



# Charting the course for ocean sustainability

in the Indian Ocean Rim

SOUTHERN OCEAN

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# About this research

*Charting the course for ocean sustainability in the Indian Ocean Rim* is an Economist Intelligence Unit report, sponsored by Environment Agency Abu Dhabi and the Department of Economic Development Abu Dhabi, which highlights key ocean challenges facing the Indian Ocean Rim countries and showcases initiatives undertaken by governments and the private sector in the region to address these challenges. The report explores how ocean sustainability can be achieved through the lens of developing nations, taking into consideration the challenges of a low-income population as well as an environmental regulatory framework that has yet to mature.

In the introductory chapter, we discuss the importance of the Indian Ocean in the global conversation on ocean sustainability, identify key ocean issues facing the rim countries and assess the pace of progress towards a blue economy.

Chapters one to five are deep dives on five key challenges issues facing the Indian Ocean - the degradation of the marine ecosystem, plastics pollution, unsustainable fishing, extraction of non-renewable marine resources and rising water salinity from desalination. Each chapter includes case studies that explore key facets of the ocean issue and reflect the ecological and economic diversity of the region.

The concluding chapter ties in learnings from the deep dives and maps the way forward for the region through the efforts of governments, the private sector and multilateral organisations under three pillars: governance, finance and innovation.

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# Executive summary

The Indian Ocean is a vast body of water enclosed on three sides. This not only makes it a compelling scientific study, but an economic one too, given the characteristics of the countries that surround it. These countries are home to 2.5bn people, the majority of whom fall into the low-income bracket, and many of these countries are poised for rapid economic growth. The ocean industry is an important contributor, and the sustainable use of this resource is crucial.

This report explores how ocean sustainability can be achieved through the lens of developing nations, taking into consideration the challenges of a low-income population as well as an environmental regulatory framework that has yet to mature. Our investigation delves into five key ocean issues in the region—degradation of marine ecosystems, plastics pollution, unsustainable fishing, extraction of non-renewable marine resources and rising salinity from desalination—and highlights key steps that governments and companies in the Indian Ocean Rim need to take on the path to ocean prosperity.

## Key findings of the report:

**The Indian Ocean is vital to the global conversation on ocean sustainability but is currently an afterthought among global ocean experts compared with other regions.** The Indian Ocean, as the third-largest ocean, houses 30% of the world's coral reefs, has 40,000 sq km of mangroves, some of the world's largest estuaries, and nine large marine ecosystems (LMEs). Approximately 13% of the world's wild-caught fish is from the Indian Ocean. It plays a central role in international trade, carrying 40% of the world's containerised cargo and 80% of the world's oil shipments. Mapping the way for the sustainable use of these resources is crucial, particularly for coastal communities dependent on marine resources.

**Governments and organisations recognise that land-based initiatives can address ocean issues.** Brine from desalination plants, often discharged into the ocean, is being diverted into aquaculture and agriculture in the UAE and being used for salt production in Somaliland; a waste-insurance clinic in Indonesia is offering healthcare in exchange for garbage that often ends up in the ocean. Ocean sustainability initiatives therefore need to involve a wide range of stakeholders, factoring in wider climate change considerations too.

**Advanced technologies are proving useful in tackling ocean issues.** Illegal fishing is being dramatically reduced across Indonesia with open-source satellite data and GPS technology significantly lowered the cost of mapping mangrove forests across Sri Lanka. Information technology also facilitates public engagement: in Zanzibar, Tanzania, dive operators are helping to record coral bleaching events through an online portal; In Kenya, social media galvanised political will for the ban on plastic bags. Understanding emerging technologies and how these can be leveraged can go a long way in accelerating efforts towards ocean sustainability.

**Ocean challenges can be reframed as commercial opportunities for the blue economy.** In a southern state in India, plastics in the ocean are being collected and repurposed to build roads; in the Seychelles, a focus on ocean sustainability is creating new opportunities to raise finance for economic development; and in Thailand, seagrass conservation is strengthening conch production in some villages. Thus, ignoring pressing ocean issues such as plastic pollution and unsustainable fishing not only increases the risks to the environment and people, but also means that opportunities for economic diversification and sustained, inclusive growth may be overlooked. This mindset shift is imperative to further engaging the private sector in this space.

**A strong return on sustainable projects is imperative for institutional investors, despite a growing interest in impact investing.**

To make it worthwhile for institutional investors, projects need to encompass three key characteristics—scalability, leverage and security—and have an economic model that provides a return on investment and a real sustainability benefit. Within sustainable finance, although ocean projects will have unique considerations, experts we interviewed conclude that blue finance does not need to be treated differently from the “green finance” market.

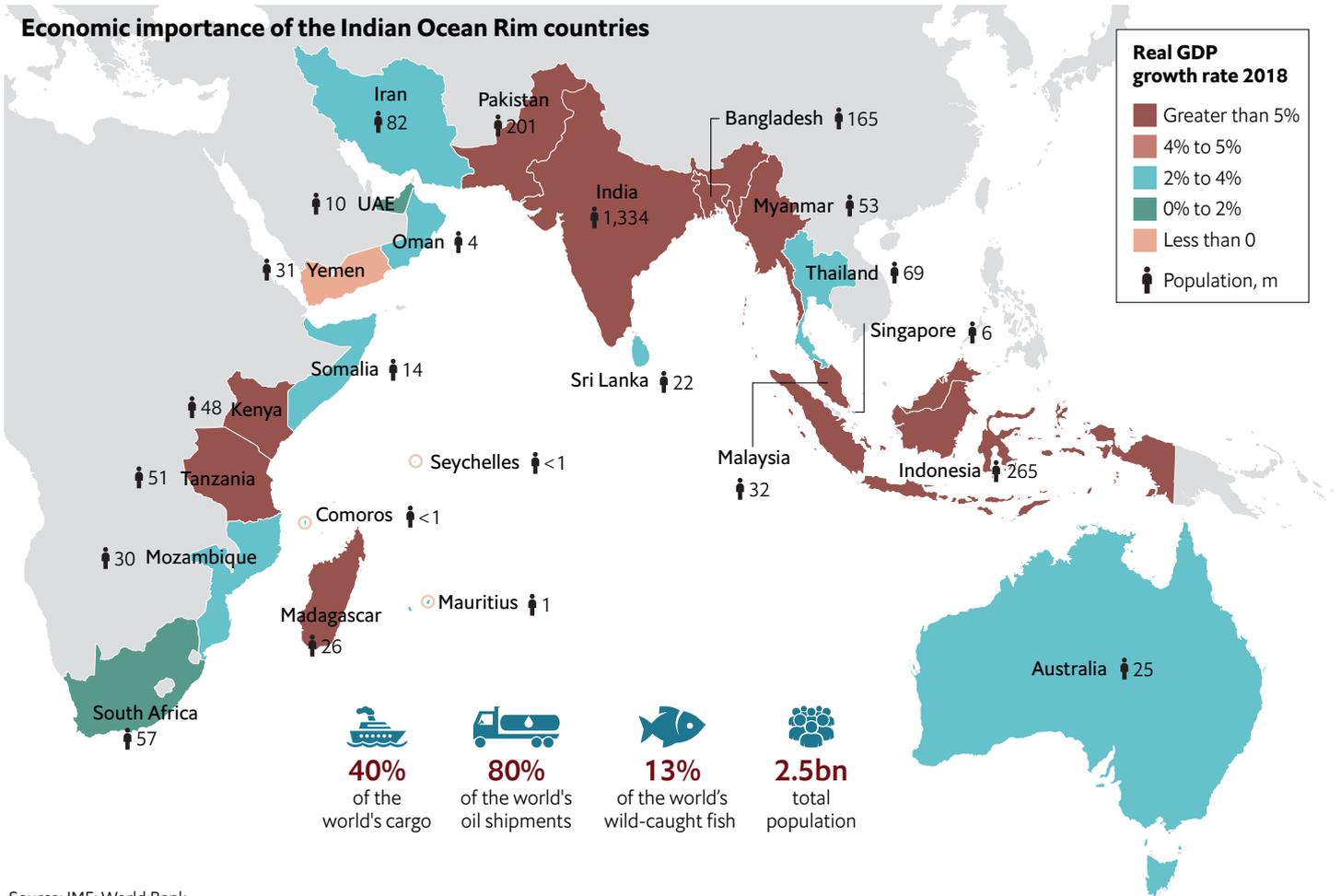
**Strong political will is the engine for blue economic growth.** Setting assertive targets and policies captures the imagination, provides a clear checklist for countries and partners to get behind and creates an enabling environment for the blue economy. Government sources of finance have been the first port of call for sustainable ocean projects too; gaining traction on this front not only requires participation from environment ministries but also the buy-in of finance ministries. Case studies from the Seychelles, Kenya, India, Sri Lanka, Indonesia, among others, showcase examples within the Indian Ocean where this leadership is shining through. Beyond national priorities, governments have an important role to play in regional and global coordination, without which the blue economy will not achieve its full potential.

This paper invites the Indian Ocean Rim countries to grasp the opportunities, scale innovations and approaches already present within the region, and take strategic action against future threats.

# Introduction

The ocean forms a vital part of the livelihoods and cultural identities of the 2.5bn people residing in the Indian Ocean Rim countries. Spanning fisheries, sea trade, coastal tourism, the extraction of marine resources and more besides, the global ocean economy generates approximately US\$2.5trn of value annually,<sup>1</sup> to which the Indian Ocean rim countries make a significant contribution. Approximately 13% of the world's wild-caught fish is from the Indian Ocean.<sup>2</sup> It plays a central role in international trade, carrying 40% of the world's containerised cargo<sup>3</sup> and 80% of the world's oil shipments.<sup>4</sup>

Importantly, many of the rim countries are predicted to dominate economic growth over the next decade as more mature economies stagnate. "A lot of the countries around the Indian Ocean are hungry for economic development," explains Lyndon Llewellyn, research programme leader for data and technology innovation at the Australian Institute of Marine Science. "And so you have the risk of unbridled development, which subsequently has a long-term impact on [the region's] marine ecosystems." Given the degree of subsistence-level challenges (including food, clothing and



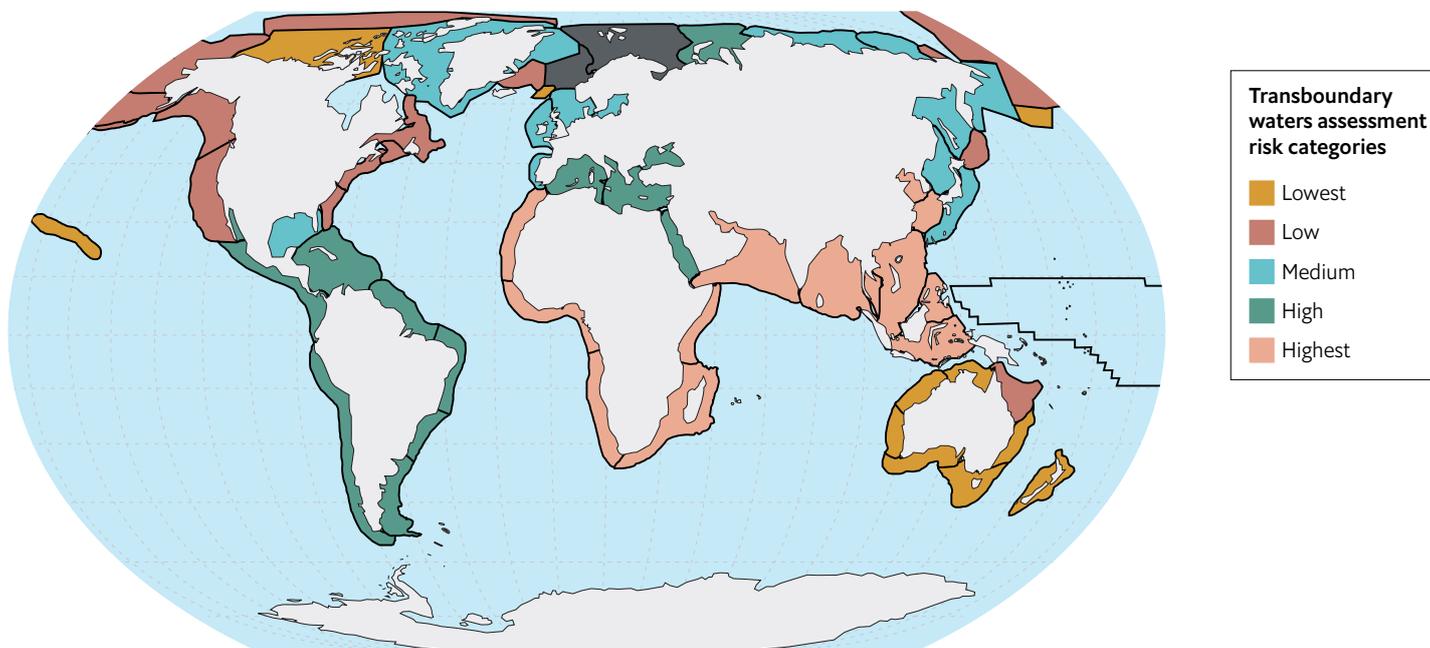
Source: IMF; World Bank

shelter) facing much of the region’s population, long-term ocean sustainability may well be a secondary concern.

The Indian Ocean, as the third-largest ocean, houses 30% of the world’s coral reefs, has 40,000 sq km of mangroves, some of the world’s largest estuaries, and nine large marine ecosystems (LMEs).<sup>5</sup> Mapping the way for the sustainable use of these resources is crucial, particularly for coastal communities dependent on marine resources. “You look at countries like Seychelles and the Maldives—they survive on tourism, so if their reefs die, then they lose their source of income,” explains Mr Llewellyn, citing the example of small island developing states (SIDS) in the Indian Ocean, for which this problem is most acute.

Yet the Indian Ocean is a bit of an afterthought among global ocean experts compared with other regions. Insufficient observation, the costs of which run in the millions of dollars, is one reason the region is not well understood. A lack of human, institutional, and technical capabilities in some Indian Ocean countries underpins this and has led to a varied level of understanding of the biodiversity of the Indian Ocean.<sup>6</sup> Recent missions, such as the Second Indian Ocean Expedition<sup>7</sup> and Nekton’s Mission II,<sup>8</sup> aim to fix this.

**Transboundary Waters Assessment of LMEs in the Indian Ocean**  
(based on overall risk scores)



Through their efforts, the organisations leading these expeditions aim to enhance knowledge of this body of water, which presents unique ocean dynamics not seen in the Pacific or Atlantic. “The maritime continent and the anomalies of convection and precipitation in the [Indian Ocean] region are quite influential [on climatic conditions including monsoons],” explains Vladimir Ryabinin, executive secretary of the Intergovernmental Oceanographic Commission and co-chair of the Second Indian Ocean Expedition. The Indian Ocean strongly influences the Asian monsoon, which in turn has a significant effect on moisture transport for a quarter of the globe and beyond.<sup>9</sup> Insights from these expeditions will therefore shed more light on these unique characteristics and shape the region’s blue economy strategies for years to come.

**The Indian Ocean in hot water**

The pressures on the marine ecosystem are evident. The Transboundary Waters Assessment Programme, run by the UN Environment Programme, has classified six of the nine LMEs in the Indian Ocean as being at “very high risk”, taking into consideration fisheries, pollution, socioeconomic status, pollution and ecosystem health, and governance.<sup>10</sup>

Source: IOC-UNESCO and UNEP (2016). Large Marine Ecosystems: Status and Trends, Summary for Policy Makers. United Nations Environment Programme (UNEP), Nairobi.

Among the leading causes of marine ecosystem degradation has been climate change. “Increasing amounts of carbon dioxide absorbed by the ocean has led to acidification and rising atmospheric temperatures have led to ocean warming and deoxygenation. These are very pronounced in the Indian Ocean,” says Zouhair Lachkar at New York University Abu Dhabi. Temperatures have risen by around 0.23°C between 1980 and 2017.<sup>11</sup> “In turn, the combination of the deoxygenation, acidification and warming has a very strong [adverse] impact on marine ecosystems.” One example is coral bleaching, a whitening of corals which indicates coral reef degradation and their reduced ability to provide ecosystem services such as fish production and shoreline protection.<sup>12</sup> Coral reefs along the East African coast in the Indian Ocean are most at risk. “I think we’re now going to see increasing incidences of these events and the period allowing for recovery is going to get shorter and shorter,” says Kristian Teleki, director of the Sustainable Ocean Initiative for the World Resources Institute. “That obviously is going to be a real problem in terms of the resiliency of these ecosystems and has a knock-on effect on the economies in the region.”

Further degrading the ocean environment is marine debris, in particular, plastics pollution. Worldwide, an estimated 8m tonnes of plastic enters the ocean each year,<sup>13</sup> the majority of which originates from land and is transported through rivers. Recent research has revealed that 90% of this plastic debris comes from just ten rivers, eight of which are in Asia and two in Africa.<sup>14</sup> As a result, it is estimated that there are about 60,000 tonnes of plastic floating in the Indian Ocean, the second highest after the North Pacific.<sup>15</sup> Discarded plastic has a major impact on marine life, through ingestion or entanglement, and breaks down to leach toxic chemicals into the sea, with wider implications on human health as a result of seafood contamination. In the Indian Ocean, a large marine garbage patch was first discovered in 2010, estimated at roughly 5m sq km,<sup>16</sup> and this continues to grow.

The extraction of marine resources, ranging from food to minerals, poses further risks to the marine environment. Offshore oil and gas extraction and deep-sea mining are among the most polluting. Oil spills from tankers, offshore platforms, submerged pipelines and waste from seabed

mining across the Indian Ocean have put marine habitats under threat. Just under a third of the world’s offshore oil and gas rigs are located in the Indian Ocean,<sup>17</sup> and as shallow oil reserves are depleted oil producers will be motivated to move further offshore.

The fisheries industry is plagued by illegal, unreported and unregulated (IUU) fishing, which destroys marine habitats, distorts competition and weakens coastal communities. In the Indian Ocean, between 26% and 33% of stocks are being fished at biologically unsustainable levels.<sup>18</sup> Many experts believe that weak regulation and enforcement, combined with limited alternatives for sources of income in low-income coastal communities, are driving this trend.

Overfishing can also have unintended consequences, says Mr Teleki. Studies have shown a link between illegal fishing and a rise in piracy.<sup>19,20</sup> Overfishing has also been linked to rising HIV infections in some communities as women turn to prostitution to supplement income as a result of the decline in the fishing industry. There is evidence of this near Lake Victoria in Kenya, but further investigation is required to assess the scale of the problem in coastal communities reliant on fisheries.<sup>21,22</sup>

Furthermore, in countries where groundwater is scarce, such as the UAE and Oman, and those that face an impending water crisis such as South Africa, governments have turned to water desalination. This process draws large volumes of water from the ocean to produce water for irrigation and drinking, but creates hot, saturated brine effluent, often released back into the ocean. Especially in cases where the release has been poorly managed, this has resulted in a rapid increase in water salinity in specific regions, such as semi-enclosed basins like the Arabian Gulf. Rising salinity has had an adverse impact on marine life including seagrass and benthic fauna as well as juveniles and larvae of various marine species.<sup>23</sup>

Many of these issues are set to get worse as the coastal population increases, according to Dixon Waruinge, secretariat to the Nairobi Convention. “Greater demand for marine resources globally could be a potential risk to coastal communities that depend on those resources, be it for fisheries or coastal tourism, and it’s very hard to figure out how to strike a balance,” he says.

The interconnectedness of these issues means that the effects of one often compound the effects of another. The cumulative impacts of all of these challenges are difficult, if not impossible, to gauge. As such, the Indian Ocean must be treated as an indivisible whole and any efforts to create

opportunities for a blue economy must be co-ordinated. At the very least, says Mr Llewellyn, “this would require integrated regional planning between nations, cross-country adoption of marine-specific policies, robust governance and a sharing of knowledge and skills.”

### Ocean health for ocean wealth: A blue economy

The ocean challenges discussed in this chapter can be attributed a number of ocean-related economic activities, but also to some land-based activities. Mangroves and seagrass meadows are often cut down for coastal development, including for constructing hotels and residential properties “with a view”, and coastal tourism. Inadequate waste management on land contributes significantly to marine litter, and plastics pollution in particular. Equipment left behind by the fishing industry further exacerbates this.

Is it possible, then, to engage in any ocean-related economic activity without damaging the marine environment? Can the ocean economy truly be “sustainable”? There is as yet no consensus on a definition of a “blue economy”, but to frame our discussion we have used the following definition:

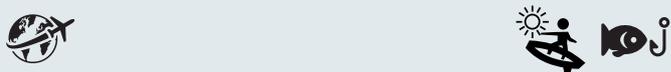
*A blue economy emerges when economic activity is in*

*balance with the long-term capacity of ocean ecosystems to support this activity and remain resilient and healthy.*

The most exciting component of this is the emergence of ocean industries for a blue economy, including sustainable fisheries, eco-tourism, renewable energy from the ocean, blue carbon for carbon sequestration and coastal protection services, among others. Underpinning these emerging industries are the technological innovations making some of these possible, from satellite surveillance and big data analysis to the development of biodegradable packaging and peer-to-peer financing platforms.

To develop a sustainable blue economy though, it is not only imperative that industry players themselves shift their mindset and adopt sustainable practices. It also requires the full force of government action in the Indian Ocean Rim countries. The UN recommends a co-operative approach for tackling issues, with governments regulating, businesses innovating and individuals acting.

### Source industries for key ocean challenges in the Indian Ocean Rim countries

Ocean issue	Source industry
Degradation of the marine ecosystem	 <p>Tourism; coastal development; shipping; port infrastructure and services</p>
Plastics pollution	 <p>Land-based activities (and improper waste management); tourism; fisheries</p>
Pollution from extraction of non-renewable marine resources	 <p>Oil and gas; seabed mining</p>
Unsustainable fishing	 <p>Fisheries; aquaculture</p>
Rising water salinity	 <p>Desalination</p>

## The pace of progress

“There was a turning point on ocean action [in 2017],” states Peter Thomson, special envoy to the ocean at the UN. “Prior to that, we were sleepwalking towards disaster when it came to ocean health.” The most universal sign of global action on ocean sustainability has been Sustainable Development Goal

(SDG) 14, the dedicated goal for life below water, which sets out targets for the years up to 2030.

Among the low-hanging fruit, Mr Thomson explains, are altering fishing practices and policies, curbing plastics pollution and designating marine protected areas. “I do believe that all those are doable, and I am optimistic about the success of our plan.”

### SDG 14 sub-targets and deadlines

Sub-target	Description		Deadline
14.1	Prevent and significantly <b>reduce marine pollution</b> of all kinds, particularly from land-based activities, including marine debris and nutrient pollution		2025
14.2	Sustainably <b>manage and protect marine and coastal ecosystems</b> to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration, to achieve healthy and productive oceans		2020
14.3	<b>Minimise</b> and address the impacts of <b>ocean acidification</b> , including through enhanced scientific co-operation at all levels		n/a
14.4	Effectively regulate harvesting, and <b>end overfishing, IUU fishing</b> and destructive fishing practices and implement science-based management plans, to restore fish stocks in the shortest time feasible at least to levels that can produce maximum sustainable yield as determined by their biological characteristics		2020
14.5	<b>Conserve</b> at least 10% of <b>coastal and marine areas</b> , consistent with national and international law and based on best available scientific information		2020
14.6	<b>Prohibit certain forms of fisheries subsidies</b> that contribute to overcapacity and overfishing, and eliminate subsidies that contribute to IUU fishing, and refrain from introducing new such subsidies, recognising that appropriate and effective special and differential treatment for developing and least developed countries (LDCs) should be an integral part of the World Trade Organisation fisheries subsidies negotiation		2020
14.7	Increase the economic benefits to SIDS and LDCs from the <b>sustainable use of marine resources</b> , including through sustainable management of fisheries, aquaculture and tourism		2030
14.a	<b>Increase scientific knowledge</b> , develop research capacities and transfer marine technology taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and enhance the contribution of marine biodiversity to the development of developing countries, in particular SIDS and LDCs		n/a
14.b	<b>Provide access</b> for small-scale artisanal fishers <b>to marine resources and markets</b>		n/a
14.c	Ensure the <b>full implementation of international law</b> , as reflected in the UN Convention on the Law of the Sea for states parties to it, including, where applicable, existing regional and international regimes for the conservation and sustainable use of oceans and their resources by their parties		n/a

Source: UN<sup>24</sup>

The weakness of environmental regulations in some Indian Ocean Rim countries has been a barrier to progress, but Mr Thompson is seeing governments increasingly legislate using SDG 14 as a guideline. In April 2018 the Indian prime minister, Narendra Modi, announced an ambitious plan to tackle global plastic pollution by banning all single-use plastics by 2022. In the Indian Ocean Rim, eight countries have implemented national bans on plastic bags, while an additional four have applied bans in specific cities or states.<sup>25</sup> In addition, the Seychelles is the latest country to establish a large marine protected area as part its blue economy strategy. By 2020 nearly a third of Seychelles' waters is expected to be protected under a marine spatial plan to manage unregulated or illegal fishing, oil and gas exploration and development, and mining and dredging in deep waters.

But it has been difficult to engage all levels of civil society and the private sector to work towards ocean sustainability. To achieve this, experts agree that the narrative needs to extend beyond conservation alone. "Marine protected areas, for instance, should be considered part of a country's infrastructure," states Mr Teleki. "They [can be] fish factories, they [can be] income generators, and they sequester carbon and help build resilience in your ecosystems." Aimee Gonzales, executive director of Partnerships in Environmental Management for the Seas of East Asia, emphasises their potential for local job creation too, using local communities for monitoring and enforcement. "The really compelling narrative is what's going to get countries [and companies] to invest in a sustainable blue economy," Mr Teleki reiterates.

In the coming months, we aim to contribute to this narrative. We will release deep dives into five challenges identified in this chapter: degradation of the marine ecosystem, plastics pollution, unsustainable fishing, extraction of non-renewable marine resources and rising water salinity from desalination. These chapters will explore the issues in the context of the Indian Ocean, but more importantly, focus on compelling case studies from among the Indian Ocean Rim countries showcasing key initiatives to address ocean issues.

In these chapters, we will tell the stories of how fishermen in India are using plastics from the ocean to build roads and how Indonesia has set up a waste-insurance clinic, offering healthcare in exchange for garbage. We will look at modular farming practices repurposing brine from desalination in the UAE and Sri Lanka's community-based mangrove conservation project. We will explore how the Seychelles government balanced economic and conservation objectives in recent marine spatial planning efforts and the successes and shortcomings of the plastics ban in Kenya.

