades.[62] Coastal development, dynamite and cyanide fishing, pollution, climate change-induced ocean acidification and marine heatwaves are all contributing to the collapse of coral reef colonies.

The value of coral reef ecosystem services is estimated at $29.8 billion a year: $9.6 billion for tourism and recreation; $9.0 billion in coastal protection; $5.7 billion supporting fisheries; and $5.5 billion for biodiversity.[63] Thriving reef systems protect almost 200 million people from storms and flooding, preventing an estimated $4 billion a year in storm damage.[64]

Protecting and restoring coral reefs is therefore of vital economic and environmental importance.

Restoring coral reefs

There are a number of techniques that have been applied to restore coral reefs:

- Direct transplantation of coral fragments from a donor site to a recipient site have shown to have a success rate of 64% and typically use fast-growing coral species.
- Coral gardening raises corals in nurseries for transplanting to recipient sites. Although coral gardening has reported similar success rates of 66%, one definite benefit is the reduction in coral biomass sourced from donor sites.
- Although rare, sexual propagation has received more attention in recent years, given that this increases genetic diversity and promotes more resilient reefs.

Lessons learnt

Coral restoration takes decades, which means that projects should budget and plan for the long term. Other common problems include:[65]

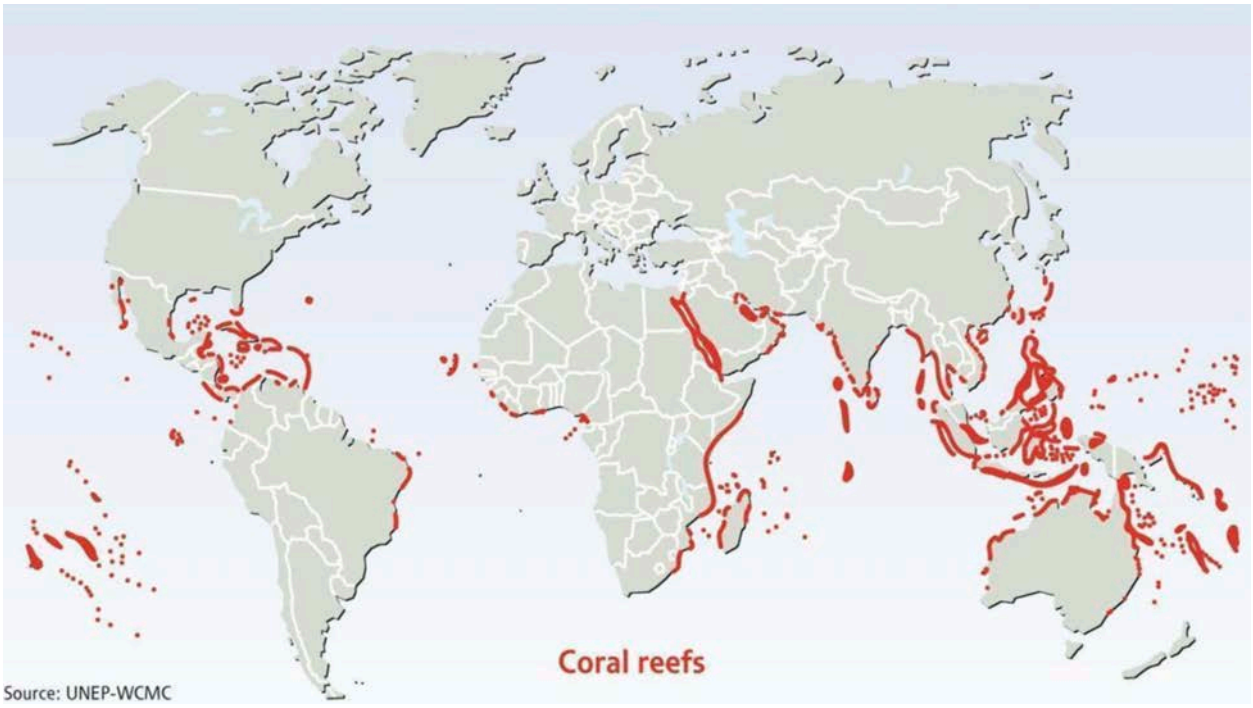
- Lack of science-based input into the restoration methodology design.
- Short monitoring periods, when decades are needed to ascertain the long-term self-sufficiency of restored reef.
- Monitoring metrics that are too narrow. For example, most monitoring programmes seek to establish the survival rate of transplanted corals, but do not measure other factors, such as biodiversity, shoreline protection and natural regeneration.
- Restoration methods should seek to prevent negative impacts such as the loss of coral from donor sites.