In our conclusion, we will tie in the learnings from the deep dives to and map the way forward for the region as a whole through the efforts of governments, the private sector and multilateral organisations under three pillars: governance, finance and innovation. We have chosen a solution-driven approach to this white paper; the reason for this was best articulated by Mr Teleki: "We have a good handle on the state of the problems. We now need to walk the walk."

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- Fish" Economy in Nyanza Province, Kenya", 2013, AIDS Education and Prevention, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3717412/>
22. P Nathenson et al, "No sex for fish: empowering women to promote health and economic opportunity in a localized place in Kenya", 2017, Health Promotion International, <https://www.ncbi.nlm.nih.gov/pubmed/27053643>
23. Sustainable Desalination Handbook, [https://websites.pmc.ucsc.edu/~apaytan/publications/2018\\_Articles/Impacts%20of%20Desalination.pdf](https://websites.pmc.ucsc.edu/~apaytan/publications/2018_Articles/Impacts%20of%20Desalination.pdf)
24. UN Development Programme, "Goal 14 Targets", <http://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-14-life-below-water/targets.html>

# Chapter 1: Degradation of marine ecosystems

The extent of the benefits that communities and economies derive from the ocean depends on the overall health of the ocean. While some components of the marine ecosystem and the services they provide are more visible, such as fisheries, others are hidden below the surface. In this chapter, we conduct a closer examination of mangroves, seagrass meadows and coral reefs, among the most undervalued elements of the marine environment. Their degradation and the resulting adverse impact on marine life have been well documented,<sup>1,2</sup> but only in recent years has there been a more widespread recognition of their value.

Mangroves occur across 188 countries, but 75% of mangrove forests are found in just 15 countries. The Indian Ocean Rim countries are home to 20% of these,<sup>3</sup> translating to roughly 40,000 sq km.<sup>4</sup> Coral reef area is estimated at close to 69,000 sq km, around 30% of the global total.

Data on seagrass coverage in the Indian Ocean are scarce. This is indicative of the broader sentiment, explains Blandina Lugendo, lecturer in the department of aquatic sciences and fisheries at University of Dar es Salaam. “We are seeing greater awareness around mangroves and corals, but less so with seagrass meadows. Most people don’t know why we need to conserve seagrasses. It is the ‘silent’ habitat, often forgotten.”

In the Indian Ocean Rim, South-east Asia is especially rich in mangroves, corals and seagrass meadows. It is said to have the highest levels of coral biodiversity,<sup>5</sup> followed by the northern Mozambique Channel. In the western Indian Ocean, coral cover is the highest in Madagascar, Tanzania, Mozambique and the Seychelles,<sup>6</sup> whereas mangrove forests are mainly concentrated in Mozambique, Madagascar, Tanzania and Kenya.<sup>7</sup>

So far, conversations on these three habitats have mostly treated them in isolation but joined-up management would be more effective. “There’s limited understanding of the linkages among the three,” says Dominic Wodehouse, adviser at the Mangrove Action Project. “The system works much better if all three are healthy.” Seagrass beds are better protected against strong waves if coral reefs are present and mangroves prevent harmful sedimentation from land from reaching seagrass meadows and coral reefs. Many species, including snapper and spiny lobster, depend on multiple habitats through the



1 FAO, A review of mangrove and seagrass ecosystems and their linkage to fisheries and fisheries management, <http://www.fao.org/docrep/018/i3355e/i3355e00.htm>

2 S S Romañach et al, Conservation and restoration of mangroves: Global status, perspectives, and prognosis, 2018, *Ocean & Coastal Management*, <https://www.sciencedirect.com/science/article/pii/S0964569117301710>

3 UN Environment, 2018. Ocean and Habitat Atlas.

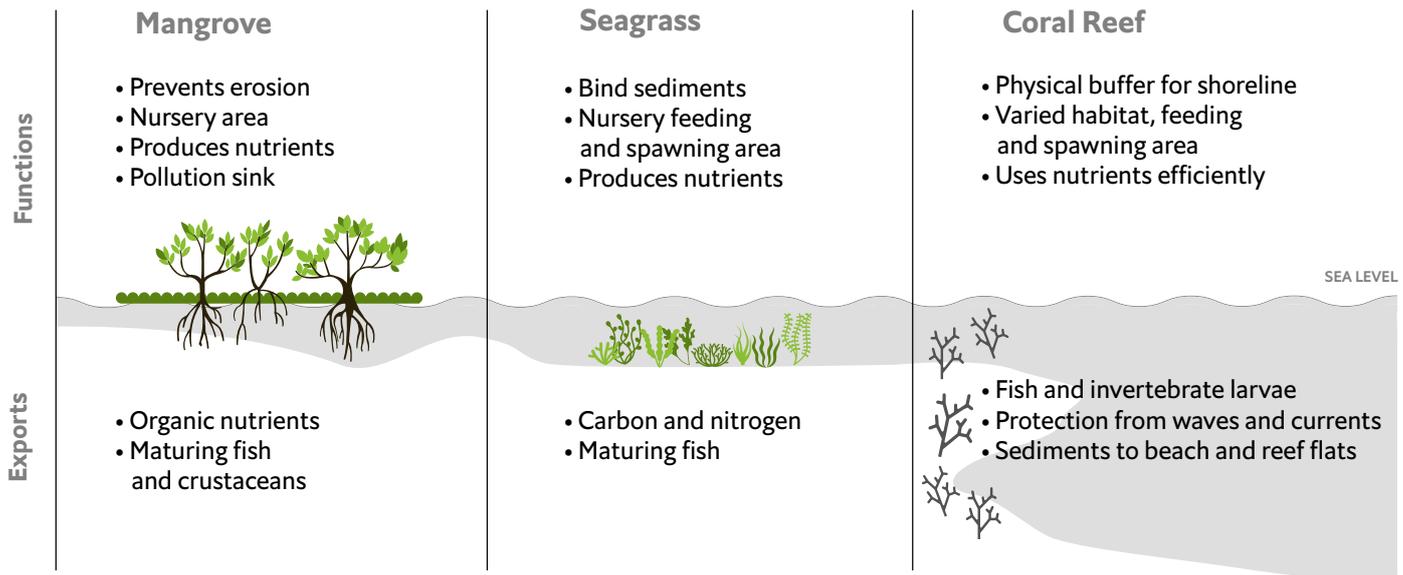
4 <https://www.ncbi.nlm.nih.gov/pubmed/21297949>

5 World Resources Institute, Reefs at Risk in Southeast Asia, [http://wriorg.s3.amazonaws.com/s3fs-public/pdf/rrseasia\\_full.pdf](http://wriorg.s3.amazonaws.com/s3fs-public/pdf/rrseasia_full.pdf)

6 Coral reef status report for the Western Indian Ocean, <https://drive.google.com/file/d/1PkHG7-xSixodgvnbgYMoZjLjkQs2-.8p/view>

7 Mangroves of the Western Indian Ocean: Status and Management, [https://www.researchgate.net/publication/311399453\\_Mangroves\\_of\\_the\\_Western\\_Indian\\_Ocean\\_Status\\_and\\_Management](https://www.researchgate.net/publication/311399453_Mangroves_of_the_Western_Indian_Ocean_Status_and_Management)

## A coastal ecosystem



Source: A T White, 2001, *Philippine coral reefs: A natural history guide*, 2nd ed. Bookmark Inc and Sulu Fund for Marine Conservation Foundation, Inc.

various stages of their life cycles, explains John Burt, associate professor of biology at New York University Abu Dhabi. “They use seagrasses as juveniles and coral reefs as adults. They migrate between habitats over the course of their lifetime.”

Together these habitats provide a variety of ecosystem services: they are breeding grounds for marine species and protect the coast from erosion. Mangroves are recorded as being the most effective in preventing coastal erosion, however, seagrasses and corals also play a vital role in diminishing wave size and power.<sup>8</sup> In addition, mangroves and seagrasses are vital for carbon sequestration—around the world they occupy only 0.5% and 1.1% of the total coastal ocean area but are responsible for 14% and 10%, respectively, of carbon sequestration in the world’s oceans.<sup>9</sup> The value of ecosystem services—including fisheries,

tourism and coastal protection—is estimated at US\$57,000 per ha per year on average,<sup>10</sup> equating to roughly US\$228bn across the Indian Ocean.<sup>11</sup>

### Degradation over decades

Given their proximity to land, these habitats are exposed to a variety of human activities and have suffered irreparable damage as a result. Their decline can be attributed to multiple sources including urban development and tourism; overexploitation by fisheries; agricultural and aquaculture conversions; and climate change.

Closer to land, mangroves are cut down to build beach-front hotels and residential properties as well as for infrastructure development. Seagrasses and coral reefs, further offshore,

8 G Guannel, et al, The Power of Three: Coral Reefs, Seagrasses and Mangroves Protect Coastal Regions and Increase Their Resilience, 2016, *PLoS One*, doi:10.1371/journal.pone.0158094

9 D M Alongi, Carbon sequestration in mangrove forests, [https://www.researchgate.net/profile/Daniel\\_Alongi2/publication/274116107\\_Carbon\\_sequestration\\_in\\_mangrove\\_forests/links/556b926408aec22683037b84/Carbon-sequestration-in-mangrove-forests.pdf](https://www.researchgate.net/profile/Daniel_Alongi2/publication/274116107_Carbon_sequestration_in_mangrove_forests/links/556b926408aec22683037b84/Carbon-sequestration-in-mangrove-forests.pdf)

10 WWF, Reviving the Ocean Economy, [http://d2ouvy59p0dg6k.cloudfront.net/downloads/reviving\\_ocean\\_economy\\_report\\_low\\_res.pdf](http://d2ouvy59p0dg6k.cloudfront.net/downloads/reviving_ocean_economy_report_low_res.pdf)

11 Estimate by The Economist Intelligence Unit, based on approximately 40,000 square km of mangrove cover in the Indian Ocean.

are often removed to improve port access. In Kenya, 100 ha of mangroves were lost as a result of dredging in the Sabaki river for an infrastructure project.<sup>12</sup>

Certain fishing practices can also be harmful. Seagrasses are often damaged when individuals dig up types of shellfish or collect bait species for larger fishing efforts. More destructive practices, such as dynamite fishing, are seeing an uptick in parts of Tanzania (Dar es Salaam and the Songosongo archipelago), although government intervention had succeeded in clamping down on this temporarily.<sup>13,14</sup>

The development of aquaculture has driven vast amounts of mangrove deforestation, particularly for shrimp farms in Thailand for which the environment around mangrove forests is ideal. Mangroves have been cut down in Thailand for palm oil production as well. Nutrient run-off from agricultural systems close to these habitats results in eutrophication, an oversupply of nutrients that leads to the growth of algae and eventually ocean deoxygenation.

In addition to some of these more direct impacts, the enormous pressures of climate change on the degradation of marine ecosystems must not be ignored. Roughly 40% of CO<sub>2</sub> emissions since the beginning of the industrial era have been absorbed by oceans,<sup>15</sup> leading to acidification. Rising atmospheric temperatures have led to ocean warming and deoxygenation.

Around the world, ocean warming has led to an increasing frequency of global coral bleaching events—in 1998, 2010 and 2015-16. Coral bleaching is the whitening of coral that results from the loss of a coral's symbiotic algae or the degradation of the algae's photosynthetic pigment<sup>16</sup>

and can be triggered with an increase in temperature of only two degrees centigrade. The death of coral reefs leads to a critical decline in ecosystem productivity, as fish species that depend on them for food and shelter perish or migrate, and coastlines erode rapidly without the coral's protection. Even if the target of 1.5°C for global warming under the Paris Agreement is met, it is estimated that 70-90% of reef-building corals will be lost.<sup>17</sup> Some reefs in Sri Lanka, the Maldives, India, Kenya, Tanzania and the Seychelles have experienced high coral mortalities of up to 95% as a result of warming.<sup>18</sup> In the western Indian Ocean, coral bleaching events in 1998 and 2016 resulted in 25% and 10% losses respectively,<sup>19</sup> resulting in direct financial losses to the diving industry estimated at US\$4m in Zanzibar, Tanzania, and US\$16m in Mombasa, Kenya, in 1998, according to one study.<sup>20</sup>

Furthermore, ocean warming, through melting glaciers at the poles and the thermal expansion of water, is contributing to rising sea levels. Global sea levels are expected to rise by 0.63 metres on average by 2100, with coastlines experiencing a sea-level change within a 20% margin of the global average.<sup>21</sup> Without the shoreline protection services offered by mangroves, coral reefs and seagrass meadows, the region's coastal population, estimated at over 250m, face a greater risk of displacement as sea levels rise.<sup>22</sup>

Many coastal areas lack effective frameworks for resource management and governance. In some there are financial constraints and in others commercial interests are prioritised over conservation. "More effort needs to go towards conserving and protecting the remaining habitats

12 E P Green and F T Short, World atlas of seagrasses. 2003

13 Coral reef status report for the Western Indian Ocean, <https://drive.google.com/file/d/1PkHG7-xSixodgvnbgYMoZjLjkQs2-.8p/view>

14 <https://www.wri.org/tanzania-deadly-dynamite-fishing-resurfaces>

15 Nature, Recent increase in oceanic carbon uptake driven by weaker upper-ocean overturning, <https://www.nature.com/articles/nature21068>

16 Encyclopaedia Britannica, Coral Bleaching, <https://www.britannica.com/science/coral-bleaching>

17 O. Hoegh-Guldberg et al., 2018, Impacts of 1.5°C Global Warming on Natural and Human Systems. In: Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.

18 Coral Bleaching in the Indian Ocean: SocioEconomic Assessment of Effects, [https://www.researchgate.net/publication/237453282\\_Coral\\_Bleaching\\_in\\_the\\_Indian\\_Ocean\\_SocioEconomic\\_Assessment\\_of\\_Effects](https://www.researchgate.net/publication/237453282_Coral_Bleaching_in_the_Indian_Ocean_SocioEconomic_Assessment_of_Effects)

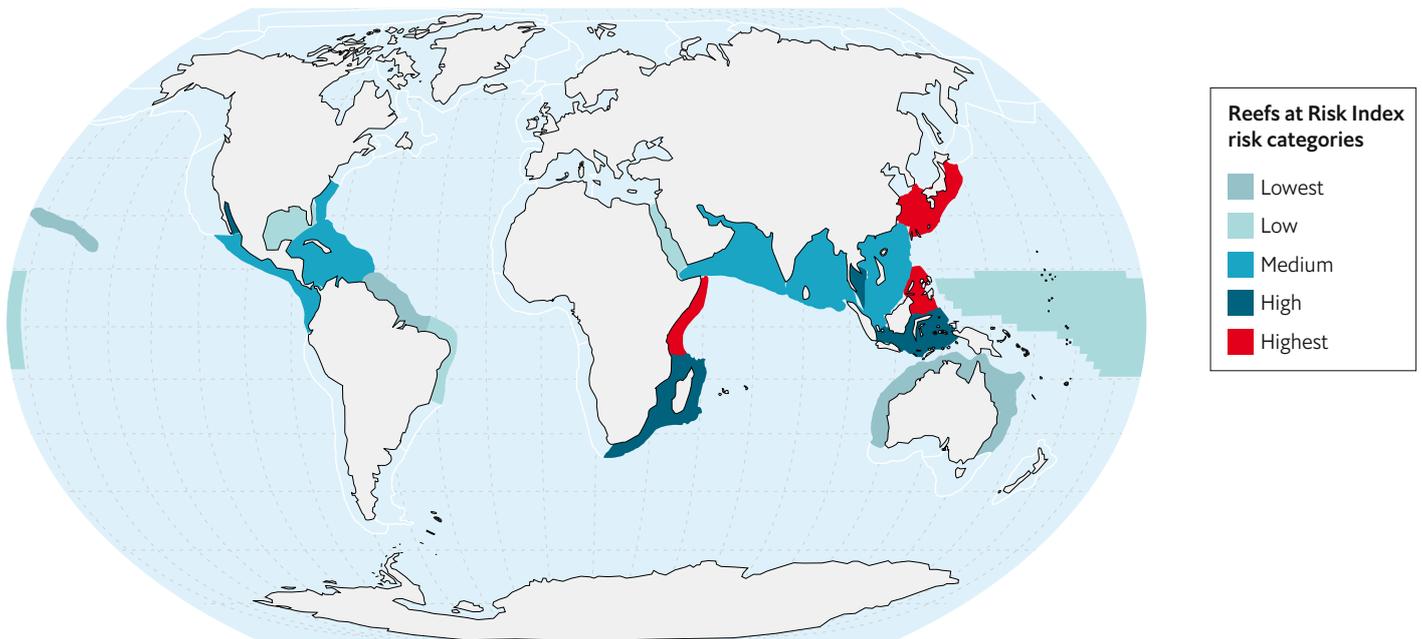
19 Coral reef status report for the Western Indian Ocean, <http://cordioea.net/gcrmnwio2017-2/>

20 Coral Bleaching in the Indian Ocean: SocioEconomic Assessment of Effects, [https://www.researchgate.net/publication/237453282\\_Coral\\_Bleaching\\_in\\_the\\_Indian\\_Ocean\\_SocioEconomic\\_Assessment\\_of\\_Effects](https://www.researchgate.net/publication/237453282_Coral_Bleaching_in_the_Indian_Ocean_SocioEconomic_Assessment_of_Effects)

21 IPCC, Climate Change 2014 Synthesis Report: Summary for Policymakers, [https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5\\_SYR\\_FINAL\\_SPM.pdf](https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf)

22 P Mondal and A J Tatem, Uncertainties in Measuring Populations Potentially Impacted by Sea Level Rise and Coastal Flooding, 2012, PLoS One, <https://journals.plos.org/>

## Reefs at risk



Source: IOC-UNESCO and UNEP (2016). Large Marine Ecosystems: Status and Trends, Summary for Policy Makers. UN Environment Programme. [http://onsharedocean.org/public\\_store/publications/lmes-spm.pdf](http://onsharedocean.org/public_store/publications/lmes-spm.pdf)

that we still have in place in order to maintain their ecological integrity,” asserts Mr Burt. “Expanding existing marine protected areas, developing networks of marine reserves, and heavily enhancing enforcement of maritime regulations and policies would go a long way towards preserving the important ecosystems that are still in place.”

Governments across the Indian Ocean Rim countries, in partnerships with global organisations and local non-government organisations (NGOs), are taking steps to establish marine protected areas, encourage environmental impact assessments and, most importantly, educate the local population to drive sustainable grassroots protection. “Protection of marine ecosystems is really a social challenge,” says Mr Wodehouse. “If you truly want to make an impact, it’s almost a village-by-village campaign, with boots on the ground, changing hearts and minds. It can be a slow, agonising grind.”

The case studies in this chapter take a closer look at some of these initiatives, weaving in these local, social considerations. In the Sri Lankan mangrove conservation project, we show how local commitment to mangrove

protection is secured in exchange for microloans and enforced by community organisations themselves; we reinforce the need for community-based monitoring in the story of seagrass protection in Thailand; and, finally, consider how the tourism industry in Zanzibar was trained to protect coral reefs and, in turn, their livelihoods.

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**Without the shoreline protection services offered by mangroves, coral reefs and seagrass meadows, the region’s coastal population, estimated at over 250m, face a greater risk of displacement as sea levels rise**

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## CASE STUDY 1

**Manning mangroves: Sri Lanka's mangrove conservation project****Case summary**

- Through this project, Seacology (a US-based conservation organisation) aims to make Sri Lanka the world's first nation to comprehensively protect all of its mangrove forests.
- Seacology offered a unique deal across 1,500 villages situated near mangrove forests, trading a commitment to protect a mangrove forest or marine reserve for funding for a village project or microloans.
- Training is a vital component of the programme, as locals often have few business management skills, without which loans may be squandered.
- The support from the government has been critical to its success.

**A tragic history**

A lot was destroyed during the two-decade civil war in Sri Lanka between 1983 and 2009, and mangrove forests were among the collateral damage, serving as a hiding place for civilians and soldiers alike. Today, Sri Lanka has over 85 sq km of mangroves, but it is estimated that 74% has been lost since the 19th century.<sup>23</sup>

In the aftermath of the war and the 2004 tsunami that devastated coastal regions and livelihoods, many mangroves were cleared to make way for shrimp farming and to produce wood for fuel. Coastal development, primarily the construction of resorts, led to the vast deforestation of mangroves.

Mangroves are not only vital for the marine ecosystem, in that they replenish fish stocks and absorb excess nutrients, but they also limit coastal damage from storms or rising sea levels, crucial for an island like Sri Lanka. But most important is their ability to sequester carbon, in amounts much greater than other forests. Growing global awareness of this has galvanised political will in Sri Lanka too, where the government offered its full support for the conservation project led by Seacology, a US-based conservation organisation, in collaboration with a local NGO, Sudeesa. Through this project, Seacology aims to make Sri Lanka the world's first nation to comprehensively protect all of its mangrove forests.

**A successful trade: loans for conservation**

The first step in this effort was to map all existing mangrove areas. "This may come as a surprise," explains Duane Silverstein, executive director of Seacology, "but most countries in southern Asia do not have an accurate sense of where their mangroves are." Over 70% of the mangroves (around 60 sq km) have currently been mapped, but Mr Silverstein expects to accelerate these efforts as, since the project's inception, improvements in GPS technology have lowered costs for mangrove mapping. "The budget for mapping went way down," he exclaims.

Next, they had to enlist the local population. Among the biggest challenge Seacology faced in this effort was the poverty that drove locals to exploit the mangrove habitat in unsustainable ways. To provide a financial incentive, Seacology offered a unique deal across 1,500 villages situated near mangrove forests, trading a commitment to protect a mangrove forest or marine reserve for funding for a village project or microloans.

plosone/article?id=10.1371/journal.pone.0048191#pone.0048191.s001

23 Seacology, The Sri Lanka Mangrove Conservation Project,

One recent beneficiary was 54-year-old Thavanesan Rageshwary, who ran a small retail shop in Mannar district before joining the Sri Lanka Mangrove Conservation Programme. The SLRs10,000 (US\$145) microloan and three-day training she received enabled her to expand her business. Her earnings have increased by SLRs5,000 a month and she is planning further expansion while managing and protecting the local mangrove forest.

The initiative focuses on such small-scale, win-win trade-offs. To date, Seacology has provided training on mangroves and business management, and disbursed microloans to 10,500 local women, many of them widows from the war.<sup>24</sup> In exchange, they have secured a commitment to help conserve, rehabilitate and replant mangrove forests along Sri Lanka's coasts. Roughly 30% of the US\$4m budget for this programme over five years was earmarked for microloans.

Training is useful, as locals often have few business management skills, without which loans may be squandered. Education on the value of mangroves is equally important. "People completely undervalue mangroves. This is because most people think of them as smelly, mosquito-infested swamps and a place where trash collects," explains Mr Silverstein. "Now they understand its value, such as nurseries for fish and other marine species." That these three elements—training, microloans and mangrove protection—are tied together is vital to the programme's success.

To enforce this, the programme has created "community benefit organisations" (CBOs). "These are very unofficial organisations, with about eight people but some have up to 30," describes Mr Silverstein. "These are also almost entirely made up of women, because one lesson I've learnt over 220 projects is, on an island, if you

# US\$4m

## Budget for mangrove conservation project in Sri Lanka

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**Seacology offered a unique deal across 1,500 villages situated near mangrove forests, trading a commitment to protect a mangrove forest or marine reserve for funding for a village project or microloans**

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24 Seacology, The Sri Lanka Mangrove Conservation Project, <https://www.seacology.org/project/sri-lanka-mangrove-conservation-project/>

want something done quickly and efficiently, have the local women do it.” Mr Silverstein cites their wide local networks, strong influence on the community and ability to get things done as reasons for why this is the case.

A recent change Seacology made was to disburse loans directly to the CBOs, instead of routing them through the NGO Sudeesa, giving the local community more administrative power. The CBOs also play an important role in monitoring and enforcement—applying social pressure to ensure mangroves are being protected and loans repaid.

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**“Seacology has ensured that the programme is truly grassroots and has secured the all-important public buy-in. “That’s the best way to make sure that protecting mangroves remains a priority,” says Mr Silverstein.**

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### Key ingredients for success

Through CBOs and the broad press coverage that the initiative has received, Seacology has ensured that the programme is truly grassroots and has secured the all-important public buy-in. “That’s the best way to make sure that protecting mangroves remains a priority even in the face of opportunities for economic growth such as building hotels for tourism,” says Mr Silverstein. More conversations

need to be had about generating value without degrading these habitats, such as through honey production.

The support from the government has been critical in this regard. “It’s very hard to go ahead if the government isn’t receptive,” says Mr Silverstein. The government has pledged to create a hotline to report illegal mangrove harvesting. Even the navy in Sri Lanka played an active role in planting and protecting mangroves. “One thing we tried to take into account though is that government officials come and go. We tried to set up a project that would outlive the turnover of a particular environmental minister or government [by focusing on common and long-term objectives for the project].”

The long-term view and preparation for “all the things that could go wrong” was the foundation on which this programme was built. They spent over a year on this analysis, but it allowed them to prepare for and altogether avoid some of those eventualities.

However, there is one change Seacology would have made, Mr Silverstein admits: offering microgrants instead of microloans. “Microloans are great and offer two main advantages—theoretically, the money repaid sustains an ongoing fund and people are educated on how loans work. But record-keeping for [a] grassroots organisation, to keep track of 15,000 loans of US\$100 each (in terms of how they’re being used and repayments) is very burdensome. So that’s a practical reason to go with microgrants.” It would also help sidestep the cultural challenge with the Muslim population (who make up 15% of Sri Lanka’s population) of charging interest on loans, which is prohibited in Islam.

### Conservation versus restoration

As part of the mangrove protection efforts, Seacology aims to replant 9,600 acres of destroyed mangrove habitat. As of July 2018, over 800 seedlings have been cultivated and 1,100 acres replanted. Initial reports have

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**Sri Lanka has opened the world's first mangrove museum. It has received 20,000 visitors in the first year, most of whom are students on field trips**

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shown an increase in fish and crab populations in the mangroves, but it is still too early to assess its full impact.

A noteworthy success is the higher growth in seedlings in Sri Lanka compared with projects around the world, says Mr Silverstein. "The reason for this is Sudeesa is using a combination of Western science and local knowledge in decisions on where, when and what to plant."

Dominic Wodehouse, an adviser at the Mangrove Action Project, involved in mangrove conservation projects around South-east Asia, concurs. "From a technical point of view, rehabilitation is more difficult than it looks. It's not like dryland forestry where you can grab some seeds [and] plug them in, in straight lines."

Planting targets set by governments further complicate this. Mr Wodehouse explains: "One village might be able to find 20 ha, for instance, to plant, but another village might not have the space. To meet the targets, they may plant 20 ha inappropriately and unsuccessfully." To avoid planting the wrong species in the wrong place, working with locals is imperative.

### **Educating to inspire**

To ensure a better understanding of the long-term value of mangrove conservation, education is vital. As part of this, Sri Lanka has opened the world's first mangrove museum. It has received 20,000 visitors in the first year, most of whom are students on field trips. Schools have also introduced education on mangroves as part of their curriculum. To commemorate the opening of the museum, the Sri Lanka Post has created a stamp on the museum and the 22 species of mangroves endemic to the country. "This kind of public education is exciting," says Mr Silverstein. Fostering a sense of responsibility and a deeper understanding of this valuable marine habitat at a young age will go a long way in ensuring that mangroves remain protected for years and decades to come.

## CASE STUDY 2

**A grassroots effort: seagrass monitoring at Phra Thong Island, Thailand****Case summary**

- This project aims to document the seagrass resources, increase local awareness of the benefits of conserving the habitat, and develop a community-based programme to monitor the long-term viability of the meadows around the island.
- After the initial phase, the project shifted its focus to monitor conch, which grows in seagrass meadows, and is intensively harvested for both local consumption and sale, and has a direct economic benefit to communities.
- The project's decentralised approach is unique, explains Mr Bendell. It was established from the ground up, where local conch communities established their own marine protected areas.
- The presence of fully developed, adult conch was the real measure of success. But this took years to materialise.
- A big issue facing conservation projects in general is the lack of government support for such initiatives.

**The state of seagrass meadows**

Off the Andaman coast of Thailand lies Phang-nga province, which possesses the largest mangrove area in Thailand and extensive areas of seagrasses. More prevalent in the Andaman Sea than in the Gulf of Thailand, seagrass meadows occupy close to 8,000 ha along Thailand's western coast.<sup>25</sup>

Over the years, seagrass meadows have been threatened

as a result of coastal development and overexploitation by the fisheries and aquaculture industry. Thailand's increasing popularity as a tourist destination led to the rapid expansion of resorts across islands and consequently mangrove deforestation. In turn, water quality around seagrass meadows declined as sediment flowed further out, unimpeded.

In addition, to maintain its position as the largest exporter of shrimp, there was a sharp increase in the number of aquaculture farms in the early 2000s. With many facing challenges due to disease and pollution, tens of thousands of hectares of shrimp farms were abandoned in subsequent years.<sup>26</sup> "They're all using the same species, and so once a bacteria or a virus or a problem gets hold of some shrimp area, it spreads very quickly, and then a whole coastline's production collapses very quickly," explains Dominic Wodehouse, an adviser at the Mangrove Action Project. Seagrasses are particularly at risk, as they are often directly in the path of watershed nutrients and sediment.

But perhaps the most devastating was the damage from the tsunami in 2004. The Phang-nga region was among the hardest hit: along with nearby Ko Yao Yai island, Phang-nga province experienced a total habitat loss of 10%.<sup>27</sup> On one island in the Phang-nga province, Phra Thong, an entire fishing village was lost, including resorts on the island. In light of this, the restoration of seagrass meadows was the focus of one partnership between Mangrove Action Project (MAP) and Naucrates on Phra Thong island.

This project aims to document the seagrass resources, increase local awareness of the benefits of conserving the habitat, and develop a community-based programme to monitor the long-term viability of the meadows around the island.

25 Seagrass Watch, Thailand, <http://www.seagrasswatch.org/Thailand.html>

26 [http://www.fao.org/fishery/countrysector/naso\\_thailand/en](http://www.fao.org/fishery/countrysector/naso_thailand/en)

27 Seagrass Watch, Thailand, <http://www.seagrasswatch.org/Thailand.html>

### **A small start: community-led Marine Protected Areas**

Around Phra Thong island, most seagrasses are intertidal—that is, they are completely submerged during high tide and only exposed during low tide. Seagrass meadows near the village provide a rich harvest of rabbitfish and groupers, and many invertebrate animals, such as conch, sea cucumber and crab.

The project began as a community-based initiative, explains Barry Bendell, associate and adviser at the MAP, which encouraged locals to monitor the seagrass habitats. “However, locals quickly lost interest as they were unable to directly see the benefits of data collection [on seagrasses],” he says. Instead, the project shifted its focus to monitor conch, which grows in seagrass meadows, and is intensively harvested for both local consumption and sale, and has a direct economic benefit to communities.

The project’s decentralised approach is unique, explains Mr Bendell. It was established from the ground up, where local conch communities established their own marine protected areas (MPAs) using marker buoys. The only costs to the project were the buoys themselves and the signage. Within each 14-ha MPA, all fishing activities were prohibited, which initially limited income for the community.<sup>28</sup> The proximity of the MPAs to populated areas contributed to the success of the scheme, says Mr Bendell. “It enabled the use of social enforcement. Anyone outside of the community was recognised immediately.”

A core component of the project was to continuously monitor the development of conch in these seagrass meadows to assess the effectiveness of the MPAs. Mr Bendell would record the number and size of conch, and the proportion of juveniles to adults, within and outside MPAs. Seagrass cover was recorded too, and served

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**“The project’s decentralised approach is unique. It was established from the ground up, where local conch communities established their own marine protected areas.”**

**Barry Bendell, associate,  
Mangrove Action Project**

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as an indicator of overall ecosystem health. “Every five meters we dropped our square quadrant (50 cm x 50 cm) to sample everything from crab holes to any kind of invertebrates,” an intern on the project described.<sup>29</sup> Data collected was sent to Seagrass Watch at James Cook University in Australia for analysis.

The presence of fully developed, adult conch was the real measure of success. But this took years to materialise. “In the first year of the project, we didn’t observe any significant difference between protected and unprotected areas,” recalls Mr Bendell. “But the numbers gradually increased in year two and significantly in year three—eventually there were ten times more adult conch of reproductive age in the MPA than in unprotected areas.” Adult conch generated more revenue for the community given their size and thicker shells. More importantly, the project reinforced the value of seagrass ecosystem services, both as a nursery for fish and as a refuge for breeding adult invertebrate population.

28 The Rufford Foundation, Evaluation and Monitoring of Marine Protected Areas in Seagrass Meadows at Phra Thong Island, Thailand, [https://www.rufford.org/rsg/projects/barry\\_bendell\\_0](https://www.rufford.org/rsg/projects/barry_bendell_0)

29 Mangrove Action Project, Mangrove to Seagrass, a journey into Thailand’s coastal ecosystems, <http://mangroveactionproject.blogspot.com/2017/07/mangrove-to-seagrass-journey-into.html>

## Hurdles to overcome

For monitoring, however, the project continues to struggle to secure community engagement. “Although a few people have helped on occasion with monitoring, most people are not really involved in any direct way although they think it is a good idea,” says Mr Bendell. “They really just want to be able to collect conch for local consumption and to increase their incomes.”

Furthermore, not every MPA was successful. In one case, habitat selection was poor and, the protected area was not in direct sight of the community, so enforcement suffered. The project also failed to carry out environmental assessments prior to the selection of the MPA, one reason for poor habitat selection. As a result, despite great increases in the conch population in one MPA, the number of conch remained unchanged in another; however, the proportion of adult conch was higher.

A big issue facing conservation projects in general is the lack of government support for such initiatives. “Enforcement becomes a key inhibitor to success in that case,” explains Mr Wodehouse. “Without the backing of government, the only effective way to manage these habitats is through community rules and social control, which is not always effective on its own.”

Mr Bendell believes there is space for an NGO or local initiative to promote these small-scale, community-led MPAs across Thailand and in developing countries around the world to promote the conservation of seagrass meadows. Improvements in monitoring technology can help to a large extent. Technology recently tested in Thailand shows some promise—reporting 90% accuracy in mapping seagrass distribution and 73% and 75% accuracy in mapping percentage cover and species, respectively.<sup>30</sup> But understanding the challenges is imperative, as these need the right set of circumstances to be successful.

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**“In the first year of the project, we didn’t observe any significant difference between protected and unprotected areas. But the numbers gradually increased in year two and significantly in year three—eventually there were ten times more adult conch of reproductive age in the MPA than in unprotected areas.”**

**Barry Bendell, associate,  
Global Mangrove Alliance**

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30 W Koedsin et al, An Integrated Field and Remote Sensing Method for Mapping Seagrass Species, Cover, and Biomass in Southern Thailand, 2016, Remote Sensing, <http://www.mdpi.com/2072-4292/8/4/292>

## CASE STUDY 3

**Deep dive: training for coral conservation in Zanzibar****Case summary**

- In 2016 the coral bleaching event between March and June was particularly severe in Zanzibar, with some reefs experiencing bleaching of 80-90%.
- Awareness of the financial risk sprung scuba diving operators into action. In 2016, dive operators and NGOs requested CORDIO to run a two-day workshop for 19 participants from NGOs and dive centres in Zanzibar.
- The training session succeeded in strengthening divers' understanding of coral reef health and monitoring practices
- In the months that followed, however, the programme struggled to gain traction due to severe resource limitations.
- Monitoring programmes in some parts of Tanzania depend largely on donors. To truly get the tourism industry to move on this, it is important to demonstrate the financial benefits to the industry of sustainable tourism, which divers and reef enthusiasts value.

**The lifeblood of tourism in Zanzibar**

Corals exist in a variety of species, each presenting in different colours and patterns—from dark, boulder-like structures to vibrant, branching patterns. The aesthetic appeal of vast coral reefs has driven coastal tourism, and, in particular, the diving industry in Zanzibar.<sup>31</sup> The number of tourists on this island off the coast of Tanzania

has more than tripled between 2010 and 2017, increasing from from 132,000 to 433,000.<sup>32</sup> Tourism is central to Zanzibar's economy too, comprising 27% of GDP and employing over 72,000 people.<sup>33</sup>

But the tourism industry that depends on coral reefs is increasingly at risk. Industrialisation of coastal regions, the increase in marine pollution, extraction of marine resources (including destructive fishing practices) and heavy boat traffic from the diving industry itself have strained the region's marine environment. But perhaps most important for coral reefs has been the impact of climate change.

# 80%

**Bleaching experienced by coral reefs in Zanzibar as a result of the 2016 coral bleaching event**

In 2016 the coral bleaching event between March and June was particularly severe in Zanzibar, with some reefs experiencing bleaching of 80-90%.<sup>34</sup> Across Tanzania, over 70 observations of bleaching events were reported, with 40% experiencing "high" or "extreme" levels of bleaching (ie, above 50% of corals). Some reefs in Zanzibar have shown less recovery than in other parts of Tanzania's coastal region. Such events have a direct impact on the diving and tourism industry. In one study, the annual

31 Dimitri Dimopoulos, External risks impacting on the scuba diving industry in the East African Marine Ecoregion, [http://uir.unisa.ac.za/bitstream/handle/10500/24527/dissertation\\_dimopoulos\\_d.pdf?sequence=1&isAllowed=y](http://uir.unisa.ac.za/bitstream/handle/10500/24527/dissertation_dimopoulos_d.pdf?sequence=1&isAllowed=y)

32 Zanzibar Commission for Tourism. [http://www.zanzibartourism.go.tz/images/joomla1art/documents/OCGS\\_tourist.pdf](http://www.zanzibartourism.go.tz/images/joomla1art/documents/OCGS_tourist.pdf)

33 World Travel & Tourism Council, Travel & Tourism Economic Impact 2017, Tanzania, <https://www.wttc.org/-/media/files/reports/economic-impact-research/countries-2017/tanzania2017.pdf>

34 Coral reef status report for the Western Indian Ocean (page 144), <https://www.icriforum.org/sites/default/files/COI%20REEF%20LR%20F2.compressed.pdf>

financial loss to the scuba diving industry in Zanzibar was estimated at between US\$3.1m and US\$4.6m, as reef enthusiasts go elsewhere in search of vibrant reefs.<sup>35</sup>

## The dive community responds

Awareness of the financial risk sprung diving operators into action. “There was increasing interest from dive and conservation/community projects, and businesses, to get more involved in monitoring the health of coral reefs and being more proactive about caring for them,” says David Obura, director of Coastal Oceans Research and Development in the Indian Ocean (CORDIO).

Operational since 1999, CORDIO has been leading efforts for coral reef monitoring and conservation across East Africa and the wider Indian Ocean. In 2014 the creation of the Coral Reef Monitoring Network by the Zanzibar Department of Environment led to greater focus in Zanzibar on the need to maintain coral resilience to protect the island’s economy. Thus, in response to the bleaching experience in 2016, dive operators and NGOs requested CORDIO to run a two-day workshop for 19 participants from NGOs and dive centres in Zanzibar.

Previous workshops conducted in Zanzibar had identified knowledge gaps on longer-term changes in coral reef health and the importance of sustainable tourism.<sup>36</sup> So CORDIO’s curriculum focused on theoretical and practical sessions on monitoring coral reef health, spanning benthic cover,<sup>37</sup> fish stocks and coral bleaching, guiding the group to establish a coral reef monitoring protocol. Participants were paired up for fieldwork, practicing how to record data on spreadsheets.

The training session succeeded in strengthening divers’

understanding of coral reef health and monitoring practices, believes Mr Obura. Among the key outcomes was a pledge to conduct periodic surveys and contribute to CORDIO’s online portal recording coral bleaching observations, a real crowdsourcing effort. “They also stated a greater desire to work together, and start their individual monitoring sites, as well as dive together to help monitor one another’s sites,” says Mr Obura.

## Falling short

In the months that followed, however, the programme struggled to gain traction. “We sent out a survey six months after the training, and while all were positive about the [training] experience, the degree of implementation of their monitoring programmes was lower than initially committed to,” says Mr Obura. He attributes this to the severe resource limitations. The priority, understandably, is to use the few boats available for dive trips for tourists and earn revenue. Mr Obura reports that only one participant had conducted additional reef assessments.

There was a failure to work together to support monitoring activities too. “None had joined together to help each other as initially committed,” says Mr Obura. “They were all occupied with their internal deadlines and clients.”

Funding, however, is the perennial issue. Limited funds have constrained the extent and frequency of training programmes as well as monitoring efforts. CORDIO had hoped to raise funds through the training to help cover fees for trainers and enable the project to be scaled up. “Working out a way to get broader corporate support for training, not just from dive operators and conservation organisations but also from the tourism industry, will be important for the future,” emphasises Mr Obura. Network

35 Coral Bleaching in the Indian Ocean: SocioEconomic Assessment of Effects. [https://www.researchgate.net/publication/237453282\\_Coral\\_Bleaching\\_in\\_the\\_Indian\\_Ocean\\_SocioEconomic\\_Assessment\\_of\\_Effects](https://www.researchgate.net/publication/237453282_Coral_Bleaching_in_the_Indian_Ocean_SocioEconomic_Assessment_of_Effects)

36 P A Staehr et al, Managing human pressures to restore ecosystem health of Zanzibar coastal waters, 2018, *Journal of Aquaculture & Marine Biology*, <https://medcraveonline.com/JAMB/JAMB-07-00185.pdf>

37 Organisms that live in and on the bottom of the ocean floor

cohesion is strong among the community and dive groups in many places, he explains, but is often missing among businesses and even NGO projects, which are often competing for limited funds from clients and grants.

Establishing MPAs, and the rules that apply within these, is important for sustained coral conservation too. Zanzibar has recently expanded its area under conservation. It has increased the protected area by 10% in four MPAs and established two new MPAs, under the Marine Conservation Unit regulations of 2015.<sup>38</sup> Complementary artificial reef initiatives by small-scale artisanal fisheries, such as those in Jambiani, Zanzibar, also provide valuable lessons in local engagement, although these are still at a nascent stage and their impacts on coral conservation are yet to be measured.

### The way forward

Mr Obura believes the broad-based coral reef monitoring community in the western Indian Ocean is active but would greatly benefit from increased investment and stability, and more secure data management and sharing practices. “Management of these reefs depends on detecting changes in health status, and this is accomplished by regular monitoring, using standard protocols. The investment should specifically be directed at training to ensure continuous coral reef monitoring.”

Unfortunately, monitoring programmes in some parts of Tanzania depend largely on donors (apart from within the main MPAs, such as Mafia Island Marine Park, where internal resources support basic monitoring). To truly get the industry to move on this, it is important to demonstrate the financial benefits to the industry of sustainable tourism, which divers and reef enthusiasts value.

“The act of bringing people together with common interests for practical coral conservation activities cements their willingness and commitment to collective action,” explains Mr Obura. Governments, the tourism industry and community organisations can learn from the very organisms they’re aiming to protect and must come together much like individual corals do to form a massive network and a protective reef.

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**The broad-based coral reef monitoring community in the western Indian Ocean is active but would greatly benefit from increased investment and stability, and more secure data management and sharing practices**

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38 Coral reef status report for the Western Indian Ocean (page 144), <https://www.icriforum.org/sites/default/files/COI%20REEF%20LR%20F2.compressed.pdf>

# Chapter 2: Plastic pollution

The ability to mould plastics into anything from forks to toys has made them an integral part of everyday human activity. Global production of plastics has increased from 2m tonnes in 1950 to 380m tonnes in 2015, even outpacing GDP growth during this time with an annual growth rate of 8.4%.<sup>39</sup> Single-use plastics, such as grocery bags, cups, bottles, straws and packaging, represent the largest industrial plastics sector. These are discarded right away and thus contribute significantly to global waste: a 2012 study found that plastics made up 10% of the overall global solid waste composition.<sup>40</sup>

Unfortunately, waste management systems in many countries are unable to handle the scale of waste. Large plastics as well as microplastics (particles <5 mm) find their way into rivers and eventually into oceans. Around the world, it is estimated that 4.8m-12.7m tonnes of plastic waste enter the ocean each year.<sup>41</sup> And this appears to be concentrated around the Indian Ocean. Six of the top 20 countries that mismanage plastic are located in the Indian Ocean Rim (India, Indonesia, Malaysia, South Africa, Sri Lanka and Thailand). More recent research found that 90% of marine plastic debris originates from just ten rivers, eight of which are in Asia and two in Africa.<sup>42</sup>

A confluence of factors contributes to the high volume of plastic that ends up in the ocean, particularly around the Indian Ocean Rim countries. “Lack of basic waste collection and recycling, combined with illegal dumping, financial disincentives and excessive use of single-use plastics

are the primary drivers of plastic waste in South-east Asia, throughout broader Asia, as well as in the African continent,” notes Nick Mallos, director of the Trash Free Seas programme at Ocean Conservancy.

Looking ahead, it is predicted that waste growth will probably shift to South Asia (mainly India) in 2025, and then to sub-Saharan Africa around 2050.<sup>43</sup> Increases in population and per-head consumption, especially in urban areas, are expected to drive waste growth.<sup>44</sup>

Once in the ocean, plastic breaks down further and can be ingested by marine organisms, posing grave risks to marine ecosystems and associated economic sectors such as fisheries. Globally, more than 800 marine and coastal

**Plastics  
made up  
10%  
of global  
solid waste**

species have been found to be affected by interactions with plastic, such as entanglement and indigestion.<sup>45</sup> In the Indian Ocean specifically, plastics and microplastics have been ingested by several fish species. In South Africa, ingestion has led to the death of loggerhead turtles, an endangered species

that is critical for maintaining the health of coral reefs and seagrasses.<sup>46, 47, 48</sup> While the negative impacts of microplastics on fish and other marine life are increasingly understood, the long-term human health effects due to ingesting microplastics remain largely unknown.<sup>49, 50</sup>

39 Production, use, and fate of all plastics ever made, [https://www.researchgate.net/publication/318567844\\_Production\\_use\\_and\\_fate\\_of\\_all\\_plastics\\_ever\\_made](https://www.researchgate.net/publication/318567844_Production_use_and_fate_of_all_plastics_ever_made)

40 World Bank, What a waste, [https://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1334852610766/What\\_a\\_Waste2012\\_Final.pdf](https://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1334852610766/What_a_Waste2012_Final.pdf)

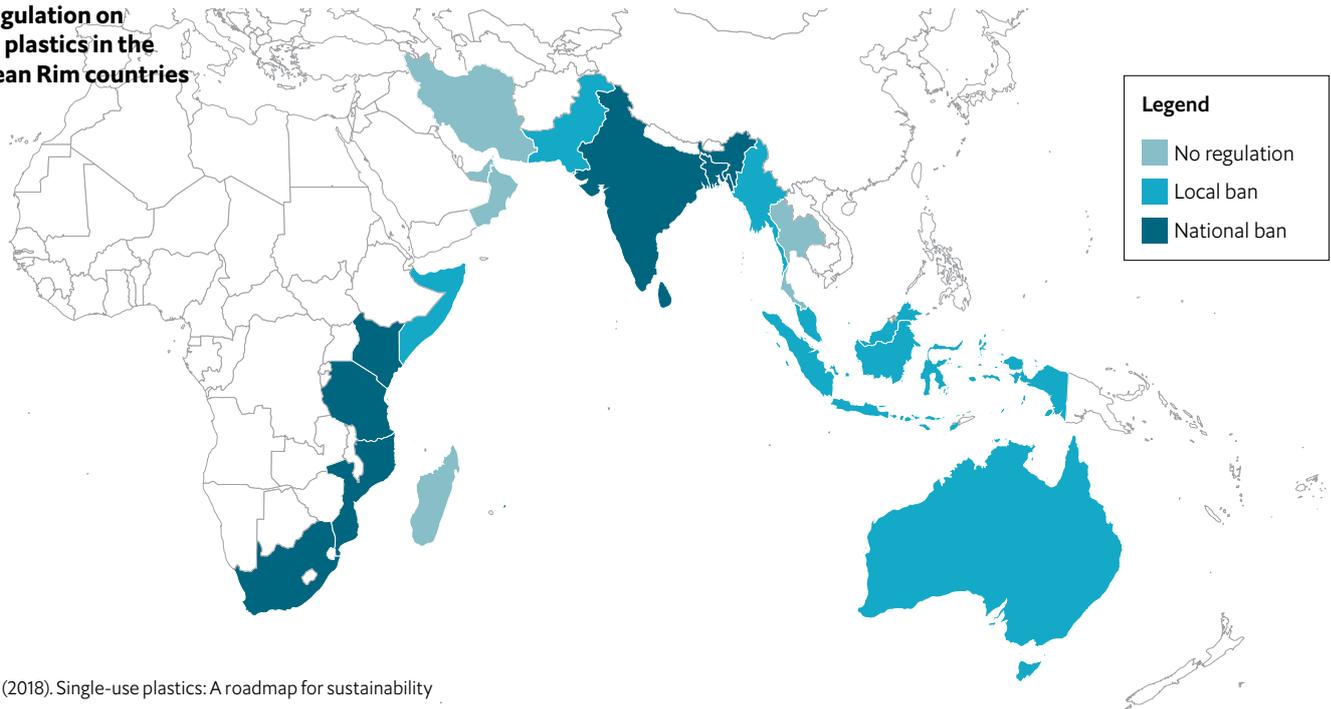
41 J R Jambeck et al, Plastic waste inputs from land into the ocean, 2015, Science, [https://www.iswa.org/fileadmin/user\\_upload/Calendar\\_2011\\_03\\_AMERICANA/Science-2015-Jambeck-768-71\\_\\_2\\_.pdf](https://www.iswa.org/fileadmin/user_upload/Calendar_2011_03_AMERICANA/Science-2015-Jambeck-768-71__2_.pdf)

42 UFZ, Rivers carry plastic debris into the sea, [https://www.ufz.de/index.php?en=36336&webc\\_pm=34/2017](https://www.ufz.de/index.php?en=36336&webc_pm=34/2017)

43 Environment: Waste production must peak this century, <https://www.researchgate.net/publication/258216813/download>

44 J R Jambeck et al, Plastic waste inputs from land into the ocean, 2015, Science, [https://www.iswa.org/fileadmin/user\\_upload/Calendar\\_2011\\_03\\_AMERICANA/Science-2015-Jambeck-768-71\\_\\_2\\_.pdf](https://www.iswa.org/fileadmin/user_upload/Calendar_2011_03_AMERICANA/Science-2015-Jambeck-768-71__2_.pdf)

### State of regulation on single-use plastics in the Indian Ocean Rim countries



Source: UNEP (2018). Single-use plastics: A roadmap for sustainability

Addressing the scale of the challenge is a huge and daunting undertaking. However, research by the Commonwealth Scientific and Industrial Research Organization (CSIRO), yet to be published at the time of writing, finds that “about 90% or more of the plastics remain within the coastal zone for at least the first month or longer,” explains Denise Hardesty, principal research scientist for Oceans and Atmosphere at CSIRO. “It may move up and down the coast, but a lot of it stays incredibly local.” This is heartening, as it means that much of the plastics pollution problem can be tackled by focusing on these areas. “It’s much more tractable when it’s closer to the source rather than further from the source,” notes Ms Hardesty. Developing a robust waste management strategy is of course the first line of defence in terms of preventing plastic from entering the water. For the plastics that end up in the coastal zone, localised clean-up opportunities remain a viable approach.

Countries are starting to address this through a range of technological and policy interventions. It is essential, though, that solutions are tailored to a country’s cultural and socioeconomic profile, notes Ms Hardesty. For most of the Indian Ocean Rim countries, this means weaving socioeconomic benefits into the policy initiatives. The case studies we present in this chapter take into consideration these constraints, touching on three facets of a holistic waste management strategy—reduce, reuse and recycle. We take a closer look at Kenya’s ban on single-use plastics to reduce the amount of plastic waste and thus the amount that ends up in the ocean; in India, we see how fishermen in a small village are reusing plastics from the ocean to build roads; and, in Indonesia, we look into how individuals are incentivised to collect and recycle garbage in exchange for health insurance.