Relevance for East Asia, Africa and GCC regions

Coral reefs occur within the equatorial belt. Figure 10 shows the location of coral reefs worldwide:[66]

Most large-scale coral reef research and restoration projects are concentrated in the Americas and Australia. Smaller-scale projects have been implemented in Southeast Asia and the MENA region. As many developing nations, particularly island and coastal communities, rely on tourism for their livelihoods, Nature-based Solutions for coral reef restoration should be considered as an integral part of sustainable economic planning and development.

Figure 10: Coral reef locations worldwide



Case Study 1
Relocation and cultivation initiatives in Jordan, UAE and Kuwait

Relocation in the port of Aqaba

The only corals in Jordan are found in Aqaba, on the Red Sea. As part of a port development project, 7,000 coral colonies were relocated and transplanted into existing degraded reef sites within Aqaba Marine Park[67] between 2012 and 2014.

Results: Monitoring over two years, an admittedly short time period, showed a survival rate of 87% and positive growth rates.

Reef regeneration in Dubai[68]

The World Islands off the coast of Dubai, UAE, have a marine life programme that has carried out 100,000 coral translocations as part of its environmental enhancement measures. The methods used include fragmentation, ex-situ rearing and out-planting on select artificial reef structures. While little data is available at this time, the initiative is promising: through using the unique technique of fragmentation, coral that would normally grow around one centimetre per year is expected to grow back up to 20 times faster. Eco-tourism activities such as coral workshops for visitors, diving and underwater viewing, are planned alongside the restoration programme.

Breeding resistant corals in Kuwait[69]

Coral cultivation was attempted successfully in 2014 and 2015 in Kuwait, in an environment with high salinity and where seawater temperatures range from 13ºC to 33ºC, which is beyond the typical lethal limits for coral survival. The study demonstrated for the first time that it was possible to restore reefs and enhance the environmental value of artificially created marine habitats by adopting a coral gardening concept and rear corals in situ despite the extreme environmental conditions of the northern Gulf.

Results: Translocation was successful and ultimately the project saw natural recruitment begin to occur, indicating that self-sustaining reef was a potential possibility in the study area.

Case Study 2
Artificial reefs in India

Massive corals were transplanted onto artificial reef structures, such as concrete triangles, with successful out-planting. A total of 215 artificial triangles were deployed with 1,569 coral fragments at a small tide-drain channel in Pirotan Island, Gulf of Kutch.[70]

Results: During the study period (February to June 2014), the overall survival rate was over 77%, which showed promise for the technique, as the study site was considered to have strong environmental stressors, such as algae cover, sedimentation and strong wave actions and current.

Case Study 3
Low-tech rehabilitation in Tanzania

This study aimed to investigate a simple inexpensive method for transplanting coral to rehabilitate degraded reefs in developing countries.[71] A number of methods were used, including tying coral fragments together before placing them on the sea bed.

Results: After two years, coral cover was measured to have increased by 50%, indicating early success.

Takeaways for policy-makers

Benefits

- Reef restoration provides a direct economic boost for the tourism sector.
- Ecosystem services include biodiversity, supporting fisheries, medicinal compounds, water purification and coastal protection.

Considerations for implementation

- While a number of techniques have been explored, in order to ensure future viability an emphasis should be placed on sexual reproduction to increase the genetic diversity and resilience of restored reefs.
- Restoration should not aggravate existing problems – for example, plastics and concrete should not be used as substrates for reef restoration.

Role of government checklist:

Enabling

- ☐ Coral reef restoration requires adequate funding. As economic relief packages are rolled out to counteract the impact of the pandemic, governments have the ability to funnel this relief into restoration budgets.
- ☐ As with other marine ecosystem restoration initiatives, knowledge sharing across different sectors, inclusive of corporate, NGO and academic as well as inter-governmental co-operation, are integral to project success.
- ☐ Partnerships with academic institutions, particularly to support R&D into coral restoration methods, should be considered an important step towards enabling wide-scale coral restoration.