- 45 Secretariat of the Convention on Biological Diversity, Marine debris: understanding, preventing and mitigating the significant adverse impacts on marine and coastal biodiversity, <https://www.cbd.int/doc/publications/cbd-ts-83-en.pdf>
- 46 [https://www.researchgate.net/profile/Vonica\\_Perold/publication/301318969\\_Impacts\\_of\\_plastic\\_ingestion\\_on\\_post-hatchling\\_loggerhead\\_turtles\\_off\\_South\\_Africa/links/5a8d4f7eaca27292c0f8ba1c/Impacts-of-plastic-ingestion-on-post-hatchling-loggerhead-turtles-off-South-Africa.pdf](https://www.researchgate.net/profile/Vonica_Perold/publication/301318969_Impacts_of_plastic_ingestion_on_post-hatchling_loggerhead_turtles_off_South_Africa/links/5a8d4f7eaca27292c0f8ba1c/Impacts-of-plastic-ingestion-on-post-hatchling-loggerhead-turtles-off-South-Africa.pdf)
- 47 <https://www.nature.com/articles/srep14340>
- 48 <https://www.worldwildlife.org/species/loggerhead-turtle>
- 49 S Wright and F J Kelly, Plastic and Human Health: A Micro Issue?, 2017, Environmental Science & Technology, [https://www.researchgate.net/publication/317078116\\_Plastic\\_and\\_Human\\_Health\\_A\\_Micro\\_Issue](https://www.researchgate.net/publication/317078116_Plastic_and_Human_Health_A_Micro_Issue)
- 50 R C Thompson et al, Plastics, the environment and human health: current consensus and future trends, 2009, Philosophical Transactions, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2873021/>

## CASE STUDY 1

**Kenya's commitment to fighting plastics pollution: from top-down to bottom-up****Case summary**

- Plastic bags represent one of the primary sources of plastic pollution in Kenya. They blocked drainage systems, created a breeding ground for mosquitoes and were being carried by rivers into oceans.
- Social activist James Wakibia used social media to garner support for the ban on single-use plastics. #IsupportbanplasticsKE
- In February 2017, the Kenyan government announced a ban on the use, manufacture and importation of plastic bags. It is considered to be the toughest ban in the world.
- Some industry players continue to oppose the ban, citing job losses. Alternatives (such as fabric tote bags) are expensive and more public education is required.
- In just one year, the ban has made its mark. The incidence of plastic found in livestock has reduced to 10% from over 30%.

**Plastics in Kenya**

Nairobi, Kenya's capital, alone generates nearly 2,500 tonnes of waste every day, according to the National Environmental Complaints Committee, and more than 10% of it is never collected.<sup>51</sup> Plastics comprise 8% of the total waste in Kenya, of which only 15% is recycled.<sup>52,53</sup>

Plastic bags represent one of the primary sources of plastic

pollution in Kenya. It is estimated that supermarkets were handing out 100m plastic bags per year.<sup>54</sup> In 2016 close to 10,000 plastic bags were found during coastal clean-ups in Kenya.<sup>55</sup> The negative environmental impacts are wide-ranging, and in turn have consequences on several sectors of the economy such as fisheries, tourism and livestock.

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**Plastics comprise 8% of the total waste in Kenya, of which only 15% is recycled**

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**The long road to a plastic bag ban**

The government of Kenya has known about its plastic bag problem for some time, but efforts to ban plastic bags in 2005, 2007 and 2011 were unsuccessful due to strong resistance from industry groups representing manufacturers and other businesses.

Nonetheless, pressure from those wanting a Kenya free of plastic bags remained strong, and in 2013 James Wakibia, a 35-year-old photographer from Nakuru, a city in central Kenya, began campaigning for a ban on single-use plastic bags. "Here in Kenya, most people knew plastic was a problem, but they did not know how to address it," he explains. "Plastic bags were clogging our drainage systems, were habitats for malaria-carrying mosquitos and were also getting carried by rivers into the sea and ocean."

51 *The Star*, Garbage ATMS to be installed in Nairobi, August 3rd 2018, [https://www.the-star.co.ke/news/2018/08/03/garbage-atms-to-be-installed-in-nairobi\\_c1796656](https://www.the-star.co.ke/news/2018/08/03/garbage-atms-to-be-installed-in-nairobi_c1796656)

52 Reuters, Kenya seeks to cure plastic bag addiction with blanket ban, May 2nd 2017, <https://www.reuters.com/article/us-kenya-environment-pollution-plastic-idUSKBN17Y1RK>

53 *The Mainichi*, Kenya's strict law banning onetime use plastic bags sees some success, August 5th 2018, <https://mainichi.jp/english/articles/20180804/p2a/00m/0na/032000c>

54 National Environment Management Authority, Press statement on total ban on all plastic bags, [https://www.nema.go.ke/images/Docs/Awariness%20Materials/PRESS\\_STATEMENT\\_ON\\_TOTAL\\_BAN\\_ON\\_ALL\\_PLASTIC\\_BAGS.pdf](https://www.nema.go.ke/images/Docs/Awariness%20Materials/PRESS_STATEMENT_ON_TOTAL_BAN_ON_ALL_PLASTIC_BAGS.pdf)

55 Ocean Conservancy, 2016. International Coastal Cleanup. [www.coastalcleanupdata.org](http://www.coastalcleanupdata.org)

Mr Wakibia, who used to often pass through the dumpsite in Nakuru, was struck by the magnitude of plastic bag waste. "Plastic bags were the most visible litter around the dumpsite [and] were being blown by the wind, and sometimes even by rain water, to other areas." In many cases, these bags would end up being eaten by livestock and marine life. Studies found that more than half of the cattle in peri-urban areas had plastic bags in their guts.<sup>56</sup>

In 2015 Mr Wakibia launched a social media campaign with the hashtag #banplasticsKE. It garnered a lot of attention and support domestically, as well as internationally. But the real turning point was when the cabinet secretary of the Ministry of Environment and Natural Resources at the time, Judi Wakhungu, tweeted back her support. From that point on, he used hashtag #IsupportbanplasticsKE. He continued to get the word out by writing op-ed pieces in local publications and on his blog.

Thanks to his efforts and the ever-increasing political will to address the plastic pollution problem, in February 2017 Ms Wakhungu announced a ban on the use, manufacture and importation of all plastic bags for commercial and household packaging, effective from August 2017. Anyone found in violation would be subject to a fine of KSh2m-4m (approximately US\$20,000-40,000) and/or one to four years imprisonment, making the ban the toughest in the world.<sup>57</sup>

#IsupportbanplasticsKE

56 National Environment Management Authority, Plastic bags ban is a blessing for Kenya, [https://www.nema.go.ke/index.php?option=com\\_content&view=article&id=195&Itemid=317](https://www.nema.go.ke/index.php?option=com_content&view=article&id=195&Itemid=317)

57 National Environment Management Authority, Plastic bags ban is a blessing for Kenya, [https://www.nema.go.ke/index.php?option=com\\_content&view=article&id=195&Itemid=317](https://www.nema.go.ke/index.php?option=com_content&view=article&id=195&Itemid=317)

58 *The Guardian*, Eight months on, is the world's most drastic plastic bag ban working?, April 25th 2018, <https://www.theguardian.com/world/2018/apr/25/nairobi-clean-up-highs-lows-kenyas-plastic-bag-ban>

59 Daily Nation, Kenya Joins 40 countries in sea, ocean clean-up bid, December 8th 2017, <https://www.nation.co.ke/news/Kenya-joins-Clean-Seas-campaign/1056-4219154-2kvsjv/index.html>

10,000  
Plastic bags found  
during coastal clean-ups  
in Kenya in 2016

### Visible wins and challenges

The ban has only been in place for one year but has already made its mark. The incidence of plastics in livestock taken to slaughter has dropped to 10%, from above 30%.<sup>58</sup> Late last year, Ms Wakhungu claimed that the country's marine ecosystem had been spared by the plastic ban.<sup>59</sup> While further monitoring is necessary, the impact is visible, notes Steve Trott, a marine zoologist at the Watamu Marine Association. "It [made] a huge difference almost overnight [for] a country that was becoming more and more infamous for its plastic bag flower trees in every park and roadside."

The ban is not without opponents. Industrial players and their representatives, in particular the Kenyan Association of Manufacturers (KAM) have been the most vocal opponents of the ban. "Some people said we're going to close a lot of industries and people would lose their jobs," notes Mr Wakibia. "That's a small price to pay because you cannot compare unemployment of say 60,000 people

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**“When you protect the environment, you’re protecting 45 million people and you’re also creating more job opportunities to support a clean environment”**

**James Wakibia, photographer and activist**

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with a whole population of Kenya of around 45m people. When you protect the environment, you’re protecting 45m people and you’re also creating more job opportunities to support a clean environment.”

The Environment and Lands Court agrees. On June 22nd 2018 it ruled in favour of the plastic bag ban in a case brought by the KAM and other companies that challenged it. The three-judge-bench noted that “although some ordinary Kenyans could suffer social and economic losses as a result of the ban, the plastic ban was for the common good of the general public and, as such, lawful.”<sup>60</sup>

While the plastic bag ban is here to stay, it continues to face a number of implementation challenges. For one, alternatives are not yet widely understood or adopted, and many come with an insurmountable financial hurdle: recyclable fabric totes found in some markets are ten times more expensive than the now illegal plastic bags.<sup>61</sup> Then there’s the issue of enforcement. “Quite a few arrests have been made. When the ban just came to effect, people were arrested and when they were taken to court the judge would release them after warning them about repeat offenses,” explains Mr Wakibia.

Mr Wakibia calls for closer collaboration between the government agency that is tasked to protect the environment, the National Environment Management Authority, and county police enforcement officers and police. He also thinks more public awareness is necessary “to ensure that everybody has the information [they need].”

### **Local support for a successful national ban**

The plastic bag ban at the national level has spawned a variety of supporting initiatives, often at the local level. One

60 National Environment Management Authority, Court upholds plastic bags ban, [https://www.nema.go.ke/index.php?option=com\\_content&view=article&id=225;judges-upholds-plastic-bags-ban&catid=10:news-and-events&Itemid=375](https://www.nema.go.ke/index.php?option=com_content&view=article&id=225;judges-upholds-plastic-bags-ban&catid=10:news-and-events&Itemid=375)

61 DW, Visiting Kenya a year into its plastic bag ban, <https://www.dw.com/en/visiting-kenya-a-year-into-its-plastic-bag-ban/a-45254144>

62 Kenya Engineer, Kenyan Manufactures, Launch PET Recycling Initiative, <https://www.kenyaengineer.co.ke/kenyan-manufacturers-launch-pet-recycling-initiative/>

is EcoWorld Watamu, which addresses the plastic pollution challenges faced in Watamu Marine National Park. Over the past decade, the programme has evolved from local beach clean-ups to a full-blown plastic recycling system. “The whole model is based on a sustainable business plan where the recycled material pays for the ongoing operations and employees,” explains Mr Trott. The potential to replicate this model is high but to be successful, Mr Trott highlights that it has to be affordable to transport the plastic to recycling facilities.

In an effort to self-regulate and get ahead of future regulation, the plastics industry recently formed an organisation to collect, sort and recycle polyethylene terephthalate (PET) bottles. The PET Recycling Company (PETCO Kenya) was launched during the 2018 World Environment Day celebrations and has aggressive recycling targets. The industry currently achieves a recycling rate of around 5%, but with PETCO Kenya up and running, it aims to achieve 25% in 2018 and 70% by 2030.<sup>62</sup>

The government also plans to install 40 “garbage ATMs” in the central business district of Nairobi by the end of the year. These ATMs will accept organic waste and recyclables, such as plastic, in exchange for shopping vouchers that can be redeemed in-kind at local supermarkets.<sup>63</sup>

The various top-down and bottom-up plastics policies and initiatives under way—driven by communities, the private sector and the government—will go a long way in terms of addressing the plastic pollution problem in Kenya. However, “no country has its own environment. It is one environment,” states Mr Wakibia.

Uganda, Tanzania, Burundi and South Sudan are also considering similar plastic bag bans to that of Kenya. If enacted, it would not only benefit the local environment,

but also curb the flow of illegal plastic bags from these countries into Kenya.<sup>64</sup> “Even after Kenya banned plastic bags, it could not effectively control plastic bags coming from the borders of Uganda to Kenya or even from Tanzania to Kenya. We will need regional co-operation so that countries surrounding us ban plastic bags as well,” explains Mr Wakibia. “We are interconnected, we have to work together,” he adds. “Plastic pollution is a global problem that must be addressed by all nations with the seriousness it deserves.”

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**The plastics industry currently achieves a recycling rate of around 5%, but with PETCO Kenya up and running, it aims to achieve 25% in 2018 and 70% by 2030**

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63 *The Star*, Garbage ATMS to be installed in Nairobi, August 3rd 2018, [https://www.the-star.co.ke/news/2018/08/03/garbage-atms-to-be-installed-in-nairobi\\_c1796656](https://www.the-star.co.ke/news/2018/08/03/garbage-atms-to-be-installed-in-nairobi_c1796656)

64 UN Environment, How smuggling threatens to undermine Kenya’s plastic bag ban, <https://www.unenvironment.org/news-and-stories/story/how-smuggling-threatens-undermine-kenyas-plastic-bag-ban>

## CASE STUDY 2

**Fishermen in Kerala, India:  
paving roads with marine plastic****Case summary**

- Fishermen based in the district of Kollam, in the state of Kerala, began to notice the surge in plastics in the ocean more than a decade ago.
- One idea was to collect the plastic waste they caught, rather than dump it back into the ocean, and use the refined plastic in bitumen for road construction.
- The Clean Sea project launched in June 2017 and exemplifies effective government coordination among a number of entities for an ocean initiative.
- The project creates jobs for local fisherman and women and generates revenue through the sale of refined plastic to road construction companies. Roads constructed with plastic mixed with bitumen are cheaper to construct and are more resilient, according to Mr Vasudevan, a chemistry professor referred to as “India’s Plastic Man”.
- There are plans to replicate the Clean Sea project in other fishing centres in Kerala.

**India’s plastic pollution challenge**

In 2017 the Central Pollution Control Board conducted a study in 60 major cities around India, estimating that close to 26,000 tonnes of plastic was generated every day. Approximately 7% of India’s municipal solid waste is plastic

and, of this, 94% is thermoplastic content, or recyclable.<sup>65</sup> An earlier study by the same body found that India recycles approximately 60% of its plastic.<sup>66</sup> The plastic left uncollected litters the streets, clogs drainage systems or ends up in a river or the sea.

In fact, a study by the Helmholtz Centre for Environmental Research found that ten rivers release more than 90% of the total plastic debris found in the sea globally, of which three are in India: the Indus, Ganges and Brahmaputra.<sup>67</sup> According to the study, high populations living in the surrounding areas and less-than-ideal waste management systems are driving factors.

Evidence at sea is equally concerning. In 2017 a one-month study by India’s Central Marine Fisheries Institute found that trawls were netting more non-biodegradable marine debris than fish. Off the coast of Mumbai, trawlers netted 49 kg/sq km of debris, or 2.23% more debris than fish.<sup>68</sup> Microplastic, or small pieces of plastic less than 5 mm long, have also been found inside fish and even in sea salt.<sup>69,70</sup>

**Generating value from ocean plastic**

Fishermen based in the district of Kollam, in the southern state of Kerala, began to notice the surge in plastics in the ocean more than a decade ago. Over time, they were catching fewer fish and more and more plastic.<sup>71</sup> In 2017 the Boat Owners Association approached the state minister of fisheries, J Mercykutty Amma, to figure out how to address the problem. One idea was to collect the plastic waste rather than discard it back into the ocean and, from this, the

65 Central Pollution Control Board, Consolidated Guidelines for Segregation, Collection and Disposal of Plastic Waste, [http://cpcb.nic.in/uploads/plasticwaste/Consolidate\\_Guidelines\\_for\\_disposal\\_of\\_PW.pdf](http://cpcb.nic.in/uploads/plasticwaste/Consolidate_Guidelines_for_disposal_of_PW.pdf)

66 Press Information Bureau, Government of India, Government Notifies Plastic Waste Management Rules, 2016, <http://pib.nic.in/newsite/printrelease.aspx?relid=138144>

67 C Schmidt et al, Export of Plastic Debris by Rivers into the Sea, 2017, *Environmental Science & Technology*, <https://pubs.acs.org/doi/10.1021/acs.est.7b02368>

68 *The Times of India*, More debris than fish netted by Mumbai’s trawler nets, April 20th 2018, <https://timesofindia.indiatimes.com/city/mumbai/more-debris-than-fish-netted-by-mumbais-trawler-nets/articleshow/63837959.cms>

69 *The Times of India*, Fish are ingesting micro plastics, says study, July 30th 2018, <https://timesofindia.indiatimes.com/city/chennai/fish-are-ingesting-micro-plastics-says-study/articleshow/65193266.cms>

70 C K Seth and A Shriwastav, Contamination of Indian sea salts with microplastics and a potential prevention strategy, 2018, *Environmental Science and Pollution Research*, [https://www.researchgate.net/publication/327229637\\_Contamination\\_of\\_Indian\\_sea\\_salts\\_with\\_microplastics\\_and\\_a\\_potential\\_prevention\\_strategy](https://www.researchgate.net/publication/327229637_Contamination_of_Indian_sea_salts_with_microplastics_and_a_potential_prevention_strategy)

71 *National Geographic*, How India’s Fishermen Turn Ocean Plastic Into Roads, <https://news.nationalgeographic.com/2018/05/fishermen-kerala-india-recycle-plastic-pollution-culture/>

Clean Sea (Suchitwa Sagaram) project was born, launching in July 2017.

To make this happen, Ms Mercykutty rallied a range of government entities for various facets of the project, demonstrating effective government co-ordination for an ocean initiative. She approached the Network for Fish Quality Management and Sustainable Fishing to design a net bag suitable for fishermen to collect plastic while at sea. She then turned to the Harbor Department for space to aggregate and clean the plastic once the fishermen returned. A vacant building in the area was repurposed for this, at no additional cost to the project. Clean Kerala Mission under the Ministry of Panchayati Raj agreed to purchase a shredding machine for Rs800,000 (US\$ 11,300). They also provided the initial working capital of Rs500,000 (US\$ 7,000) to cover the salaries of 30 fisherwomen for the first six months from the Society for Assistance to Fisherwomen (SAF), a group set up under the Department of Fisheries in Kerala to empower women in the region. Finally, the Public Works Department (PWD) agreed to buy the shredded plastic for use in road construction.

Progress was rapid; the project launched a mere six months after the first meeting between Ms Mercykutty and the fishermen. Once launched, it took only three months to get the facility up and running. "In those three months we freed up the space from the Harbor Department, installed the machinery, identified 30 staff from SAF to work on this project, designed a special blue-coloured uniform for them, and equipped them with boots and gloves," explains Ms Mercykutty. She emphasises how crucial the initial capital was for the project in its early days, as the project was yet to generate any revenue.

To date, the project relies primarily on corporate social responsibility (CSR) funding from several companies but hopes to secure long-term financial sustainability in the future. They expect to generate revenue from the sale of

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**3 out of the 10 rivers that release more than 90% of total plastic debris found in the sea globally are in India: the Indus, Ganges and Brahmaputra**

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72 Onmanorama, Kerala to utilise plastic waste from sea for road tarring, July 10th 2018, <https://english.manoramaonline.com/news/kerala/2018/07/10/kerala-to-utilize-plastic-waste-from-sea-for-road-tarring.html>

## “Plastic pollution and general workplace cleanliness is the biggest result from the project”

**Mercykutty Amma,  
minister of fisheries, Kerala, India**

the plastic shreds as well as by selling advertisements in the port. On the demand side, the PWD has agreed to purchase the shredded plastic for Rs25 (approximately 36 US cents) per kg for use in road construction.

Still lacking, however, are the incentives for the 3,500 fishermen to collect plastic from the ocean, to ensure sufficient supply for the facility. “Collecting plastic waste from the sea is a task that has to be done by fishermen while they are earning their livelihood. On some days they bring a lot of waste, on other days they bring nothing. When they get a good catch, they don’t pick up the plastic waste,” explains Ms Mercykutty. “The immediate challenge the project faces is getting the fishermen to continuously and consistently collect plastic waste from the sea.”

Providing incentives from the revenue generated by the facility can resolve this.

Despite these challenges, the Clean Sea project has already produced results. It has collected approximately 12 tonnes of plastic<sup>73</sup> and, critically, it has raised awareness of plastic pollution among fishermen and their families. According to Ms Mercykutty, the “change in awareness regarding plastic pollution and general workplace cleanliness is the biggest result from the project.” This shift in mindsets will yield dividends in the future.

## Paving roads with ocean plastics

“Mindset is important,” argues Rajagopalan Vasudevan, a chemistry professor at Thiagarajar College of Engineering in the southern city of Madurai, who is known across the country and around the world as “India’s Plastic Man”. Mr Vasudevan developed the technology to integrate plastic with bitumen for road construction more than 15 years ago. A 1 km single-lane road can integrate one tonne of plastic, which in turn reduces the amount of bitumen required, saves money and makes the road more resilient, he explains.<sup>73</sup> The benefits don’t stop there. Unlike recycling plastics, which releases toxic fumes, the technique to mix the plastic and bitumen does not release any toxic gases. Mr Vasudevan also notes that for road construction many types of plastic can be used, including multilayer films that cannot be recycled. But Mr Vasudevan still circles back to the initiative’s most attractive promise: income generation. “Once you have a shredder, it becomes a wonderful job opportunity.”

## The road ahead

Ms Mercykutty aims to replicate the scheme first in the cities of Kochi and Kozhikode, and then in other fishing centres in Kerala. “If the entire coastal length of 565 km is to be taken care of, what we have done until now is just a small beginning,” notes Ms Mercykutty. “It has to be a massive drive and will create employment for many people.”

This programme will have a limited shelf life, however. The hope is that one day there will not be enough plastic in the ocean for these facilities. In addition, to truly tackle plastic pollution in the ocean, improvements to waste management programmes must complement the efforts of the Clean Sea project. In the meantime, though, the project provides an exciting opportunity to combine ocean clean-up with income generation for region’s unemployed.

<sup>73</sup> Reuters, Studier, safer, cheaper: India urged to build more roads with public waste, October 25th 2017, <https://www.reuters.com/article/us-india-environment-construction/sturdier-safer-cheaper-india-urged-to-build-more-roads-with-plastic-waste-idUSKBN1CU24W>

## CASE STUDY 3

**Garbage Clinical Insurance: one man's trash is another man's treasure****Case summary**

- Indonesia ranked second in the world in terms of mismanaged plastic waste and plastic marine debris. Four of the top 20 polluting rivers in the world are in Indonesia.
- Mr Albinsaid, CEO of Indonesia Medika, founded the Garbage Clinical Insurance (GCI), a scheme that accepts garbage as payment for healthcare services and insurance.
- Every month, each of its 500–700 members deliver 3kg of garbage in the form of plastic bottles, used cardboard boxes and organic waste.
- Mr Albinsaid has put together a 70-page start-up manual, in true open-source fashion, to assist those interested in adopting the model. So far, it has been implemented in 50 towns and villages in Indonesia.

**Indonesia's growing plastics problem**

Indonesia's population exceeds 260m people, making it the fourth most populous country behind China, India and the US. Steady growth in population and population density coupled with rapid economic development and poor waste management infrastructure have resulted in a growing plastics problem for the country. A study by the World Bank estimated that Indonesia generated 61,644 tonnes of municipal solid waste (MSW) per day in 2009, and forecasts that this will more than double, to 151,921 tonnes, by 2025.<sup>74</sup>

According to research by Sustainable Waste Indonesia, approximately 24% of MSW is left unmanaged, to litter the environment, while 7% is recycled and 69% ends up at a final disposal site. Of the total MSW, 14% is plastic.<sup>75</sup>

Indonesia was ranked second in the world in terms of mismanaged plastic waste and plastic marine debris by a landmark study by Jambeck et al in 2015.<sup>76</sup> A more recent study found that, overall, Indonesian rivers and streams are responsible for emitting 200,000 tonnes of plastic into the oceans, or 14.2% of the global total originating from rivers each year.<sup>77</sup> It also found that four of the top 20 polluting rivers in the world are in Indonesia: Brantas, Solo, Serayu and Progo.<sup>78</sup> These are all located on the island of Java, home to approximately half of the Indonesian population.<sup>79</sup>

The problem is not limited to macro, or large, plastics. A 2015 study assessed the presence of manmade debris in fish and shellfish on sale for human consumption at markets in Makassar, on Sulawesi island. Plastic debris was found in 28% of the fish and 55% of all species.<sup>80</sup>

The government of Indonesia recognises the need to address the growing problem that plastic poses to food safety, marine wildlife and a range of industries that depend on the ocean. In 2017 the co-ordinating minister for maritime affairs, Luhut Binsar Pandjaitan, announced that Indonesia would commit up to US\$1bn per year to achieve a 70% reduction in marine waste by 2025.<sup>81</sup> This is an ambitious target that will require investment into waste management infrastructure, as well as a suite of policy interventions and adjustments in consumer and producer behaviour.

74 World Bank, What a waste, [https://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1334852610766/What\\_a\\_Waste2012\\_Final.pdf](https://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1334852610766/What_a_Waste2012_Final.pdf)

75 PwC, Research: 24% of waste in Indonesia is still unmanaged, <https://www.pwc.com/id/en/media-centre/infrastructure-news/april-2018/24-percent-of-waste-in-indonesia-still-unmanaged.html>

76 J R Jambeck et al, Plastic waste inputs from land into the ocean, 2015, Science, [https://www.iswa.org/fileadmin/user\\_upload/Calendar\\_2011\\_03\\_AMERICANA/Science-2015-Jambeck-768-71\\_\\_2\\_.pdf](https://www.iswa.org/fileadmin/user_upload/Calendar_2011_03_AMERICANA/Science-2015-Jambeck-768-71__2_.pdf)

77 L C M Lebreton et al, River plastic emissions to the world's oceans, 2017, Nature Communications, <https://www.nature.com/articles/ncomms15611.pdf>

78 Ibid

79 World population review, Indonesia, <http://worldpopulationreview.com/countries/indonesia-population/>

80 <https://www.nature.com/articles/srep14340>

81 The Guardian, Indonesia pledges \$1bn a year to curb ocean waste, March 2nd 2017, <https://www.theguardian.com/environment/the-coral-triangle/2017/mar/02/indonesia-pledges-us1-billion-a-year-to-curb-ocean-waste>

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**A more recent study found that, overall, Indonesian rivers and streams are responsible for emitting 200,000 tonnes of plastic into the oceans, or 14.2% of the global total originating from rivers each year**

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### **Converting waste into health insurance**

Doctor and healthcare entrepreneur Gamal Albinsaid, CEO of Indonesia Medika, decided to tackle part of the waste management challenge, while also taking on another important issue in Indonesia: access to healthcare. Mr Albinsaid founded the Garbage Clinical Insurance (GCI), a scheme that accepts garbage as payment for health insurance and healthcare services.