Regulation, implementation, monitoring and evaluation

- ☐ Existing reefs should be protected by establishing a network of Marine Protected Areas, allocating no-go zones under an Integrated Coastal Zone Management programme and ensuring enforcement of fishing restrictions and other bans.
- ☐ For restoration projects, monitoring metrics need to be standardised and monitoring should be carried out over decades not years.
- ☐ Project objectives should be clearly defined and should not solely focus on initial survival rates. Broader NbS objectives should also be monitored including socio-economic impacts, water quality, biodiversity and coastal protection.

Conclusions and recommendations

Conclusions and recommendations

NbS offer significant, varied and often overlooked benefits. There is now an unprecedented opportunity for governments in East Asia, Africa and the GCC to embrace NbS as part of efforts to rebuild economies and address overlapping climate, environmental and economic crises.

By putting in place the right policies and enabling conditions, governments can play a crucial role in unleashing the potential of these solutions. For example, including NbS in national climate-change policies sends a strong signal to the private sector, NGOs, local communities and international partners, whose support is needed for the long-term success of the initiatives. Businesses can deploy NbS as part of their sustainability strategies and by financing commercially viable projects.

Of course, NbS cannot solve every environmental problem. To fully address the challenges of fighting climate change and transitioning to low carbon economies, a complementary portfolio of renewable energy, energy efficiencies, clean mobility and sustainable infrastructure initiatives are also needed.

Calls to action

01 Governments should prioritise NbS as a way of addressing key global crises

The current integrated crises of the global COVID-19 pandemic, biodiversity loss, climate change and the economic recession are all costing the global economy significantly more than the price of preventing them. Restoration of nature through NbS offers an important way to tackle these issues. The regeneration of coastal habitats such as mangroves, coral and oyster reefs and seagrass meadows has significant potential to create coastal resilience and generate multiple benefits to countries in East Asia, Africa and the GCC region. There are other NbS beyond the ones presented here that can also be used in the right context.

Recommendations:

- Governments need to pay more attention to NbS.
- NbS need to be integrated into national development planning and across government departments, not just environment ministries.
- Policies must be supportive of NbS objectives. This helps ensure accountability.
- Policies should be long-term to enable NbS to mature and become self-sustaining.
- Economic development initiatives should be examined through an NbS 'lens' to highlight potential NbS approaches to development needs.

02 NbS require long-term funding

NbS confer economic benefits to local communities as well as wider regional and global ecosystem services. But the current global economic system and national planning and budgeting processes do not adequately value the contribution of ecosystem services. This means they are underfunded.

A fundamental reset of how governments value the natural environment is required to recalibrate national spending priorities. For example, the global biodiversity funding gap, estimated at between $598 and $824 billion a year,[72] can be viewed as an untapped investment opportunity that could provide long-term economic returns as well as social and environmental benefits.

Recommendations:

- The full value of ecosystem services should be calculated to allow transparent cost comparisons between NbS and traditional approaches.
- Repurposing agricultural and fisheries subsidies is one of the best sources of finance, with evidence of the ripple effects this has on finance for biodiversity. This will require lots of public spending to be repurposed.
- COVID-19 stimulus packages should be geared towards supporting NbS and green job creation.
- Governments of high-income countries in the regions discussed in this report should seek to provide development aid that explicitly supports NbS to low and middle-income countries in their regions.
- Facilitate the growth of other sources of finance including those outlined in the Biodiversity Finance Initiative:[73]

    1. Generate revenue: increase the funds deployed towards biodiversity protection through public spending, private investment or other measures that can generate or leverage financial resources allocated to biodiversity.
    2. Deliver better: deliver results for biodiversity conservation through better resource management, improved efficiency and greater alignment of incentives among stakeholders.
    3. Realign expenditures: reduce investments that have negative impacts on biodiversity and redirect those financial flows towards activities that positively impact biodiversity.
    4. Avoid future expenditures: prevent future costs through strategic investments and policy changes that protect biodiversity today and reduce the need for larger expenditures in the long term to restore or replace lost ecosystem services.
    5. Catalyse: enhance policy, administrative or investment measures or enabling conditions that can result in new, improved or scaled-up biodiversity finance.