In a country where it is common for residents to throw garbage into the street or river, changing the perception of garbage has been central to ensuring that it is properly managed. Before the GCI, the people in Mr Albinsaid's hometown of Malang, East Java, had "a low awareness and a low willingness to manage the garbage," he says. "We have now given them a reason to start managing garbage."

Every month, each of its 500-700 members at two sites deliver roughly 3 kg of garbage in the form of plastic bottles, used cardboard boxes and organic waste. The organisation has been able to sell or process this garbage for at least Rp10,000 (approximately 70 US cents) per member on average. In return, the GCI provides them with basic healthcare services such as preventative medicine, rehabilitative healthcare and in-clinic counselling. In this way, the GCI not only attaches a monetary value to garbage but takes it one step further and provides a service that many feel was expensive and out of reach.

### **Achieving financial sustainability**

The most important sources of revenue for the GCI, which supports a staff of 30, is converting organic waste to solid and liquid fertiliser or creating products from inorganic waste for sale.

A key challenge to achieving financial stability has been the monthly variance in the number of members seeking care. The organisation needs to continually innovate to identify new ways to generate income to cover the costs of the services it provides. It is exploring how to turn the garbage it receives into higher value-added products. Among the most

promising, Mr Albinsaid explains, is crushing the plastic waste to create palettes, rather than simply recycling it. “In Indonesia, for example, we get about Rp4,000 to Rp9,000 per kg for recycling, but when we make the palettes and sell it to the factory, we can get a higher price.” Factory demand for palettes is so high that the GCI is partnering with another clinic that also accepts payment in garbage.

### Replication for scale

Mr Albinsaid is excited about the potential to scale and replicate the model, working with the government and the private sector, as well as exploring the potential with other vital services such as education. Indonesia Medika, his company, has put together a 70-page start-up manual, in true open-source fashion, to assist those interested in adopting the model. So far, the model has been used by more than 50 towns and villages in Indonesia.<sup>82</sup>

When assessing sites for replication, there are a couple of critical variables to consider. “The commitment of the partner is important, and the resource availability,” says Mr Albinsaid. For those sites that the GCI team is directly involved in assessing, they engage in a preliminary survey to estimate the amount of garbage and the number of people lacking health insurance. Correctly assessing these is the key to success, he says.

In terms of helping to address the plastics pollution problem, the GCI has certainly contributed a great deal. It has made great strides in changing perceptions of plastic, and of waste management in general. As a consequence, large amounts of plastic that would have otherwise ended up on roadsides or in a river have been properly recycled or reused. Looking ahead, Mr Albinsaid

recognises that raising awareness further about the importance of reducing plastic consumption is required. He also hopes to continue to expand the services that the GCI is able to provide to its members. “We cannot solve the garbage problem only with humanity, awareness or willingness. We must also integrate the economics.”

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**Every month, each of its 500-700 members at two sites deliver roughly 3 kg of garbage in the form of plastic bottles, used cardboard boxes and organic waste**

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82 Sutaya, How Indonesia Turns Garbage into Healthcare, <https://www.sutava.com/indonesia-garbage-healthcare/>

# Chapter 3: Unsustainable fishing

The health of the oceans and the communities that depend on it are mutually dependent. In no ocean industry is that truer than fisheries. People around the world rely on the industry as an important source of food and jobs. In 2016 fisheries and aquaculture generated revenue estimated at over US\$360bn globally, employing 10-12% of the world's population.<sup>83</sup> Roughly 85% of those engaged in the sector are located in Asia and 10% in Africa, dominated by small-scale operations in developing countries, many of which lie on the Indian Ocean Rim. It is important, therefore, for governments and other stakeholders in this region to actively participate in efforts to develop sustainable fisheries.

The Indian Ocean was the source of 13% of the world's wild-caught fish in 2016, producing 20% of the world's tuna such as skipjack, yellowfin and bigeye tuna.<sup>84</sup> On average, between 26% and 33% of wild-caught fish were estimated to be exploited at biologically unsustainable levels. The fundamental problem says Dirk Zeller, head of the Sea Around Us—Indian Ocean programme at the University of Western Australia, is that “a fisherman will keep on fishing most likely until he no longer makes a profit.”

Illegal, unreported and unregulated (IUU) fishing is a global problem with far reaching economic costs—revenue lost globally is estimated at between US\$10bn and US\$23bn per year.<sup>85</sup> Indonesia alone is estimated to lose more than US\$3m each year.<sup>86</sup> In the western Indian Ocean, estimates range from US\$400m in losses per year, with the FAO stating<sup>87</sup> that “one

out of every five fish is caught illegally” in that region. Although exact figures are hard to extract, it has been estimated that 10% of highly lucrative tuna catches are illegal.<sup>88</sup>

Weak national regulation followed by weak enforcement in exclusive economic zones, as well as the lack of monitoring in the high seas, allows IUU fishing to persist. Key weaknesses include poor port control measures, a lack of penalties and pervasive governance issues, including corruption. Offenders have honed the art of deception, using forged documents, multiple vessel IDs, changing flags and registering with offshore subsidiaries, among others, to evade detection.

The situation was even worse before “the Indian Ocean countries really started to work together to take a stand against IUU fishing,” recalls Kristin von Kistowski, FAO consultant and former senior adviser to FISH-i Africa, who says that “some foreign fleets basically exploited these high value resources of the western Indian Ocean with impunity.”

Somalia is a case in point. “Years of weak governance created an opportunity for foreign fleets to plunder Somali waters,” explains Ms von Kistowski. “With governance still weak and capacity to monitor and control the Somali waters very low, this has again resulted in an increase in IUU fishing activities - which does not only affect Somalia but also neighboring Kenya.

IUU fishing practices provide an avenue for other illicit activities such as money laundering, labour violations on-board fishing vessels and smuggling, including marine wildlife

83 FAO, State of the World's Fisheries, 2018

84 WWF, Indian Ocean Tuna Fishery Improvement Project, <https://www.wwf.org.uk/what-we-do/projects/indian-ocean-tuna-fishery-improvement-project>

85 Reuters, Fish piracy costs \$10 billion to \$23 billion a year –report, May 8th 2013, <https://www.reuters.com/article/us-piracy-fish/fish-piracy-costs-10-billion-to-23-billion-a-year-report-idUSBRE94703R20130508>

86 EIBN, Fisheries and Aquaculture, [http://indonesien.ahk.de/fileadmin/ahk\\_indonesien/Publications/EIBN/Fisheries\\_and\\_Aquaculture\\_Sector\\_Report\\_2017\\_FULLL.pdf](http://indonesien.ahk.de/fileadmin/ahk_indonesien/Publications/EIBN/Fisheries_and_Aquaculture_Sector_Report_2017_FULLL.pdf)

87 IUU Watch, East Africa: Illegal Fishing in Western Indian Ocean 'Alarming', <http://www.iuuwatch.eu/2017/07/east-africa-illegal-fishing-western-indian-ocean-alarming/>

88 Liddick, D., 2014. The dimensions of a transnational crime problem: the case of IUU fishing. In: Trends in Organized Crime. 17. pp. 290–312.

trafficking. Examples in the Indian Ocean include the IUU catch and trade of sea turtles in Mozambique, Somalia and South-east Asia.<sup>89</sup> Some studies have shown a link between illegal fishing and a rise in piracy.<sup>90,91</sup>

A more integrated approach is required to tackle overfishing and its cross-cutting drivers, and a host of initiatives already exist. At the global level, the FAO's International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing lies at the heart of the fight. In the Indian Ocean, the Regional Plan of Action to Promote Responsible Fishing Practices aims at strengthening fisheries management in South-east Asia and Australia, with countries in the region adopting national plans as well.

In addition to the above, the Indian Ocean Commission has set up joint monitoring, control, and surveillance efforts in the region, including through the regional Vessel Monitoring System programme, which has played a positive role in bringing the countries of the Indian Ocean together, enabling them to join forces for better fleet control. Initiatives to enhance seafood traceability, potentially using blockchain technology, could reinforce these efforts.

Complementing governance and technology solutions, novel approaches to blue financing are also being explored. The Seychelles has agreed to a debt-for-nature swap and have recently issued a blue bond, the proceeds from which will be used for marine conservation and developing a blue economy.

However, the information about the potential impact of many of these initiatives has not been shared widely for other countries to learn from. In fact, according to Mr Zeller, “the Indian Ocean is somewhat underrepresented in global fishery science and also underrepresented in the policy debate,” adding that “most research and most policy action in fisheries relates to the Pacific Ocean, or the Atlantic Ocean.”

Paradoxically, many of the biggest players in the lucrative tuna industry in the Indian Ocean—China, Taiwan, South

Korea and Europe—are actually not situated on the Indian Ocean Rim. However, their actions and policies, including heavy government subsidies, have a direct impact on Indian Ocean Rim countries. “[Small-scale fisheries therefore] face intense pressure from distant water fishing fleets for access to their resources,” says Mr Zeller.

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## **The Indian Ocean was the source of 13% of the world's wild-caught fish in 2016, producing 20% of the world's tuna such as skipjack, yellowfin and bigeye tuna**

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The Indian Ocean Rim countries need to make an important decision on what to prioritise—the safeguarding of their small-scale fisheries or further development of foreign fleet fishing in their waters. Concurrently, stresses Mr Zeller, dominant fishing nations also need to ask themselves the question “what policy decisions, and what human rights position will the nations of Europe, and the big industrialised nations in Asia take with regards to Indian Ocean Rim countries?”

Given the many challenges highlighted above, a recurring thread that emerged in our research is the inherent need to do things differently when it comes to ensuring the sustainability of the Indian Ocean and to break away from siloed structures. Thus, the overarching objective of the three cases studies we present in this chapter is to challenge traditional biases on three fronts—financial, social and technological. Our first case study presents an innovative new approach to blue financing from the Seychelles; the second considers the potential for more involvement from women along the fisheries value chain, taking a look at training offered in Somalia; and the final case study explores the role of emerging monitoring technology in combating IUU in Indonesia.

89 K A Riskas et al, Evaluating the threat of IUU fishing to sea turtles in the Indian Ocean and Southeast Asia using expert elicitation, 2018, Biological Conservation, [https://www.researchgate.net/publication/322179847\\_Evaluating\\_the\\_threat\\_of\\_IUU\\_fishing\\_to\\_sea\\_turtles\\_in\\_the\\_Indian\\_Ocean\\_and\\_Southeast\\_Asia\\_using\\_expert\\_elicitation](https://www.researchgate.net/publication/322179847_Evaluating_the_threat_of_IUU_fishing_to_sea_turtles_in_the_Indian_Ocean_and_Southeast_Asia_using_expert_elicitation)

90 CSIS, “Illegal, Unreported and Unregulated Fishing as a National Security Threat”, [https://csis-prod.s3.amazonaws.com/s3fs-public/publication/171102\\_Poling\\_IUU\\_Fishing\\_Web.pdf](https://csis-prod.s3.amazonaws.com/s3fs-public/publication/171102_Poling_IUU_Fishing_Web.pdf)

91 R Sumaila and M Bawumia, “Fisheries, ecosystem justice and piracy: A case study of Somalia”, 2014, Fisheries Research, [https://www.researchgate.net/publication/262490853\\_Fisheries\\_ecosystem\\_justice\\_and\\_piracy\\_A\\_case\\_study\\_of\\_Somalia](https://www.researchgate.net/publication/262490853_Fisheries_ecosystem_justice_and_piracy_A_case_study_of_Somalia)

## CASE STUDY 1:

**Blue Finance Revolution:  
blue bonds to turn the tide****Case summary**

- Creating an effective mechanism for sustainable ocean financing can plug a crucial gap facing governments intent on furthering their national blue economy strategies
- In a first-of-its-kind initiative, the Seychelles issued a blue bond in October 2018. Funds raised (US\$15m) are directed exclusively towards sustainable ocean activities.
- To attract investors, the Seychelles government had to offer a higher interest rate on the bond. The loan guarantee from the World Bank and the loan from the GEF that shares the interest repayment burden made this possible.
- Activities financed by the blue bond will complement other ocean sustainability initiatives in the Seychelles and will be informed by the assessments conducted under the debt swap agreement. The most important of these is the marine spatial planning that is under way.

After years of observing ecological and social systems, Gunter Pauli, who is credited as the creator of the Blue Economy concept, developed a bold new vision for natural resource management with the release of his report, *The Blue Economy: 100 innovations, 10 years, 100 million jobs*, in 2010. Since then, a framework has emerged outlining the positive and innovative role that private capital can play in a sustainable ocean economy, culminating in the creation of the Blue Economy Financing Principles developed by the World Wildlife Fund and its partners.<sup>92</sup>

The emphasis on financing is particularly important, as the shortfall continues to be the biggest hurdle marine

conservationists have to overcome. To establish and improve fisheries governance alone is estimated to cost over US\$200bn worldwide.<sup>93</sup> Creating an effective mechanism for sustainable ocean financing can plug a crucial gap facing governments intent on furthering their national blue economy strategies.

This is by no means an easy feat, but one small developing island state—which has placed sustainable development at the centre of its economic agenda—is charting the course for the future of sustainable private investment.

**The mechanics of a blue bond**

In a first-of-its-kind initiative, the Seychelles issued a blue bond in October 2018, a funding instrument akin to a green bond, in that the funds raised are directed exclusively towards sustainable ocean activities. The US\$15m bond issued by the government of the Seychelles raised money from three investors—Calvert Impact Capital, Nuveen and Prudential Financial.<sup>94</sup>

The bond is being backed by a US\$5m partial credit guarantee from the World Bank and a US\$5m loan from Global Environment Facility's (GEF) Non-Grant Instrument Pilot fund. The loan from GEF will be used to partially cover the bond's interest payments, with the rest covered from government revenue, possibly from savings generated through a reduction of fuel subsidies, according to experts close to the project.

The blue bond has a specific purpose within marine conservation. "The blue bond itself is designed as a fisheries management financial instrument," explains Martin Callow, CEO of the Seychelles Conservation and Climate Adaptation Trust (SeyCCAT), a local trust set up to co-manage the funds from the debt-swap and the blue

92 WWF, The Sustainable Blue Economy Finance Principles, <https://www.wwf.org.uk/updates/sustainable-blue-economy-finance-principles>

93 [https://seyccat.org/wp-content/uploads/2018/02/financing\\_fisheries\\_reform\\_january\\_2018.pdf](https://seyccat.org/wp-content/uploads/2018/02/financing_fisheries_reform_january_2018.pdf)

94 World Bank, Seychelles launches World's First Sovereign Blue Bond, <https://www.worldbank.org/en/news/press-release/2018/10/29/seychelles-launches-worlds-first-sovereign-blue-bond>

# US\$15m

**In a first-of-its-kind initiative, the Seychelles issued a blue bond in October 2018. Funds raised are directed exclusively towards sustainable ocean activities**

bond, as well as co-ordinate project implementation and stakeholder participation.

Funds raised will be used to implement the Mahe plateau fisheries management plan, supporting a range of activities including rebuilding fish stocks, restructuring fishing capacity, developing effective post-harvest activities as well as harvest control measures and additional scientific support services.<sup>95</sup> Funds will be disbursed mainly through a mix of loans and grants, split roughly 80:20.<sup>96</sup>

“US\$12m is going to the Development Bank of the Seychelles as a revolving loan fund for fisheries businesses,” explains Rob Weary, treasurer at SeyCCAT. “US\$3m will come to SeyCCAT, that is US\$500,000 each year for six years, to be distributed as grants.” Half of those grants will be directed towards fisheries projects and the other half towards the low biodiversity MPAs created through the marine spatial planning process.

They have already issued a call for proposals to disburse grants. Given that the World Bank is underwriting the bond, Mr Weary explains that “the Development Bank of the

Seychelles will have to meet very stringent requirements on social and environmental safeguards” to demonstrate that funds are being used for the right purposes.

For transparent and effective management, SeyCCAT’s board has been structured in a unique way, states Mr Callow. The board includes three key ministries as well as six members of civil societies that represent tourism, the chamber of commerce and NGOs. “This really provides the breadth and depth necessary in conversations on how our finances are deployed.” A Blue Economy Department, headed by the minister of finance, trade and the blue economy, provides “an umbrella function for discussions across ministries,” explains Mr Callow. “It’s all about stakeholder engagement, and those that have a direct interaction with the ocean are the most important stakeholders in all of this. It’s about providing them with a long-term future.”

## Building bonds

The blue bond was born on the side-lines of discussions on another innovative financing strategy in the Seychelles in 2012, the debt-for-nature swap deal (the first to focus exclusively on marine conservation).<sup>97</sup> The process was long and arduous, requiring multiple meetings between the presidents of the Seychelles and France, to ensure that the debt issues of the Seychelles were on the agenda for meetings of the Paris Club, a group of creditor countries. The presidential poll in the Seychelles, which resulted in a run-off election, further delayed a decision on this.

Securing investors for the blue bond proved challenging too. “There’s not a lot of [investors] out there specifically funding this sort of work and so it took the World Bank and the Seychelles Government a while,” explains Mr Weary.

95 FAO, Innovative Ocean financing: Seychelles Blue Bonds, <http://www.fao.org/blogs/blue-growth-blog/innovative-ocean-financing-seychelles-blue-bonds/en/>

96 Environmental Defense Fund, Financing Fisheries Reform, [https://seycat.org/wp-content/uploads/2018/02/financing\\_fisheries\\_reform\\_january\\_2018.pdf](https://seycat.org/wp-content/uploads/2018/02/financing_fisheries_reform_january_2018.pdf)

97 In the debt swap, The Nature Conservancy (TNC), a conservation organisation, purchased roughly US\$20m of the government’s debt (comprising a US\$15m loan from TNC and grants worth US\$5m from various foundations) in exchange for a commitment to designate over 200,000 sq km of ocean as a marine protected area.

To attract investors, the Seychelles government had to offer a higher interest rate on the bond. The loan guarantee from the World Bank and the loan from the GEF that shares the interest repayment burden made this possible.

In financing broad ocean sustainability initiatives, the reality is that no one entity will fund the entire reform process. Financial support therefore tends to be staggered and can require a blend of financing options, including funds from philanthropic organisations, development finance institutions and even the private sector. Furthermore, different investors may want to intervene at different times in the reform process. But one investor's backing can be used as leverage to gain further investors for other parts of the reform process.

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**To attract investors, the Seychelles government had to offer a higher interest rate on the bond. The loan guarantee from the World Bank and the loan from the GEF that shares the interest repayment burden made this possible**

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As the initiative is still in its infancy, Mr Callow and the SeyCCAT board look ahead to anticipate future challenges. "The bond is very much about the small-scale fishers having a sustainable future. How that interacts internationally with pressures of new fishing fleets is a very different beast and is important to consider." In addition,

more needs to be understood about the mechanics of disbursing loans, and, more importantly, monitoring that they're being used for sustainable purposes.

### **A solution for island states and beyond**

Activities financed by the blue bond will complement other ocean sustainability initiatives in the Seychelles and will be informed by the assessments conducted under the debt swap agreement.<sup>98</sup> The most important of these is the marine spatial planning that is under way. "The marine spatial planning process helps determine protected areas and provides an opportunity for [stakeholders] to understand where ocean-based business can take place in the most sustainable way," says Mr Callow.

"I know that some countries in the western Indian Ocean are looking at marine spatial planning as [the basis for designing] financing options to encourage private investment in sustainable ocean activities," says Mr Callow. This will especially facilitate impact measurement, a core pillar of the growing field of environmental, social and governance investment, or impact investing.

In this way, the Seychelles has become the poster child for innovative blue economy financing. "The biggest barrier in this, especially for a lot of these island states that have high debt loads and low or no credit rating, is not only [gaining] environmental resiliency, but also financial resiliency," says Mr Weary. The Seychelles has demonstrated how this can be achieved, having reduced its public debt from 83% to 66% of GDP from 2010 to 2017.<sup>99</sup> The government of the Seychelles must carry this responsibility, taking great care to effectively implement various facets of this financing programme, so that investors globally may continue to look to the Seychelles for innovative ways in which to bridge the financial gap.

98 FAO, Innovative Ocean financing: Seychelles Blue Bonds, <http://www.fao.org/blogs/blue-growth-blog/innovative-ocean-financing-seychelles-blue-bonds/en/>  
99 The Economist Intelligence Unit. 2010 data actual; 2017 data is an estimate.

## CASE STUDY 2

**Women in the front seat:  
driving blue growth in East Africa****Case summary**

- With funding from the government of Norway, and in partnership with USAID, the FAO launched a programme to train women to build stronger and safer boats for small-scale fishing operations.
- Building quality boats that can fetch a competitive price was a crucial part of ensuring that these efforts were self-sustaining.
- Associated projects have been launched in parallel. Women are being trained to use and maintain tracking devices on fishing boats. Another FAO-led project has trained 120 women to make lifejackets for fishermen registered in parts of Somalia.
- The most important outcome of these training programmes has been the confidence instilled in these women. Many are using this as a springboard for further education, with a few even expressing an interest in pursuing engineering degrees.

While fishing has largely been perceived as a male profession, particularly in developing countries, women play an active role in the sector. Their domain has largely been the post-harvest sector, including activities such as financing fishing trips, securing the best landing spots, fixing nets and salting fish. Some coastal women even fish, as part of the family business or, at the very least, to feed their families.

The FAO reports that of those engaged in fisheries and aquaculture, 14% are women but many acknowledge that this is significantly underreported. "Insufficient funding for research on women in fisheries may be one reason for the lack of available data," explains Sarah Harper, a PhD candidate at the Institute for the Oceans and Fisheries at the University of British Columbia, adding that, "women are involved in the fisheries value chain but not necessarily recognised in management and policy, underestimating the contribution of women to small-scale fisheries." Often too, workplace statistics do not capture headcount by gender.

Across East Africa, a host of case studies reveal more. In the Comoros, the fisherwomen of Ngazidja island have long been side-lined from management consultations and training despite playing a vital role in assuring food security.<sup>100</sup> In Tanzania, research shows that women's participation in fisher organisations is lower than men, as leaders.<sup>101</sup>

As countries work towards strengthening their fisheries sectors, involving women will be particularly valuable in accelerating efforts towards sustainability. Given their inclusive and collaborative approach, women are perceived

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**The FAO reports that of those engaged in fisheries and aquaculture, 14% are women but many acknowledge that this is significantly underreported**

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100 M Hauzer et al, The fisherwomen of Ngazidja island, Comoros: Fisheries livelihoods, impacts, and implications for management, 2013, *Fisheries Research*, <https://www.sciencedirect.com/science/article/abs/pii/S0165783612003451>

101 FAO, Strengthening organizations and collective action in fisheries: towards the formulation of a capacity development programme, <http://www.fao.org/3/a-i6205e.pdf>

102 E Gissi et al, Un-gendering the ocean: Why women matter in ocean governance for sustainability, 2018, <https://www.sciencedirect.com/science/article/pii/S0308597X1730787X>

to be effective actors in driving sustainability.<sup>102</sup> But policymakers in fisheries and marine conservation have fallen behind in adopting a more gender-aware approach.

<sup>103</sup> In some countries across East Africa, steps are being taken to change this.

### Rebuilding Somalia's fisheries

Somalia has been looking for ways to rebuild its economy, which has been devastated by years of conflict. With a 3,300 km coastline, fishing is particularly important for this impoverished state on the Horn of Africa, in view of achieving the twin goals of food security and job creation. In a project led by the FAO, efforts to rehabilitate the fishing sector began in 2015.<sup>104</sup>

Right at the outset, it was obvious that women had an important role to play, not just in promoting food security but also along the fisheries value chain. In recognising this itself, this programme was already challenging sector traditions and paving the way for long-term sustainability. With funding from the government of Norway, and in partnership with USAID, the FAO launched a programme to train women to build stronger and safer boats for small-scale operations.

Since its inception, specific projects in Mogadishu, Berbera and Bossaso have trained 34 women to build 16 vessels<sup>105</sup> that met the full safety specifications of the FAO, using new designs that have passed rigorous trials at sea. Building quality boats that can fetch a competitive price was a crucial part of ensuring that these efforts were self-sustaining. There has already been interest from the private sector to purchase boats built on these training yards.<sup>106</sup>

Associated projects have been launched in parallel. Women are being trained to use and maintain tracking devices on fishing boats. Another FAO-led project has

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**With a 3,300 km coastline, fishing is particularly important for this impoverished state on the Horn of Africa, in view of achieving the twin goals of food security and job creation**

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trained 120 women to make lifejackets for fishermen registered in parts of Somalia. Additional programmes run by USAID and the Women's Business Umbrella in Puntland have included training on budgeting and business planning. "In Somalia, women own restaurants, stores that sell fish and fish processing efforts," adds Sarah Glaser, associate director of One Earth Future's Secure Fisheries programme, which contributes to efforts to empower women in fisheries in Somalia.

Ms Glaser is excited about the prospects for women in ensuring seafood transparency (knowing where and how a fish was caught), an emerging field in global fisheries. "Seafood labelled 'sustainable' can command a market premium and women have an opportunity to encourage eco-labelling schemes. Just like fair trade policies and behaviour, trade in fish that promotes sustainable fisheries is a win for women and a win for the ocean."

But the most important outcome of these training programmes has been the confidence instilled in these women. Many are using this as a springboard for further education, with a few even expressing an interest in pursuing engineering degrees.

103 ILO 2002]

104 FAO, Rehabilitating the fisheries sector in Somalia, <http://www.fao.org/blogs/blue-growth-blog/rehabilitating-the-fisheries-sector-in-somalia/en/>

105 FAO, Fisheries sector support programme in Somalia, <http://www.fao.org/somalia/news/detail-events/en/c/1027947/>

## Through the gender lens

Together, these programmes demonstrate how women can play a vital role across the fisheries value chain beyond just post-harvest activities. To scale-up and provide ongoing training, these programmes must be crafted bearing in mind regional challenges. For instance, in one area, nine out of ten women could not read, rendering training manuals largely ineffective.

Given the higher percentage of small-scale fisheries in the Indian Ocean, a boat-building training programme could be particularly successful in this region. This will require adopting a “gender and social justice lens” when developing fisheries policies, says Ms Harper. “The Indian Ocean Rim countries could serve as a test-bed for enhancing our understanding of these issues.”

When developing future programmes, however, changes in the fisheries and aquaculture sector must be considered. Industrial expansion of fisheries more often than not comes at the expense of small-scale fisheries, with long-term implications for women and their communities: “When big industry comes in, often women take the hit, as women who work in small-scale fisheries sub-sectors such as processing and marketing are displaced by men or foreign workers brought in to work in these industrial operations.” Ms Glaser highlights the disproportionate impact of industrial fisheries on women in certain fishing communities all around the world, citing the example of aquaculture, which might result in “women getting pushed out of the market as technology improves or foreign investment in the arena increases.”

Failure to take into account the cross-cutting role of women in the sector is considered by a growing number of academics and experts as a threat to long-term ocean sustainability,<sup>107</sup> food security and even maritime security.<sup>108</sup> Cornelia Nauen, president of Mundus Maris, an ocean

conservancy group, warns: “If their role is eroded, the entire domestic economy will suffer”.

However, after decades of neglect, a slow change is on the horizon at the international level, explains Ms Glaser. “[Many organisations] are realising the impact of omitting the perspective of women in the conversation. Including a gender perspective is critical for lasting solutions.” In guidelines developed by the FAO, Securing Sustainable Small-Scale Fisheries, gender equality is a key guiding principle.

By understanding the contribution women can make along the fisheries value chain and developing gender-aware fisheries policies, governments can effectively engage fisherwomen to help play a positive role in improving sustainable fishing practises. In this way, sustainable fisheries policies can go beyond just achieving Sustainable Development Goal (SDG) 14, which is dedicated to ocean sustainability, but can also contribute to SDG 5: gender equality.

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**“[Many organisations] are realising the impact of omitting the perspective of women in the conversation. Including a gender perspective is critical for lasting solutions”**

**Sarah Glaser, associate director,  
One Earth Future**

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106 FAO, Promoting gender in fisheries activities in Somalia, <http://www.fao.org/blogs/blue-growth-blog/promoting-gender-in-fisheries-activities-in-somalia/en/>  
107 Vogel 2012.

## CASE STUDY 3

**Taking back control: satellite monitoring to combat IUU in Indonesia****Case summary**

- To support its efforts to develop a national maritime surveillance programme, the Indonesian government launched the Infrastructure Development of Space Oceanography (INDES0) programme.
- Using information broadcast from vessels, analysts can determine vessel speed and, importantly, whether or not they are carrying out fishing activities when their transceivers have been switched off.
- Through these efforts, they estimate that they detected between 30–50% of illegal vehicles.
- Although surveillance technology is relatively easy to access, getting finance ministries in the region to earmark budgets across departments has been among the top challenges in trying to set up a comprehensive vessel monitoring programme.

**IUU in Indonesia: low risk, high gain**

Indonesia is the second-largest fish producer in the world, with an estimated value of wild capture and aquaculture exports ranging between US\$3.2bn and US\$4.1bn in 2017.<sup>109</sup> But the Indonesian government estimates that IUU fishing costs the economy more than US\$3m annually in lost revenue.<sup>110</sup> With many Indonesians reliant on fisheries and aquaculture for their livelihood, better safeguarding fisheries from IUU activities is a key policy priority.

Globally, illegal activities on the high seas are estimated to cost up to US\$23bn each year.<sup>111</sup> This “low risk, high gain”

activity<sup>112</sup> has been fuelled in part by an ever-increasing demand for seafood<sup>113</sup> and an overcapacity in fishing fleets, often supported by government subsidies.<sup>114</sup> Governments around the world face a number of hurdles in monitoring their waters, including limited resources, lack of specifically trained personnel and difficulties in co-ordinating with various authorities.

SDG 14, dedicated to life below water, aims to end IUU fishing by 2020. A tall order, but success stories like Indonesia’s offer some encouragement.

**Visible gains**

To support its efforts to develop a national maritime surveillance programme, the Indonesian government turned to a global satellite monitoring provider, Collecte Localisation Satellites (CLS), and in September 2014 the Ministry of Marine Affairs and Fisheries launched the Infrastructure Development of Space Oceanography (INDES0) programme.

“INDES0 was conceived as a complete system to monitor legal and illegal fishing, including [fish] stock assessment,” explains Philippe Gaspar, head of innovation, sustainable management of fisheries at CLS France, the scientific co-ordinator for the programme. “Reasonable stock estimates would enable the government to [craft and] implement measures that would ensure sustainable fishing in Indonesia.”

When it comes to effectively monitoring vessels, a multi-layered approach is required, which combines radar satellite imagery—known as synthetic aperture radar (SAR)—with information broadcast through the vessel monitoring system (VMS) transceiver installed on vessels. This is further layered with an automatic anti-collision transceiver, similar to a global positioning system, which is broadcast by vessels usually to avoid collision, called the automatic identification system (AIS).

108 Beseng 2017.

109 California Environmental Associates, Trends in Marine Resources and Fisheries Management in Indonesia, <https://www.ceaconulting.com/casestudies/indonesia-report/>

110 EIBN, Fisheries and Aquaculture, [http://indonesien.ahk.de/fileadmin/ahk\\_indonesien/Publications/EIBN/Fisheries\\_and\\_Aquaculture\\_Sector\\_Report\\_2017\\_FULL.pdf](http://indonesien.ahk.de/fileadmin/ahk_indonesien/Publications/EIBN/Fisheries_and_Aquaculture_Sector_Report_2017_FULL.pdf)

111 FAO, Growing momentum to close the net on illegal fishing, <http://www.fao.org/news/story/en/item/1137863/icode/>

112 Chatham House, IUU Symposium 2018. <https://www.chathamhouse.org/event/11th-international-forum-illegal-unreported-and-unregulated-fishing>

113 <http://www.fao.org/3/a-a0699e.pdf>

114 UNCTAD, Harmful Incentives: The Case of Fisheries Subsidies, [http://unctad.org/en/PublicationChapters/ditcted2016d3\\_part3\\_en.pdf](http://unctad.org/en/PublicationChapters/ditcted2016d3_part3_en.pdf)

Fishing vessels leave a distinctive trail. Using information broadcast from vessels, analysts can determine vessel speed and, importantly, whether or not they are carrying out fishing activities when their transceivers have been switched off.

“A key project requirement was that we would have to have information available at 30-minute intervals,” said Olivier Germain, director of operations at CLS Vietnam, who helped provide training to 40 Indonesian staff during the implementation phase. CLS estimates that they detected between 30-50% of illegal vehicles. Offenders faced stiff penalties, including Indonesia’s controversial “sink the vessel” policy.<sup>115</sup>

Beyond monitoring vessels, the INDESO programme also included “a new-generation stock assessment component to the system, which enabled the Indonesian authorities to better manage key fish stocks, notably tuna and tuna-like species, as well as predict the evolution of fish stocks,” added Mr Gaspar. As the leading producer of tuna worldwide,<sup>116</sup> Indonesia commissioned CLS to run stock assessment models for three types of highly prized migratory and transboundary tuna stocks: skipjack, yellowfin and bigeye tuna.

CLS also used the system to monitor shrimp, seaweed farming and coral reef farming. In its study of the evolution of mangroves in two specific areas, CLS was able to demonstrate that “when the mangrove was degraded, it was better to let it rejuvenate rather than plant a new mangrove,” says Mr Gaspar.

Furthermore, data from INDESO were fed into a global model, for better analysis of stock variability in the Indian and Pacific oceans. Data from regional fisheries management organisations such as the Indian Ocean Tuna Commission further enhanced the dataset.

## Plotting the way forward

Despite being hailed by the Indonesian government as a

success story, a number of Indian Ocean Rim countries have yet to follow suit. Although surveillance technology is relatively easy to access, getting finance ministries in the region to earmark budgets across departments has been among the top challenges in trying to set up a comprehensive vessel monitoring programme.

This was less of an issue for Indonesia’s INDESO programme, as the entire project was funded using a loan from a French development bank, AFD. Given difficulties in securing budgets at the national level, developing nations may have to continue to rely on external donors for the near future.

Another precondition for a successful programme is the need for a combination of technologies (SAR, VMS, AIS), as data from all these can help pin-point IUU activity more accurately, according to Mr Germain. “But I do stress that VMS should be the core surveillance tool to enforce national fishing laws,” he says. He recommends a broadcast interval for the transceiver of 10-15 minutes, which still had a margin of error of 20%.

Rapid advances in technology are promising. Sentinel One, a satellite system that provides open-source data, was a game changer, according to Mr Germain. Overcoming data gaps in estimating catches is another key area that would benefit from technological developments. “Anything that helps automatically monitor the catches will be a big help,” said Mr Gaspar. He advocates for the widespread adoption of electronic reporting systems, such as a combination of artificial intelligence with cameras on vessels to automatically calculate volume of fish caught.

While IUU from foreign fleets in distant waters may have declined, Indonesia continues to face issues of overfishing by domestic fleets. But its experience demonstrates that the technology is available to tackle IUU in the Indian Ocean. Political commitment, effective monitoring standards and finance need to follow.

115 California Environmental Associates, Trends in Marine Resources and Fisheries Management in Indonesia, <https://www.packard.org/wp-content/uploads/2018/08/Indonesia-Marine-Full-Report-08.07.2018.pdf>

116 Indonesia Investments, Fishing Industry Indonesia: Leading Tuna Producer, Concern about Overfishing, <https://www.indonesia-investments.com/news/todays-headlines/fishing-industry-indonesia-leading-tuna-producer-concern-about-overfishing/item6835?>

# Chapter 4: Extraction of non-renewable marine resources

This century has seen accelerated exploitation of the earth's resources for economic gain. Alongside the depletion of land-based resources to meet the world's growing appetite for energy and mineral resources, humankind has turned to the oceans for vital resources. This has underpinned the growth of industries such as offshore oil and gas, deep-sea mining and bioprospecting (the discovery of products from biological marine resources) in addition to the system that supports it, including port infrastructure and shipping.

Among the extractive industries, offshore oil and gas has a strong presence in the Indian Ocean, with 31% of the total number of active offshore rigs as at August 2018.<sup>117</sup> India and the UAE are key players, while Malaysia, Thailand, Indonesia and Australia have fewer active offshore rigs.

Some countries on the Indian Ocean Rim that have no prior experience with offshore petroleum production, such as Tanzania, have also shown interest in offshore exploration.<sup>118</sup>

The outlook for offshore oil and gas varies—based on policies announced (ie, a country's intention to

**31%**  
of the total  
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Indian Ocean

develop the sector) the industry is set to grow, particularly offshore gas. But if more stringent sustainability measures are implemented, future offshore production could potentially flatten or even decline.<sup>119</sup>

Deep-sea mining activity, however, is still at a nascent stage, largely because of the prohibitive cost of mining in the high seas. But the Indian Ocean has been identified as one of the hotspots for polymetallic nodules and sulphides.<sup>120</sup> In the Indian Ocean Rim, India is the only country that has been awarded a licence by the International Seabed Authority (ISA), an intergovernmental body with jurisdiction over the high seas. In 2016 the ISA extended India's exclusive rights for exploration of polymetallic nodules in the Central Indian Ocean Basin by five years, up to 2022.<sup>121</sup>

"So far, India has made significant progress on all the four components of deep-sea mining, namely site identification, collection of baseline data, development of mining technology and metallurgical processing," explains Rahul Sharma, retired chief scientist from the National Institute of Oceanography, India. Other countries that have expressed interest in deep-sea mining are South Africa, Mozambique and the Seychelles.<sup>122</sup>

But although efforts remain largely exploratory, ocean experts around the world have raised concerns about the harmful environmental impact they anticipate. "It is expected that a mechanism of long pipes and pumps for [extracting]

117 Baker Hughes Rig Count, <http://phx.corporate-ir.net/phoenix.zhtml?c=79687&p=irol-rigCountOverview>

118 *The East African*, Firms complete drilling two offshore gas wells in Tanzania, January 26th 2017, <http://www.theeastafrican.co.ke/business/Tanzania-offshore-gas-wells/2560-3787840-11wvt9q/index.html>

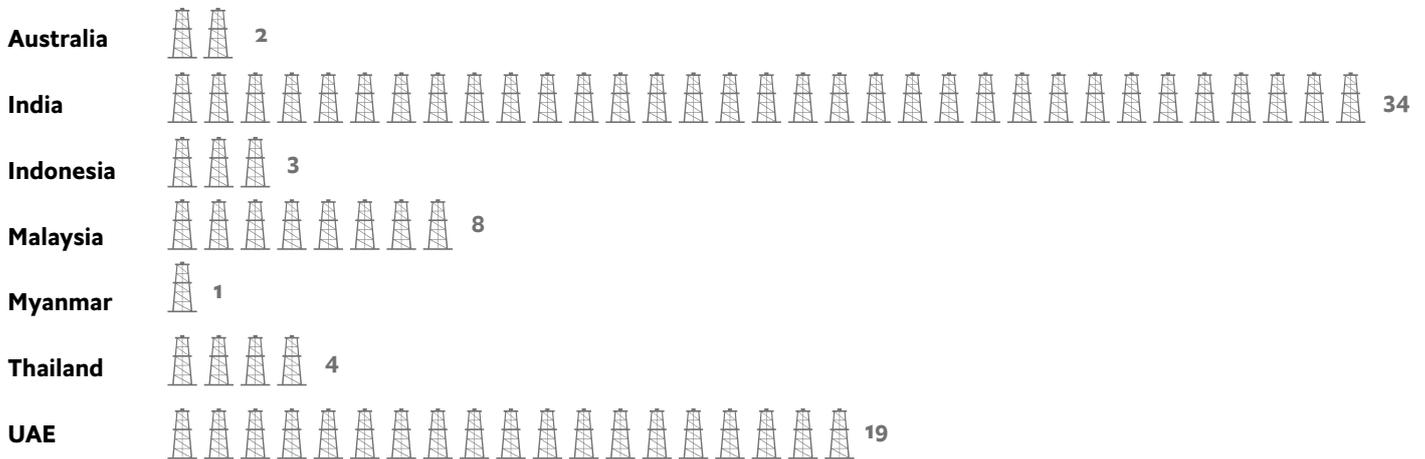
119 IEA, Offshore Energy Outlook, [https://www.iea.org/publications/freepublications/publication/WEO2017Special\\_Report\\_OffshoreEnergyOutlook.pdf](https://www.iea.org/publications/freepublications/publication/WEO2017Special_Report_OffshoreEnergyOutlook.pdf)

120 ISA, Polymetallic Nodules, <https://www.isa.org.jm/files/documents/EN/Brochures/ENG7.pdf>

121 GK Today, ISA extends India's exclusive rights to explore Polymetallic Nodules, <https://currentaffairs.gktoday.in/tags/isa/page/3>

122 L E Llewellyn et al, A roadmap to a sustainable Indian Ocean blue economy, 2016, *J. Indian Ocean Reg.*, <https://www.tandfonline.com/doi/abs/10.1080/19480881.2016.1138713>

## Active offshore oil and gas rig count, August 2018



Source: Baker Hughes Rig Count. <http://phx.corporate-ir.net/phoenix.zhtml?c=79687&p=irol-rigCountOverview>

the ore from the seabed is likely to impact the environment—creating sediment clouds, changing the characteristics of the water column and [adversely] impacting marine life at different levels,” explains Mr Sharma. As such, the deep-sea mining industry is striving to avoid the devastating environmental impacts of other extractive industries.

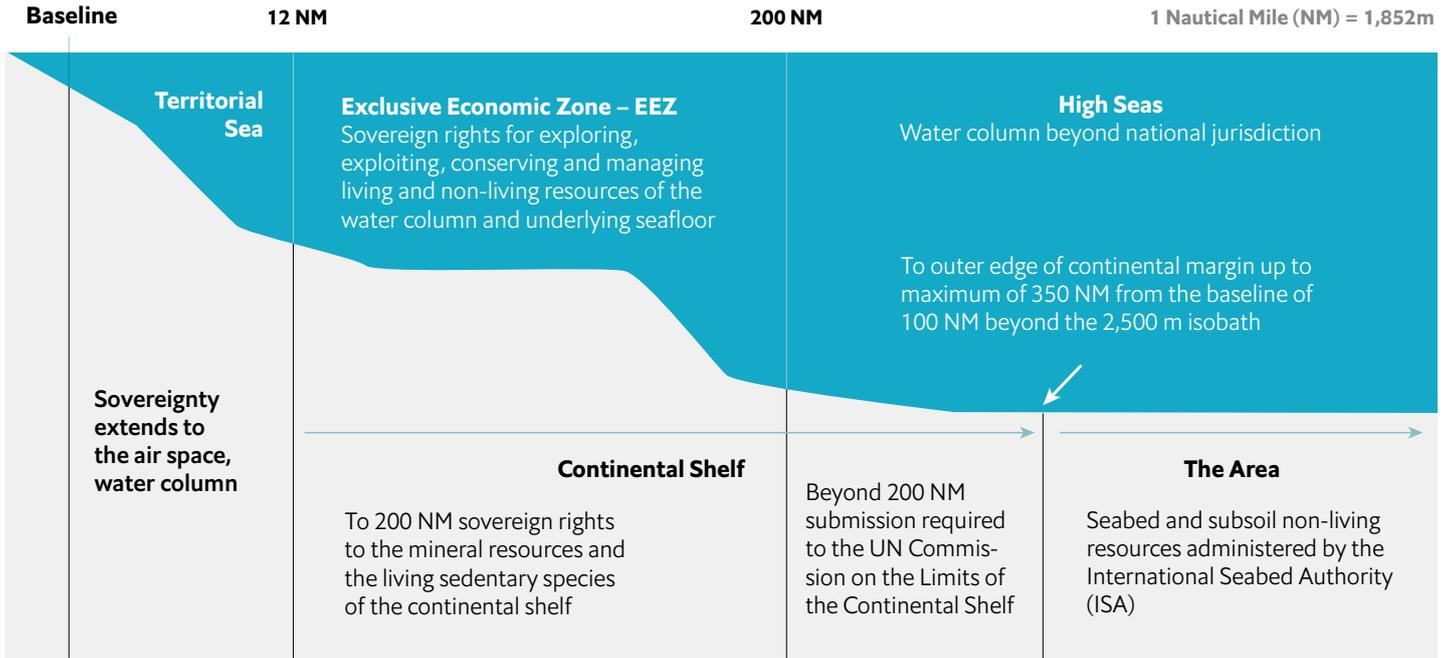
The environmental damage resulting from offshore oil and gas is well documented. Drilling for oil destroys marine habitats, not only when oil rigs are installed but when they are decommissioned too. Oil spills are toxic to all forms of marine life; the 2014 oil spill in the Bay of Bengal, off the

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**In the Indian Ocean Rim, India is the only country that has been awarded a licence for deep-sea mining by the International Seabed Authority (ISA)**

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UN Convention on the Law of the Sea ocean zones



Source: IUCN. <https://portals.iucn.org/library/sites/library/files/documents/2018-029-En.pdf>

**The environmental damage resulting from offshore oil and gas is well documented. Drilling for oil destroys marine habitats, not only when oil rigs are installed but when they are decommissioned too. Oil spills are toxic to all forms of marine life.**

coast of Bangladesh, was responsible for the depletion of the phytoplankton population (which many marine organisms depend on for food) and fish stocks, and damaged a considerable part of the Sundarbans mangrove area.<sup>123</sup> This in turn impacted the livelihoods of many communities depending on healthy marine ecosystems, such as commercial fisheries and tourism.<sup>124</sup> Acoustic disturbances from exploration and production have led to changes in the migration patterns of humpback whales in the western Indian Ocean.<sup>125</sup>

International agreements are in place to manage some of the adverse environmental impacts, although they are fragmented and often fall short of holistic and sustainable management of the ocean.<sup>126</sup> The Indian Ocean Rim states have ratified the global legal framework to promote ocean resource management—the UN Convention on the Law of the Sea. At a regional level, there are protocols within which countries are required to develop a contingency plan for accidents from oil and gas exploration.<sup>127</sup>

Furthermore, countries such as Australia, Indonesia, New Zealand, South Africa and Thailand have developed plans and strategies for marine spatial planning (MSP), an instrument for sustainable marine resource management. Others such as India, Sri Lanka, Bangladesh and the Seychelles have implemented MPAs or fisheries protection zones to protect critical ecological areas from offshore hydrocarbon exploration and production.

The case studies we present in this chapter delve deeper into specific initiatives to address and limit, if not altogether avoid, damage to the marine environment from offshore oil and gas and deep-sea mining. Given its importance as a tool for sustainable development, we explore marine spatial planning efforts under way in the Seychelles in our first case study, examining the delicate balance struck between economic and sustainability objectives. In the second, we look at an initiative to convert rigs (abandoned or due for decommissioning) into artificial reefs in South-east Asia. The final case study explores sustainability considerations in India's deep-sea mining plans.

123 A R Sunny, Impact of oil spill in the Bangladesh Sundarbans, [https://www.researchgate.net/publication/320471156\\_Impact\\_of\\_oil\\_spill\\_in\\_the\\_Bangladesh\\_Sundarbans](https://www.researchgate.net/publication/320471156_Impact_of_oil_spill_in_the_Bangladesh_Sundarbans)

124 Ibid

125 Indian Ocean (IOC), "A regional strategy for conserving marine ecosystem and fisheries of the Western Indian Ocean Islands Marine Ecoregion (WIOMER)," no. September. IOC, WWF, Conservation International, Fonds Français pour l'Environnement Mondial (FFEM), Wildlife Conservation Society, Réunion, 2010.

126 Nekton, The Indian Ocean, <https://nektonmission.org/mission-ii/the-indian-ocean>

127 Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution and its protocol concerning Regional Co-operation in Combating Pollution by Oil and other Harmful Substances in Cases of Emergency, 1978; Nairobi Convention for the Western Indian Ocean, 1985

## CASE STUDY 1

**Blue horizons: marine spatial planning in the Seychelles****Case summary**

- The Seychelles government is developing a marine spatial plan (MSP) to determine the mix of outputs that will be produced from the ocean over time and space, across sectors including hydrocarbons.
- The focus has been to improve ocean management using science-based design, stakeholder input and local knowledge, key principles of an effective marine spatial plan.
- Trust and transparency among stakeholders and policymakers have been critical for progress. Sincere political commitment is a must to be able to effectively balance economic and conservation interests.
- Ongoing data collection on climate change, economic vulnerabilities, resource discoveries, among others, has been vital for decisions on future operations and overall management of offshore resources.

With an exclusive economic zone (EEZ) of 1.3m sq km, more than four times the size of Madagascar, the Seychelles has one of the largest maritime jurisdictions in the western Indian Ocean. Although the island state has not yet established offshore oil and gas or mineral extraction, there is an intense desire to explore these to fuel future economic growth.<sup>128</sup>

“The country has an existing policy to continue exploration potential for oil and gas in the EEZ,” explains

Alain de Comarmond, principal secretary for the environment department, at the Ministry of Environment, Energy and Climate Change in the Seychelles. “And surveying has been ongoing over the last three decades or so under the administration of PetroSeychelles.” “Early assessments suggest “excellent” hydrocarbon reserves at shallow water depths.<sup>129</sup>

The Seychelles government is developing an MSP<sup>130</sup> to determine the mix of outputs that will be produced from the ocean over time and space, across sectors including hydrocarbons.<sup>131</sup> For marine resources this is especially important, as they are “common property resources”, free to access and thus prone to excessive use. In the Seychelles, the focus has been to improve ocean management using science-based design, stakeholder input and local knowledge, key principles of an effective MSP.

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**In the Seychelles, the focus has been to improve ocean management using science-based design, stakeholder input and local knowledge, key principles of an effective marine spatial plan**

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128 *Seychelles News Agency*, New chief of PetroSeychelles sets oil exploration at the top of agenda, March 21st 2017, [www.seychellesnewsagency.com/articles/6970/New+chief+of+PetroSeychelles+sets+oil+exploration+at+the+top+of+agenda](http://www.seychellesnewsagency.com/articles/6970/New+chief+of+PetroSeychelles+sets+oil+exploration+at+the+top+of+agenda)

129 *The Telegraph*, Oil's new frontier? The Seychelles plans to fast-track drilling despite environmental concerns, February 21st 2018, <https://www.telegraph.co.uk/business/2018/02/21/oils-new-frontier-seychelles-plans-fast-track-drilling-despite/>

130 Seychelles MSP Initiative, Zoning Proposal for the Seychelles Exclusive Economic Zone, [https://seymsp.com/wp-content/uploads/2014/06/SeychellesZoningDRAFT\\_A4\\_v3.1\\_20141210\\_JLS.pdf](https://seymsp.com/wp-content/uploads/2014/06/SeychellesZoningDRAFT_A4_v3.1_20141210_JLS.pdf)

131 Marine Spatial Planning Programme, <http://msp.ioc-unesco.org/about/marine-spatial-planning/>

## Navigating the waters

The MSP in the Seychelles has been financed using a portion of the proceeds from an innovative debt swap facilitated by The Nature Conservancy, a conservation organisation (see case study in the chapter on unsustainable fishing). As part of the agreement, the Seychelles government committed to conserve 30% of its EEZ by 2020. The first phase of the project, which ran in 2014-17 and covered half the EEZ, has been completed and 15% of it has already been established as MPAs. These milestones were set out in the legal agreements and resulted in the progress made so far.

While a science-based approach was imperative, says Rob Weary, treasurer at the Seychelles Conservation and Climate Adaptation Trust, “stakeholder engagement is key.” It was important to involve the full range of stakeholders he says, which include “the three levels of fishing (the tuna fishing fleets, the semi-industrial fleets and artisanal fishermen); PetroSeychelles, given their interest in oil and gas reserves and major shipping lanes in these waters; and the tourism sector.”

Trust and transparency among stakeholders and policymakers have been critical for progress. “I think what’s been very positive is the dialogue,” explains Mr de Comarmond. “It is the first time that we got so many stakeholders together to start thinking about what we want for the future.”

But stakeholder management can be tedious, he says. Bringing local stakeholders on board involved numerous one-to-one meetings, as many artisanal fishermen and even some of the industrial players would not turn up to the larger meetings. In addition to this, aligning priorities across such a diverse group is challenging. “Of course, everybody’s pushing their own interests, but at the same time listening and compromising in certain instances on their interests,”

says Mr de Comarmond. Mr Weary explains further: “If everybody leaves getting 80% of what they wanted and they see that everyone else around the room also had to give a little and only got 80% too, then they feel it’s a fair process, even if they are a little unhappy.”

But they believe that to balance economic and conservation interests in these conversations, sincere political commitment is a must. “We had the highest level of political commitment as we went through the exercise. When you have this, the [ultimate objectives] become clear.” In doing this, Mr de Comarmond believes they have been successful in balancing conflicting objectives. “You have to work very closely with them, to show them that the plan is not just an environment plan, but a marine resource plan.”