03 The importance of regional and international collaboration

As ecosystems often cross national boundaries, agreements between neighbouring governments are needed to get approval and define responsibility for projects. This is particularly true of marine projects, which may be affected by multiple jurisdictions.

Furthermore, NbS are an important means for governments to meet their international obligations, including the United Nations Framework Convention on Climate Change (Paris Climate Accord), the Convention on Biological Diversity (CBD) and the UN's Sustainable Development Goals (SDGs).

Recommendations:

- Governments should integrate NbS into their carbon abatement targets, known as Nationally Determined Contributions, under their obligations to the Paris Climate Accord.
- Governments should support NbS in their commitments to the CBD.
- Governments should seek to integrate NbS into their SDG goals and regularly report on progress.

Enablers

01 NbS restoration needs to follow a standardised and science-based approach

This means that project design, objectives and monitoring programmes should be standardised, reported with consistent metrics and shared on regional and global platforms. The International Union for Conservation of Nature has developed a global standard on NbS (see appendix) to enable such alignment.

02 NbS research and innovation needs official support

More research is needed on NbS to allow better methodologies to be developed. This includes research on the processes that drive ecosystems as well as technological applications to scale up NbS and improve the chances of success.

Governments can provide research and innovation grants and facilitate partnerships with the private sector and academia to enhance knowledge on ecosystem processes as well as foster greater application of technologies and commercialisation.

03 Governments should facilitate multi sectoral partnerships to scale up NbS

NbS involves many stakeholders. While government backing can establish enabling policies and provide funding, stakeholder participation – in the form of local community stewardship, invested private corporations, academic institutions and non-profit/NGOs – is also needed to implement and monitor NbS projects, which by their nature are long-term.

Early stakeholder engagement and throughout the lifecycle of NbS is paramount to success, as is knowledge-sharing – particularly of failed attempts and the lessons learnt from them, which typically go unpublished in scientific journals. Working with local communities is crucial for sustained positive impacts. Best practice approaches provide communities with tools and 'social agency' which can deter detractors and ensure their voices are part of governance arrangements. Governments can consider social-public frameworks that include models of benefit sharing.

Increasingly, environmental, social and governance (ESG) factors are at the top of both public and private-sector agendas. As the momentum behind ESG as a force for positive and lasting change continues to grow, we will see a growing demand for NbS initiatives, both from policy-makers and capital markets.

Governments and the private sector should work together to implement and scale up a green recovery. The solutions can address social and economic distress in the short-term, drive economic, humanitarian and environmental recovery in the medium-term and ultimately build a more robust and sustainable foundation to weather global crises in the future.

Appendix

Appendix

Measurement and standardisation

The International Union for Conservation of Nature (IUCN) has developed a global standard for NbS. It is designed to equip users with a robust framework for designing and monitoring the effectiveness of NbS interventions. It includes eight criteria:

1. Societal Challenges: identify the societal challenge to which the NbS is a response.
    - Currently includes climate-change adaptation and mitigation, disaster risk reduction, ecosystem degradation and biodiversity loss, food security, human health, social and economic development and water security. One or more societal challenges can be the entry point.
2. Design at scale: designing the solution to respond to the scale of the issue.
    - Scale primarily refers to geographic, economic, ecological and societal aspects of the land and seascape.
3. Biodiversity net gain: requires an understanding of the current resources and context, in the form of a baseline, and sustainable action going forward is required for implementation of a strong NbS.
4. Economic feasibility: same as 3.
5. Inclusive governance: same as 3.
6. Balance trade-offs: how to ensure there is a transparent, equitable and inclusive process to determine the choices that need to be made to achieve short and long-term gains.
7. Adaptive management: continuous learning about system-wide processes and adapting the NbS.
8. Mainstreaming and sustainability: embedding NbS into policy or regulatory frameworks and linking to national targets or international commitments.

The IUCN NbS standard is new and not widely implemented so far, but it provides governments with an important tool to measure the impact of NbS projects in a robust and scientific way.

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