All this was made possible because of a strong culture for conservation in the Seychelles. “We’re quite fortunate in that regard. The need for conservation was apparent, it didn’t take a lot of convincing,” says Mr de Comarmond.

As part of the MSP, the government will also demarcate zones for non-renewable marine resource extraction, specifically offshore oil and gas.<sup>132</sup> But how far offshore industries will progress remains to be seen. The obvious ecological damage as well as the broader impact on climate change of extractive industries may forever impede or limit the extent of offshore oil and gas production or deep-sea mining. “We still have vulnerabilities as a small island state,” expresses Mr de Comarmond. “Given our economic reliance on fishing and coastal tourism, [the climate] risk [that offshore extractive activities pose] is a big concern for us.”

## Beyond the horizon

Critical to the success of MSP in the Seychelles are several challenges related to public legitimacy, regulation and

132 Seychelles MSP Initiative, Zoning Proposal for the Seychelles Exclusive Economic Zone, pages 1-22, [https://seymsp.com/wp-content/uploads/2014/06/SeychellesZoningDRAFT\\_A4\\_v3.1\\_20141210\\_JLS.pdf](https://seymsp.com/wp-content/uploads/2014/06/SeychellesZoningDRAFT_A4_v3.1_20141210_JLS.pdf)

governance. These factors would eventually guarantee the implementation of the plan, including monitoring and evaluation. In terms of public legitimacy, “we have to keep the momentum, intensifying discussions, especially at grassroots level.” This will be important in the second phase of MSP, between 2018 and 2020, which aims to assess resources at an island level.

Effective regulatory and governance frameworks must be developed in parallel. “This will be the challenge for us,” says Mr de Comarmond. “This is why we have started to present proposals before government early on, before 2019, so that they are aware of the level of commitment that will have to be made towards that.”

Ongoing data collection on climate change, economic vulnerabilities, resource discoveries and illegal fishing, among others, has been vital for decisions on future operations and overall management of offshore resources. Local and international partnerships have been valuable here. “Partnerships have helped us to identify some of our data and information gaps,” explains Mr de Comarmond. He recognises that emerging monitoring technology, such as satellite monitoring, can help improve these efforts.

The Seychelles experience is quickly becoming best practice for MSP in planning the use of offshore resources in a sustainable manner. They are already offering advice to other countries in the region, including Mauritius, Kenya and Tanzania. “The ideas of the islands are now being adopted by continental coastal countries,” exclaims Mr Weary. “It shows the power of that thinking.” But Mr de Comarmond offers some words of advice: “There has to be flexibility, it’s not one-size-fits-all. So, it is important to talk, facilitate compromises and trade-offs and enable people to trust the process. Finally, do not rush the process.”

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**Alain de Comarmond,  
principal secretary for the environment  
department, Ministry of Environment,  
Energy and Climate Change, Seychelles**

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## CASE STUDY 2

**Rig-to-reef: creating artificial reefs from oil rigs in Malaysia****Case summary**

- In South-east Asia, Malaysia is becoming a test-bed for rig-to-reef programmes, which require the oil well to be capped and the rig to be towed to a new location, toppled on site or partially removed and subsequently managed by the state.
- A survey in 2012 of the Baram-8 platform, eight years after it was reefed, found that it had become home to populations of soft coral
- A recent survey by Blue Latitudes found that the average fish count per area under the Borneo rig in Malaysia was more than 3.5 times that of a nearby natural reef, proof, they believe, that rigs can provide some ecosystem services.
- But with few examples in practice, the ecological benefits of such programmes are still unclear and widely debated.

A wave of decommissioning in offshore oil and gas is expected in South-east Asia. “About half of an estimated 1,700 of offshore installation are reaching the end of their lifespan and need to be decommissioned,” says Loke Ming Chou, adjunct research professor at the Tropical Marine Science Institute, National University of Singapore. Thailand has more than 80 offshore installations that are more than 20 years old, while in Malaysia, of the 300 offshore installations, 60% are nearing the end of their commercial life.<sup>133, 134</sup> The cost to operators across Asia-Pacific is approximately US\$100bn, according to Wood Mackenzie, an oil and gas consultancy.<sup>135</sup>

In the current low oil price climate, operators in the region have started to explore ways to reduce costs. Given the weak regulatory environment for decommissioning, many operators in South-east Asia may even look to abandon rigs at the end of their commercial life.

One alternative increasingly under consideration is the “rig-to-reef” (R2R) programme. The process requires the oil well to be capped and the rig to be towed to a new location, toppled on site or partially removed and subsequently managed by the state.<sup>136</sup> In South-east Asia, Malaysia is becoming a test-bed for R2R—its first artificial reef was created out of the Baram-8 rig, which collapsed in 1975 and was “reefed” in 2004. In 2017 Petronas, Malaysia’s national oil and gas company, converted two platforms into artificial reefs.<sup>137</sup> But with few examples in practice, the ecological benefits of such programmes are still unclear and widely debated.

133 Rigs to Reef Scenario in Malaysia, <https://cil.nus.edu.sg/wp-content/uploads/2013/06/8.-Dr.-Noor-Amila-WAN-ABDULLAH-ZAWAWI-RIGS-TO-REEF-SCENARIO-IN-MALAYSIA.pdf>

134 RO Abdullah, Halliburton, Oil & Gas Industry – Opportunities and Challenges Ahead, pages 1-39, [http://www.mida.gov.my/env3/uploads/events/InvestMalaysia2012/4-Oilngas\\_Halliburton.pdf](http://www.mida.gov.my/env3/uploads/events/InvestMalaysia2012/4-Oilngas_Halliburton.pdf)

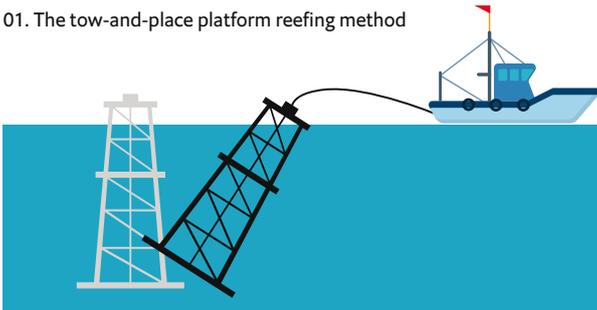
135 Bloomberg, Getting Old Is Expensive If You’re An Oilwell, <https://www.bloomberg.com/news/articles/2018-02-01/100-billion-clean-up-bill-awaits-asia-s-old-offshore-oil-wells>

136 Blue Latitudes, Rigs to Reefs, <http://www.rig2reefexploration.org/read-me/>

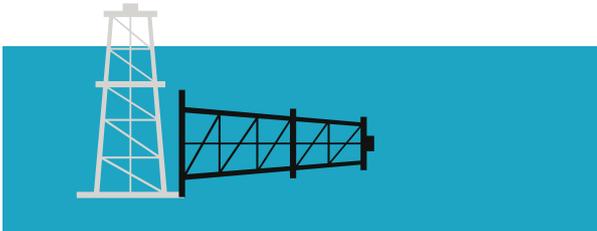
137 The Maritime Executive, Asia Unprepared for Decommissioning its 2,600 Platforms, <https://www.maritime-executive.com/editorials/asia-unprepared-for-decommissioning-its-2-600-platforms>

## Converting rigs to reefs

01. The tow-and-place platform reefing method



02. The topple-in-place platform reefing method



03. The partial removal platform reefing method



Source: Blue Latitudes. <http://www.rig2reefexploration.org/read-me/>

## The argument against decommissioning

Right from the time offshore rigs are set up on site, the damage to the marine environment has begun. They cause physical damage to existing benthic habitats within the “drop zone”, undesired changes in marine food webs and release contaminants as rigs corrode.<sup>138</sup>

“But once the structure is in place, it starts to attract fish and other marine organisms,” explains Mr Chou, who has been advocating for R2R for decades. For structures already in place, therefore, some ocean experts argue against decommissioning. “By just cutting and bringing it back to shore, we’re going to lose this entire ecosystem that has developed, leading to [a] double negative impact.”

In addition to ecological losses, decommissioning is an expensive process—it can cost millions of dollars to decommission a rig. In comparison, setting up an artificial reef can cost a few hundred thousand dollars.<sup>139</sup> Given the savings it generates, Mr Chou imagines that offshore operators would be more than eager to foot the bill. Beyond financial benefits, it is an opportunity for them to enhance their brand and strengthen their CSR programmes.

## A whole new world

The R2R programme is still at a nascent stage and so, Mr Chou explains, “we don’t have too many of these cases to make a fair assessment.” But anecdotal evidence from initial experiments is promising. “I have not yet come across an unsuccessful one,” he says, encouragingly.

A survey in 2012 of the Baram-8 platform, eight years after it was reefed, found that it had become home to populations of soft coral. “There are lots of schools of fish coming around and encrusting organisms are attaching themselves to the structure,” explains Mr Chou. “Even corals are growing in the shallow parts of the installation, so it becomes a very rich

138 P I Macreadie et al, Rigs-to-reefs: Will the deep sea benefit from artificial habitat?, *Front. Ecol. Environ.*, 2011, <http://www.esa.org/pdfs/Macreadie.pdf>

139 <https://www.youtube.com/watch?v=J0IG8R6ymrl>

ecosystem.” But monitoring around this R2R programme has been weak, so apart from photographs, little evidence is available in the form of hard data.<sup>140</sup>

Another rig in Borneo, Malaysia, has been converted into a dive platform and resort. This ecotourist site, teeming with marine life below the rig, generates revenue for its operators, Seaventures. A recent survey by Blue Latitudes found that the average fish count per area under the rig was more than 3.5 times that of a nearby natural reef, proof, they believe, that rigs can provide some ecosystem services.<sup>141</sup> Although this is evidence from a single artificial reef and a higher fish count does not necessarily mean a healthier reef, studies like this provide a framework for further research.

Regulated fishing around these rigs can also be a source of income for communities in surrounding areas. Even when fishing is not permitted directly along the artificial reefs, as is the case for the one in Borneo, “the rigs eventually become a kind of source reef, which means that the fish go there, produce and then go off to replenish other areas that are degraded,” says Mr Chou.

### Shifting mindsets

R2R programmes offer a new perspective on the role of the offshore petroleum industry in ocean sustainability. The programme no longer pits “Big Oil” against marine conservation groups, rather positions them as a partner in their efforts to promote sustainability. “But stakeholders need to come together and reach an agreement,” says Mr Chou.

He claims oil and gas industries are willing, and Petronas is a case in point, but ecological uncertainties are holding them

back. Additional research on existing R2R programmes will go a long way. Discussions must also address the question of liability—if oil wells leak, oil and gas companies must be financially liable and charged with repair and restoration.

“We need to really be thinking out of the box, as this is one case where I see a lot of ecological benefits rather than destruction,” asserts Mr Chou. “It would be an effort that requires local government commitment, the NGOs, the business sector, and also the coastal communities in the surrounding area.” The opportunity to replicate the programme in other parts of South-east Asia and the Indian Ocean Rim is high, especially around productive coastal habitats such as coral reefs and seagrass meadows.

Of course, not all rigs qualify for artificial reefs and the idea of using oil platforms as reefs is unpalatable to some. Research from Youna Lyons, senior research fellow at the Centre for International Law at the National University of Singapore, summarises the sentiment worldwide: while operators and ocean experts in the US are more receptive to R2R, the general sentiment in Europe is that it is “disguised dumping”.<sup>142</sup> Many are unconvinced of its potential and others feel that leaving these metallic structures in the water is not ecologically sound. Further assessment of existing projects, such as the one in Borneo and those led by Petronas, are required to be conclusive.

140 S Jagerroos and P R Krause, Rigs-To-Reef; Impact or Enhancement on Marine Biodiversity, *J Ecosys Ecograph*, 2016, <https://www.omicsonline.org/open-access/rigstoreef-impact-or-enhancement-on-marine-biodiversity-2157-7625-1000187.php?aid=7448>

141 Matador Network, Rigs to Reef: Transecting Borneo, <https://www.youtube.com/watch?v=J0IG8R6ymrI>

142 Y Lyons, Prospects for Rigs to Reef in Southeast Asia: Regional Workshop Findings and Recommendations, [https://cil.nus.edu.sg/wp-content/uploads/2015/08/YounaLyons-Bandung2015\\_ProspectsforR2RinSEA-1.pdf](https://cil.nus.edu.sg/wp-content/uploads/2015/08/YounaLyons-Bandung2015_ProspectsforR2RinSEA-1.pdf)

## CASE STUDY 3

**Canary in the deep-sea mine: India's early steps towards mining the ocean floor****Case summary**

- In 2002, the International Seabed Authority (ISA) granted a 15-year exploration claim to the government of India for polymetallic nodules in the Central Indian Ocean Basin (CIOB). Last year, this exclusive claim was extended until March 2022.
- One condition of the Indian government's right to mine the deep sea floor is that it must conduct yearly environmental impact assessments.
- Concern for the environmental impact of deep-sea mining is shaping the development of mining technology.
- National Institute of Ocean Technology is currently developing a system for mining polymetallic nodules in the CIOB. The system consists of a 12 tonne "crawler" vehicle that collects and processes mineral deposits from the sea floor (6 km below the surface) and pumps the collected material up to a ship on the surface.

The deep sea, meaning water with depths below 200 metres, covers nearly 65% of the Earth's surface.<sup>143</sup> Buried beneath the floor of the deep sea are vast unexploited metallic and non-metallic mineral deposits<sup>144</sup> that are increasingly important for development opportunities and sophisticated applications in automobiles,<sup>145</sup> information technology and clean energy.<sup>146</sup>

India was early to recognise the economic value of these deep sea resources. "We started with this issue way back in 1987," explains Madhavan Rajeevan, secretary to India's Ministry of Earth Sciences. "India has been given a pioneering investor status by the UN."

Back in 2002, the International Seabed Authority (ISA) granted a 15-year exploration claim to the government of India for polymetallic nodules in the Central Indian Ocean Basin (CIOB). Last year, this exclusive claim was extended until March 2022.<sup>147</sup> In September 2016 the ISA entered into another 15-year contract with the government of India for the exploration of polymetallic sulphides (also called black smokers) in the Southwest Indian Ridge.<sup>148</sup>

The estimated polymetallic nodule resource potential in the CIOB is 380m tonnes, containing 4.7m tonnes of nickel, 4.3m tonnes of copper, 0.55m tonnes of cobalt and 92.6m tonnes of manganese, which are expected to be ready for exploitation in 10-15 years.<sup>149</sup> "Nickel is an important component for steelmaking and cobalt is important for magnets, cancer therapy and a lot of medical uses," explains M A Atmanand, director at National Institute of Ocean Technology (NIOT), an autonomous body of the earth sciences ministry. "We have to import these at a high cost, so in the future it will definitely be required that we should have our own source of cobalt and nickel." But from an initial area of over 75,000 sq kilometres allocated to India for deep-seabed exploration of polymetallic nodules, just 7,860 sq kilometres has so far been identified as economically viable for mining.

143 Woods Hole Oceanographic Institute, Seafloor Mining, <https://www.whoi.edu/main/topic/seafloor-mining#>

144 Woods Hole Oceanographic Institute, Deep-sea Mining FAQ, <http://www.whoi.edu/page.do?pid=157656>

145 OCEAN ATLAS: Facts and Figures on the Threats to Our Marine Ecosystems, Heinrich Böll Foundation Schleswig-Holstein, the Heinrich Böll Foundation (national foundation), and the University of Kiel's Future Ocean Cluster of Excellence, Kiel, 2017

146 ICUN, Deep-sea mining, <https://www.iucn.org/resources/issues-briefs/deep-sea-mining>

147 Press Information Bureau, Government of India, India's Exclusive Rights to Explore Polymetallic Nodules from Central Indian Ocean Seabed Basin Extended by Five Years, <http://pib.nic.in/newsite/PrintRelease.aspx?relid=170138>

148 [https://www.isa.org/jm/deep-seabed-minerals-contractors?qt-contractors\\_tabs\\_alt=1#qt-contractors\\_tabs\\_alt](https://www.isa.org/jm/deep-seabed-minerals-contractors?qt-contractors_tabs_alt=1#qt-contractors_tabs_alt)

149 "National Mineral Policy (For non - fuel and non - coal minerals)." Government of Indian Ministry of Mines, 2008.

## Proceeding with caution

In extracting resources from the deep sea, the likely ecological impact of deep-sea mining must be better understood. Data from the General Bathymetric Chart of the Oceans shows that the Indian Ocean region is a biodiversity hotspot and an Ecologically or Biologically Significant Area.<sup>150</sup> Commercial exploitation or extraction of the deep seabed could have extreme ecological impacts if done irresponsibly and unsustainably. “When we do the exploration, we have to be really careful on [its] impact for the environment,” says Mr Rajeevan.

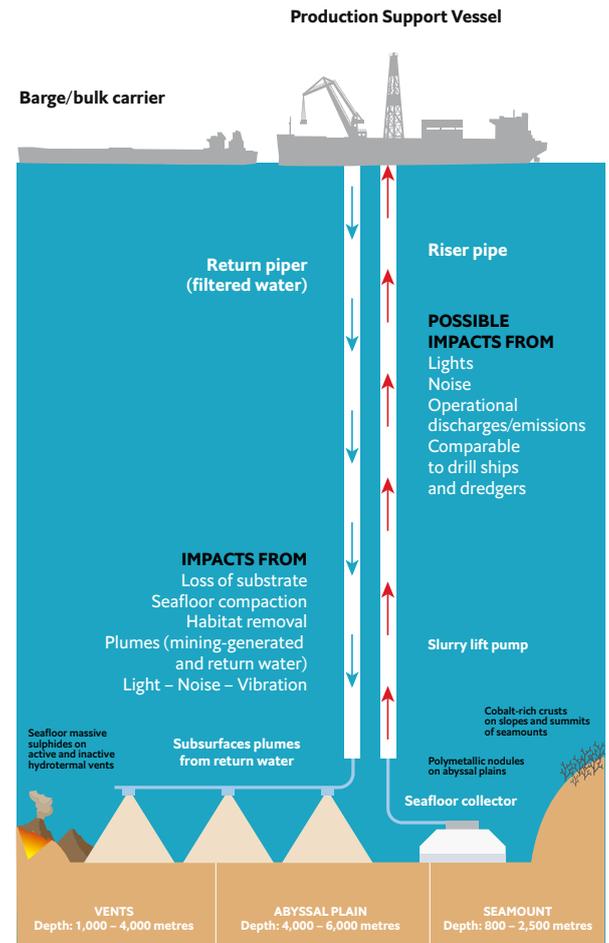
According to a 2017 brief by the International Union for Conservation of Nature, potential negative outcomes from activities related to deep-sea mining include toxic waste spills, noise and light pollution; physical disturbance of the seafloor; and sediment plumes or clouds, which result from the dispersal of seafloor sediment. The impact of those outcomes on local species and ecosystems is yet to be fully understood.<sup>151,152</sup>

One condition of the Indian government’s right to mine the deep sea floor is that it must conduct yearly environmental impact assessments. “If you start deep-sea mining commercially, you’re going to affect the ecosystem of the deep ocean, unfortunately. The ISA will allow us to [do this] commercially, only after we have done enough assessments to take care of the ocean and the ocean ecosystem. So every year we conduct environmental studies and submit a report to the ISA for review,” Mr Rajeevan explains.

## Technology for marine protection

Concern for the environmental impact of deep-sea mining is shaping the development of mining technology. “We

## Potential impacts from deep-sea mining



Source: ICUN, <https://www.iucn.org/resources/issues-briefs/deep-sea-mining>

need to develop mining technology [so that it] doesn’t really affect the environment,” says Mr Rajeevan.

The technology required to mine the deep-sea environment, which is characterised by very high pressure, very low temperature and very soft soil,<sup>153</sup> is still in development. “This technology is not commercially

150 GEBCO, <https://www.gebco.net/>

151 H J Niner et al, Deep-Sea Mining With No Net Loss of Biodiversity — An Impossible Aim, 2018, *Frontiers*, <https://www.frontiersin.org/articles/10.3389/fmars.2018.00053/full>

152 O. O. F. D. Mining and E. S. G. Risks, “Opportunities of deep-sea mining and esg risks,” no. August, 2017]

153 NIOT, Deep Sea Mining, <https://www.niot.res.in/index.php/node/index/33/>

available so we need to develop it ourselves,” explains Mr Rajeevan. It requires unique considerations too, as “unlike shallow waters, the organisms that are there are quite different and are few in number because of the absence of light and oxygen,” says Mr Atmanand.

NIOT is currently developing a system for mining polymetallic nodules in the CIOB. The system consists of a 12 tonne “crawler” vehicle that collects and processes mineral deposits from the sea floor (6 km below the surface) and pumps the collected material up to a ship on the surface. A critical environmental consideration has been minimising the plume of silt kicked up by the crawler. “It moves on the sea bed and the collection system is like a potato harvesting machine,” explains Mr Atmanand. “And so the disturbance to the benthic organisms at that depth is minimal.” The system is due to be ready for demonstration in 2020.

India’s early interest in deep-sea mining means that it is confronting many emerging technological and environmental challenges. As such, it is developing knowledge that is of increasing value to other ocean-bordering countries. Indeed, another condition of its agreement with the ISA is that it provides free training to neighbouring countries. India’s progress will therefore be especially influential in the future of deep-sea mining in the ocean that bears its name.

# Chapter 5: Rising salinity from desalination

Water security is a chief concern for many countries around the world, particularly arid regions with scarce groundwater resources and low rainfall. In some regions, despite high precipitation and abundant groundwater, withdrawals are taking place at unsustainable levels and are contributing to a growing water crisis. Across the world too, climate change has led to extreme weather conditions, including prolonged drought. The World Bank estimates that 2.1bn people do not have access to safely managed water, over 800m of whom do not even have access to basic drinking water.<sup>154</sup> Many of them, unsurprisingly, live in countries surrounding the Indian Ocean Rim. Forecasts suggest that among the hardest hit from growing water scarcity will be countries in East Africa as well as the Middle East (where water is already in short supply).<sup>155</sup>

To address this, countries are applying techniques to optimise water usage and, where possible, expand water supply. Among the more expensive and energy-intensive techniques is water desalination. Global desalination capacity is estimated at 90m cu metres/day of water.<sup>156</sup> In the Indian Ocean Rim, countries such as the UAE, Australia, Singapore and India have desalination plants, although the UAE leads with a capacity of over 7m cu metres/day<sup>157</sup> compared with roughly 1.4m cu metres/day in Australia<sup>158</sup> and 500,000 cu metres/day in Singapore.<sup>159</sup> South Africa, facing an impending water crisis as a result of drought conditions, recently set up its first desalination plant and is expected to expand capacity in the coming years.<sup>160</sup>

Lower oil prices and renewable options to power desalination plants may make the process more feasible for some countries. There are many planned projects in the Indian Ocean Rim countries. Oman has desalination projects in the pipeline with a total capacity of 1.9m cu metres/day.<sup>161</sup> Singapore is hoping that desalinated water can meet 30% of its future water needs by 2060, up from 25% today.<sup>162</sup> “Necessity is driving desalination growth,” says Wendell Ela, professor of desalination and water treatment at Murdoch University, Australia. “You cannot conserve yourself out of water scarcity. Conservation just saves water, it doesn’t make water.”

A growing desalination market brings some of the environmental concerns to the fore. There are two leading approaches to commercial desalination. Thermal desalination requires saline water to be heated to high temperatures to produce water vapour, which is then condensed to produce desalinated water. Desalination using membrane technology entails using semipermeable materials to separate water from the salt. In both cases, concentrated brine is left over (which can include chemicals added during the process), often discharged into the ocean. In the waters surrounding the plant, this can contribute to increased water salinity, adversely impacting marine life and habitats.

154 World Bank, Water, <http://www.worldbank.org/en/topic/water/overview>

155 World Bank, High and Dry: Climate Change, Water, and the Economy, <http://www.worldbank.org/en/topic/water/publication/high-and-dry-climate-change-water-and-the-economy>

156 International Water Summit, Energy Efficient Desalination, [https://www.internationalwatersummit.com/\\_\\_\\_media/Energy-Efficient-Desalination-2018.pdf](https://www.internationalwatersummit.com/___media/Energy-Efficient-Desalination-2018.pdf)

157 Ibid

158 Australian Water Association, Desalination Fact Sheet, [http://www.awa.asn.au/AWA\\_MBRR/Publications/Fact\\_Sheets/Desalination\\_Fact\\_Sheet.aspx](http://www.awa.asn.au/AWA_MBRR/Publications/Fact_Sheets/Desalination_Fact_Sheet.aspx)

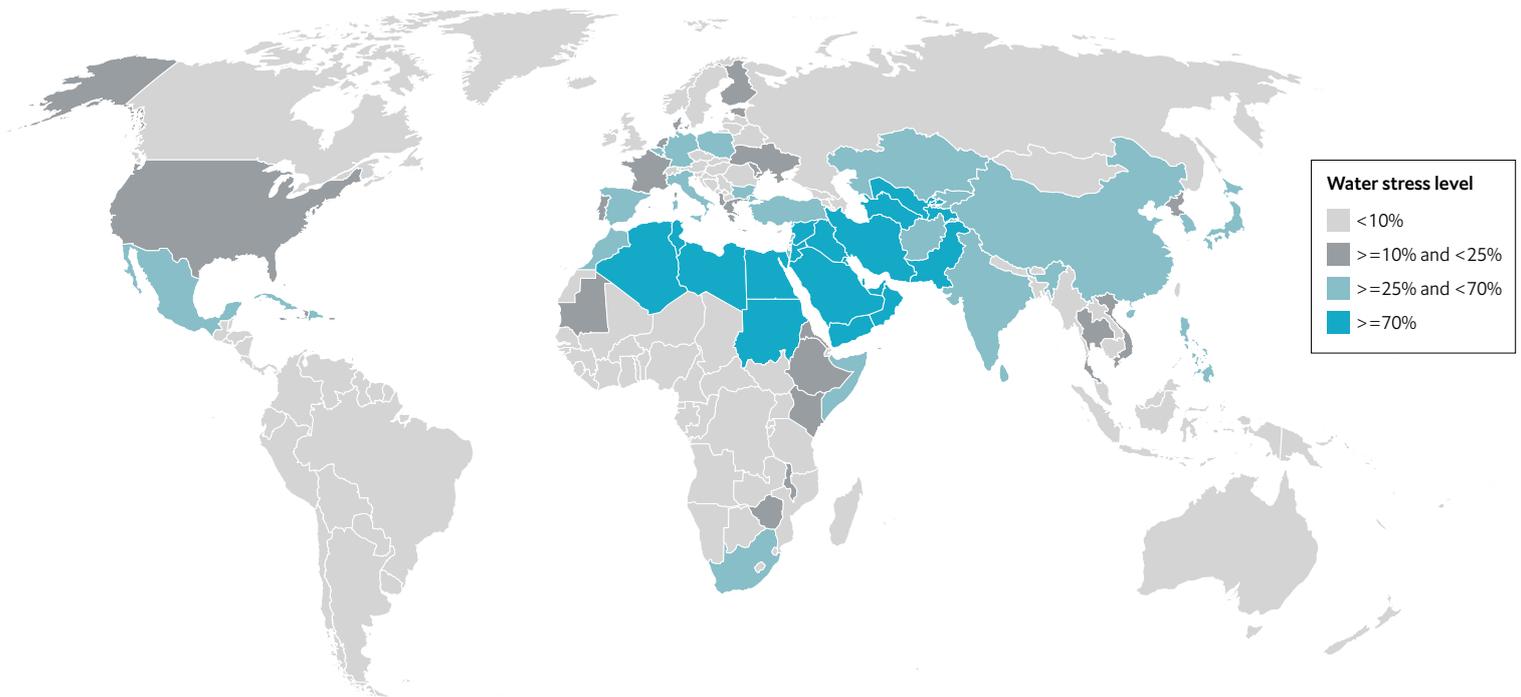
159 PUB, Desalinated Water, <https://www.pub.gov.sg/watersupply/fournationaltaps/desalinatedwater>

160 Times Live, Cape Town’s first desalination plant comes online, May 21st 2018, <https://www.timeslive.co.za/news/south-africa/2018-05-21-cape-towns-first-desalination-plant-comes-online/>

161 International Water Summit, Energy Efficient Desalination, [https://www.internationalwatersummit.com/\\_\\_\\_media/Energy-Efficient-Desalination-2018.pdf](https://www.internationalwatersummit.com/___media/Energy-Efficient-Desalination-2018.pdf)

162 PUB, Desalinated Water, <https://www.pub.gov.sg/watersupply/fournationaltaps/desalinatedwater>

## Sustainable Development Goal indicator 6.4.2: water stress



Source: FAO. <http://www.fao.org/sustainable-development-goals/indicators/642/en/>

Water stress level is defined as the ratio between total freshwater withdrawn by major economic sectors and total renewable freshwater resources, after taking into account environmental water requirements.

This problem is particularly acute in the semi-enclosed Arabian Gulf.<sup>163</sup> Research in the region finds that for every 1 cu metre of desalinated water, 2 cu metres of brine is produced.<sup>164</sup>

The result has been increasing salinity in local waters by around 5-10 parts per million,<sup>165</sup> such that the Arabian Gulf is now 25% saltier than normal seawater<sup>166</sup> although “the impact of high evaporation rates resulting from high temperatures in the region on salinity is also significant,” explains Bruce Smith, acting director of planning and

studies at ADWEC, a government utility company in the UAE. According to one study, at current rates, brine discharge from desalination will continue to increase salinity in the Gulf. It is estimated that brine discharge will increase the salinity by 2.24 grams per litre by 2050, unless more sustainable initiatives are implemented.<sup>167</sup>

Most marine organisms can adapt to minor changes in salinity and temperature and some can tolerate extreme changes temporarily, but sustained exposure will lead to significant degradation.<sup>168</sup> As discharge from desalination is

163 A Areiqat, Optimization of the negative impact of power and desalination plants on the ecosystem, doi:10.1016/J.DESAL.2005.04.038

164 M Dawoud, Environmental Impacts of Seawater Desalination: Arabian Gulf Case Study, 2012, *International Journal of Environment and Sustainability*, <https://www.sciencetarget.com/Journal/index.php/IJES/article/view/96>

165 Ibid

166 <https://www.theguardian.com/global-development-professionals-network/2016/sep/29/peak-salt-is-the-desalination-dream-over-for-the-gulf-states>

167 R A I Bashitishaaer, Estimated future salinity in the Arabian gulf, the Mediterranean sea and the Red sea consequences of brine discharge from desalination, 2011, *International Journal of Academic Research*

heavier than seawater and sinks to the seafloor, the damage is greater to seagrasses, which in turn impacts marine organisms that depend on the habitat.<sup>169,170,171</sup> Research has shown a decrease in species diversity in the Arabian Gulf and significant changes to the phytoplankton community.<sup>172,173</sup> Research conducted in the Red Sea showed a negative impact on the physiology of three species of corals.<sup>174</sup> In the Arabian Gulf, experts indicate that the water is approaching peak salinity, beyond which it will no longer be economically viable to desalinate the water.

An important point to note is that ocean-wide change in salinity is highly variable based on depth, circulation levels and evaporation, among others. “The issue of rising water salinity therefore must be taken with a pinch of salt and must be viewed as a local issue, not a global one,” explains Mr Ela.

There are two main approaches to reducing water salinity from desalination—one is to manage brine discharge and the other is to repurpose brine discharge on land. Our first case study focuses on the former, looking at sustainable practices adopted by a desalination plant in Perth, Australia. The second and third case studies focus on the latter, exploring how brine is repurposed for modular farming in the UAE and agriculture and salt production in Somaliland.

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**In the Indian Ocean Rim, countries such as the UAE, Australia, Singapore and India have desalination plants, although the UAE leads with a capacity of over 7m cu metres/day compared with roughly 1.4m cu metres/day in Australia and 500,000 cu metres/day in Singapore**

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- 168 M L Cambridge et al, Effects of high salinity from desalination brine on growth, photosynthesis, water relations and osmolyte concentrations of seagrass *Posidonia australis*, 2017, *Marine Pollution Bulletin* <https://www.sciencedirect.com/science/article/pii/S0025326X16309869>
- 169 AGEDI. 2016. Final Technical: Regional Desalination and Climate Change. LNRCCP. CCRG/IO
- 170 H Frank et al, Short-term effects of SWRO desalination brine on benthic heterotrophic microbial communities, 2017, *Desalination*, <https://www.sciencedirect.com/science/article/pii/S0011916416321749>
- 171 K L Petersen, Impact of brine and antiscalants on reef-building corals in the Gulf of Aqaba – Potential effects from desalination plants, 2018, *Water Research*, <https://www.sciencedirect.com/science/article/pii/S0043135418305414>
- 172 T A Said et al, Salinity-driven decadal changes in phytoplankton community in the NW Arabian Gulf of Kuwait, <https://link.springer.com/article/10.1007/s10661-017-5969-4>
- 173 H Naser, Effects of multi-stage and reverse osmosis desalinations on benthic assemblages in Bahrain, Arabian Gulf, 2013, *Journal of Environmental Protection*, <https://www.scrip.org/journal/PaperInformation.aspx?PaperID=28320>
- 174 K L Petersen, Impacts of seawater desalination brine on coastal environments, <https://cloudfront.escholarship.org/dist/prd/content/qt2485h8pc/qt2485h8pc.pdf?t=p3qtlm>

## CASE STUDY 1

## Salinity down under: sustainable desalination practices from Perth, Australia

### Case summary

- The Perth desalination plant sits on the edge of Cockburn Sound, a shallow inlet of the Indian Ocean that experiences limited water circulation. Protecting the marine environment was a priority from the beginning.
- Effective management of brine is key and techniques for dispersion and dilution were applied.
- For dispersion, the plant in Perth is fit with a pipe, nearly half a kilometre long, that extends offshore. The deeper into the ocean the brine is discharged, the better the circulation of the solution with the ocean. Another approach is to treat the brine before it is discharged.
- Despite being well-known techniques for effective brine management, all this adds to project costs, and so many take shortcuts. Every desalination project should start with a robust environmental impact study, which must serve as a guide across plant design, operations and, most importantly, the ongoing monitoring and evaluation of the impact on the marine environment.

Between 1997 and 2009 Australia experienced a severe water crisis across much of the country as a result of “The Millennium Drought”. Western Australia in particular continues to experience increasingly arid climatic conditions—rainfall run-off in Perth dams has dropped over 90% over the past century.<sup>175</sup> A combination of increased water usage, underpinned by population growth, and lower

rainfall created a water crisis that spurred the Australian government into action.

The US\$280m Perth Seawater Desalination Plant in Kwinana opened in 2006, as one among many initiatives to address the water crisis. The plant supplies 18% of the city’s total water supply, amounting to roughly 120,000 cu metres/day.<sup>176</sup> “As part of the cost-benefit analysis, they considered importing water from the tropics where they have monsoons but the infrastructure costs were far higher than desalination,” explains Mr Ela, who has studied the desalination plant. There are plans to build two more seawater desalination plants to the north and south of Perth to protect the city’s water supply as the population continues to grow.<sup>177</sup>

The Perth desalination plant sits on the edge of Cockburn Sound, a shallow inlet of the Indian Ocean that experiences limited water circulation.<sup>178</sup> The surrounding community relies on this inlet for fishing activities, mussel farming and recreational diving. Protecting the marine environment was therefore a priority from the beginning.

Since operations commenced more than a decade ago, efforts to protect Cockburn Sound have been successful.<sup>179</sup> But a host of sustainable practices adopted have made this possible.

### All about the engineering

“There are plants around the world where the discharge from the desalination plant has not been as well engineered, creating some of the issues in the surrounding marine environment,” says Mr Ela. “It really is an engineering game.” Effective management of brine is key and techniques for dispersion and dilution need to be applied.

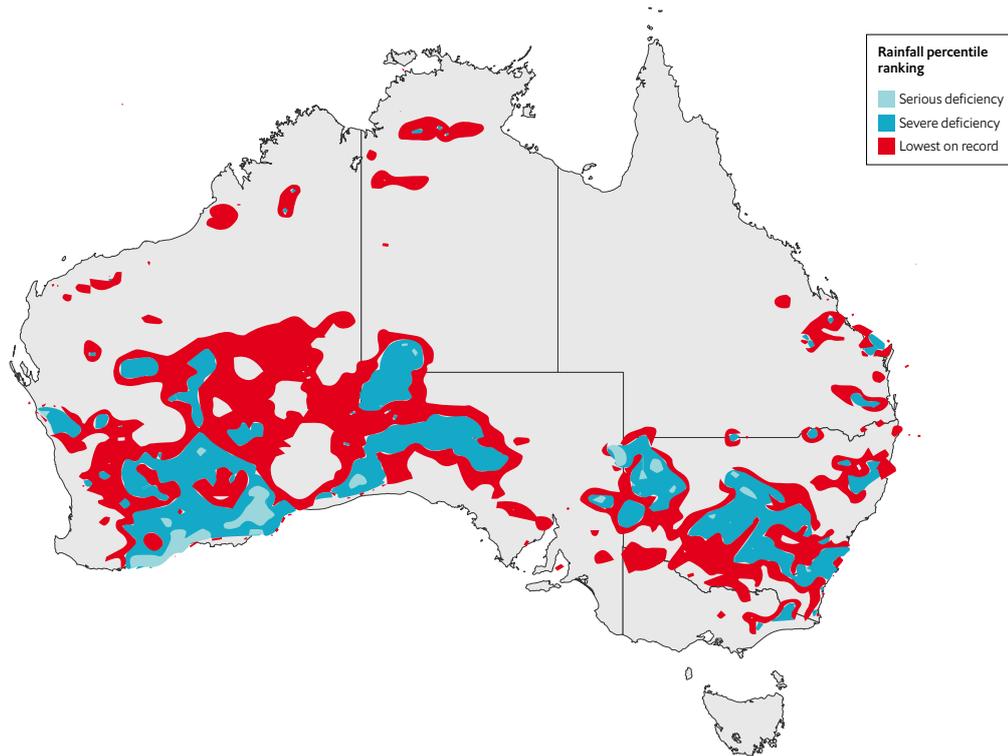
175 ABC, Desalination plant deemed vital for Perth water seen as mere costly insurance in Sydney as climate gets drier, February 13th 2018, <http://www.abc.net.au/news/rural/2018-02-13/seawater-you-are-drinking-it-debate-over-desalination/9422632>

176 Water Corporation, Perth Seawater Desalination Plant, <https://www.watercorporation.com.au/water-supply/our-water-sources/desalination/perth-seawater-desalination-plant>

177 Water Corporation, Desalination, <https://www.watercorporation.com.au/water-supply/our-water-sources/desalination>

178 Pacific Institute, Key Issues in Seawater Desalination in California, <http://pacinst.org/wp-content/uploads/2013/12/desal-marine-impacts-full-report.pdf>

### Three-month drought map of Australia, March-May 2018



Source: Australian Bureau of Meteorology, 2018

For dispersion, the plant in Perth is fit with a pipe, nearly half a kilometre long, that extends offshore. The deeper into the ocean the brine is discharged, the better the circulation of the solution with the ocean (compared with the limited circulation in the inlet). “But the trick is how you mix it in the ocean water,” explains Mr Ela. “Brine is denser than the water out there, so if you release it slowly, it’ll just sink to the bottom and form a layer of salt.” Diffusers attached to the pipe carrying the brine offshore facilitate dispersion. At the plant in Perth, the 40-port diffuser placed towards the end of the pipe allows the brine to enter the ocean at a higher velocity, which enables better mixing.

Another approach is to treat the brine before it is discharged. The integration of desalination plants with

power plants presents an opportunity for this. “If you combine cooling water from the power plant with brine from desalination, you automatically dilute it,” explains Mr Ela. “The power plant generates more water than the desalination plant so it will be diluted effectively. This can be mixed in the pipe as it is sent offshore.” However, with desalination plants increasingly being powered by renewable energy sources, a process that does not generate wastewater as thermal power generation does, this option may not be available for future projects.

Despite being well-known techniques for effective brine management, all this adds to project costs, and so many take shortcuts, admits Mr Ela. Mr Smith of ADWEC reiterates: “If, for instance, a 2 km [pipe offshore] needs to be built, then that needs to be

specified. Of course, [developers] won't do that unless an environmental assessment highlights the need for it." Environmental impact assessments therefore have an important role to play.

### **Monitor, monitor, monitor**

In fact, every desalination project should start with a robust environmental impact study, which must serve as a guide across plant design, operations and, most importantly, the ongoing monitoring and evaluation of the impact on the marine environment. In Perth, a survey was conducted six months before the plant was operational, to map the state of marine habitats, such as seagrasses, and other forms of marine life. This has been valuable in delivering an evidence-based assessment of the impact of desalination on the marine environment. The plant undertakes continuous, real-time monitoring of the quality of water entering and leaving the plant, in addition to routine marine monitoring at various locations in Cockburn Sound to ensure that there are no adverse environmental impacts on the marine environment.

Conditions set out in the operating permit, for dilution levels from the brine discharge, for instance, have strengthened measurement, enforcement and ultimately marine protection. In 2008 a drop in oxygen levels below permissible limits required plant production to be reduced temporarily.<sup>180</sup> Results from monitoring in 2016 were positive, showing that dilution was well over the target dilution and salinity was within allowable limits.<sup>181</sup> The 2016 annual benthic health monitoring of seagrass conducted by Murdoch University showed that the median shoot density increased at all four of the Northern Reference sites when compared with 2015 results.<sup>182</sup>

As countries around the Indian Ocean explore options for desalination, sustainability considerations must be a core component of the agenda. A challenge is that research on the impacts of rising salinity from desalination is limited, making it harder to convince governments and operators to bear the additional costs of long pipes out to the ocean and continuous monitoring. Involving marine experts in conversations about reducing brine discharge and improving dilution techniques is important. Emerging technologies enabling better marine observation may also generate cost savings. Effective monitoring has proven Perth's success in preserving the marine environment.

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**“There are plants around the world where the discharge from the desalination plant has not been as well engineered, creating some of the issues in the surrounding marine environment. It really is an engineering game.”**

**Wendell Ela, professor of desalination and water treatment at Murdoch University, Australia**

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179 Ibid

180 <https://pacinst.org/wp-content/uploads/2013/12/desal-marine-impacts-full-report.pdf>

181 Water Corporation, Southern Seawater Desalination Plant Marine Environment Monitoring Annual Report, <https://www.watercorporation.com.au/-/media/files/residential/water-supply/desalination/ssdp/ssdp-memp-annual-report-jan2016-jan2017.pdf>

182 Ibid

## CASE STUDY 2

## From brine to fork: using brine from desalination in modular farming in the UAE

### Case summary

- One component of the modular farm focuses on using reject brine for fish farming; the wastewater from the fish farm is then used to grow halophytes with and without soil (in a process known as aquaponics).
- A US\$100,000 grant from Dubai's Expo 2020 Innovation Awards supported the most recent phase of the project.
- Output for one crop type increased from eight tonnes per ha (when just using saline water) to 24 tonnes per ha (using nutrient-rich water from fish farms). The average weight of one fish species grown in reject brine increased threefold from the previous season
- Crop diversity in a farm enhances the overall ecosystem and make farms less vulnerable to climate change risks

Arid climatic conditions in the UAE have constrained local agricultural production and fuelled the country's reliance on food imports. Today, the UAE imports more than 90% of food consumed in the country.<sup>183</sup> As part of its food security strategy, the government has been actively pursuing a range of options—from land acquisition abroad (for secure food sources) to expanding local agriculture.

In parallel, to ensure adequate water supply in the country, a number of desalination plants have been set up. The UAE has a desalination capacity of roughly 7m cu metres/day (although these do not operate at peak capacity). However, brine discharged into the sea from desalination facilities in the Arabian Gulf has contributed to rising salinity in the surrounding waters and there is

evidence, albeit limited, of a resulting adverse impact on marine life in the region. In addition, brine discarded on land from small-scale desalination on the few farms in the UAE have contributed to rising groundwater salinity, adversely affecting soil quality.

To hit two birds with one stone, experiments are under way to repurpose reject brine from desalination for agriculture. This is taking place as part of a "modular farming" project in the UAE, led by the International Center for Biosaline Agriculture (ICBA), an international agricultural research organisation. A modular farm consists of various components that use by-products of other industries or each other and is reflective of growing circular economy thinking in the food and agricultural industry. "Where there are limited fresh water sources, modular farming systems create a wealth of products utilising low-quality water and soil," says Dionysia Angeliki Lyra, project lead and agronomist at the ICBA in the UAE.

### A saltwater agricultural system

Ms Lyra is a halophyte agronomist. The word is derived from the ancient Greek word for salt and refers to a plant species that requires highly saline water for its growth. One component of the ICBA's farm focuses on using reject brine for fish farming; the wastewater from the fish farm is then used to grow halophytes with and without soil (in a process known as aquaponics). By combining components, modular farms can use marginal land to provide protein and other nutrients with better water efficiency. The aim is to develop a saltwater-based agricultural system in which farmers can irrigate salt tolerant crops with low-quality water in a sustainable and economical manner.

A US\$100,000 grant from Dubai's Expo 2020 Innovation

183 The National, The UAE goes Dutch to ensure their food security, April 1st 2018, <https://www.thenational.ae/uae/government/the-uae-goes-dutch-to-ensure-their-food-security-1.717923>

Awards supported the most recent phase of the project. Results published by the ICBA have been remarkable. Output for one crop type increased from eight tonnes per ha (when just using saline water) to 24 tonnes per ha (using nutrient-rich water from fish farms).<sup>184</sup> The average weight of one fish species grown in reject brine increased three-fold from the previous season.<sup>185</sup> Ms Lyra also described a reduction in fish feed—from 2 kg to 1.1 kg of feed for every kilogram of fish—as well as man-hours on the project.

One species of halophytes they are developing, *salicornia*, has multiple uses. The tips of the plant are vegetables, while the rest can be used as animal fodder, and its seeds for oil production. “We have also been using *salicornia* in other foods, such as bread and crackers,” explains Ms Lyra.

Other strains grown at the ICBA include wild barley strains that successfully grew in poor-quality soil, under high temperatures and irrigated with saline water. The team has located the genetic location responsible for the plant’s stress tolerance and are now crossing it with commercial barley strains.

Modular farming offers financial benefits too. “Farmers produce fish, livestock, vegetables and so have multiple products to sell.” Ms Lyra explains that such crop diversity in a farm enhances the overall ecosystem and make farms less vulnerable to climate change risks: “When you have an integrated farm and grow different crops, one crop is more heat-tolerant or drought-tolerant, compared to the other. You do not have a mono-culture system where the farmer’s entire income is [dependent on a single crop and therefore at greater] risk.”

## UAE and beyond

An important part of Ms Lyra’s plans is to create more opportunity for the use of halophytes in people’s diets. “I’m planning to increase the spectrum on halophytes for human consumption, exploring more uses, and even for animal feedstock.” This project is looking at additional ways to incorporate *salicornia* into more food products—they have hired chefs to experiment with this plant and create new recipes.

While the project is currently limited to the UAE, Ms Lyra hopes to expand to other countries with similar characteristics such as Egypt, Jordan, Tunisia and Morocco. There are valuable lessons in farm productivity, particularly around fish and vegetable production in water scarce regions.

To scale and sustain this programme, efforts need to be made beyond the farm and across the food value chain. Locating farms next to urban centres provides easy market access and lowers transport costs. In turn, this lowers the industry’s carbon footprint, contribution to climate change and ultimately the adverse impact on ocean health too. In this way, the story of this modular farming project in the UAE not only addresses an ocean issue that is significant to the Arabian Gulf—by repurposing brine from desalination that would otherwise be discharged into the ocean—but also provides an example of the broader contribution to emissions and climate change that the ocean community needs to work towards.

184 ICBA, Tapping the potential of reject brine from desalination, <https://www.biosaline.org/news/2017-11-20-6318>

185 ICBA, ICBA scientists manage to increase fish biomass by 300% using reject brine, <https://www.biosaline.org/news/2018-06-07-6506>

## CASE STUDY 3

**Seawater Greenhouse: worth its salt?****Case summary**

- Seawater pumped into the system is allowed to evaporate and is used to cool and humidify the greenhouse, reducing the amount of water required for irrigation. In this way, Mr Paton believes, water vapour makes a greater contribution than freshwater.
- The concentrated brine left over from the process is pumped into a brine tank for salt production.
- Such production creates additional opportunities for incomes for farmers, supplying much-needed salt to markets in Somaliland and East Africa
- Completing the value chain will be essential, particularly if salt production is fragmented in multiple facilities across farms. This will entail establishing a robust system for collection, setting up salt processing and packaging facilities, and finally creating efficient distribution channels to the end-consumer.

Food insecurity is high on the agenda in Somalia. High temperatures, low rainfall, poor soil conditions and insufficient groundwater resources have meant that local agricultural production is limited. As of May 2018 2.7m people, nearly one in five in Somalia, were unable to meet daily food requirements. Another half a million more are on the brink of famine, according to the UN.<sup>186</sup> The country has been heavily reliant on foreign aid, but some organisations involved in the rebuilding efforts want to take a different approach: creating programmes that are self-sustaining and suitable for Somalia's hot, dry climate.

Seawater Greenhouse, a UK technology company, is one such organisation. In partnership with the Pastoral and Environmental Network in the Horn of Africa and

Aston University in the UK, they are piloting a project to develop a "low-cost, rugged and modular" farm in the coastal city of Berbera, Somaliland, a self-declared autonomous region of Somalia.

Given the water scarcity in the region, seawater desalination is a core component of this project. "It enables year-round crop production in some of the world's hottest and arid regions by using seawater and sunlight," says Charlie Paton, founder and director of Seawater Greenhouse and the lead man on the ground. But unlike the large, sophisticated facilities in the Middle East and Australia, "it's the size of a washing machine and cost about £6,000," he says.

However, even the simplest forms of desalination have the same outcome: the process creates a by-product of concentrated brine, which is often discharged back into the sea and contributes to raising water salinity, particularly in semi-enclosed waters. "Seawater Greenhouse planned to convert these two seemingly intractable problems—a shortage of fresh water and brine discharge from desalination—into an elegant solution for crop cultivation, realising the value chain of salt, minerals and nutrients from seawater," says Mr Paton.

**Salt production from reject brine**

Data analysis of Berbera's climate data from Aston University informed the bespoke design for the greenhouse. One hectare of a greenhouse near a coast will typically evaporate 50 tonnes of water per day, but this increases by two to three times in regions of low humidity, like Berbera. Seawater pumped into the system is allowed to evaporate and is used to cool and humidify the greenhouse, reducing the amount of water required for irrigation. In this way, Mr Paton believes, water vapour makes a greater contribution than freshwater. The water

186 <http://www1.wfp.org/countries/somalia>

vapour is eventually filtered through a solar powered system to create fresh water, used for drinking and irrigation for a host of other essential crops.

This desalination process aims to produce only 20% of freshwater from the total volume of seawater that enters the system, explains Mr Paton, which is lower than industrial desalination rates of about 50%. “This is so that the [reject brine] is not too concentrated, so we won’t need any chemical treatment. There is no pre-treatment or post-treatment, which simplifies the whole process.”

The remaining 80% is recirculated in the system to a saturation point, after which it is pumped into a brine tank. “The brine tanks sit next to a salt shed, and we just allow the water to evaporate, creating salt.” Such production creates additional opportunities for incomes for farmers, supplying much-needed salt to markets in Somaliland and East Africa.

Completing the value chain will be essential, particularly if salt production is fragmented in multiple facilities across farms. This will entail establishing a robust system for collection, setting up salt processing and packaging facilities, and finally creating efficient distribution channels to the end-consumer.

### A challenging environment

Seawater Greenhouse has three other sites around the Indian Ocean Rim in the UAE, Oman and Australia, and across all these they have had to weather extreme climatic conditions, including a cyclone in Oman. Bearing this in mind, their team had extensive discussions on cost versus durability for the Berbera project. “If you want to make it withstand extreme conditions, it’s going to cost too much,” explains Mr Paton. “With this new design [in Somaliland], it’s a wooden pole and steel structure, which is unlikely to blow away, and is covered in net which is sown on to the structure. We haven’t lost any of the net, but we’ve had tears, which have been easy to fix.”

Politics and people presented additional challenges, but that’s just par for the course says Mr Paton. In Somaliland,

getting people to move from more traditional livelihoods (such as shepherds) to working in a greenhouse was particularly difficult.

With a relatively low price tag, the opportunities to replicate this project in water-scarce regions across the developing countries are aplenty, including parts of East Africa and India that experience hot and dry climatic conditions or are suffering from long periods of drought. “But if desalination is to grow in the region, there will be environmental consequences unless you manage the salt,” says Mr Paton.

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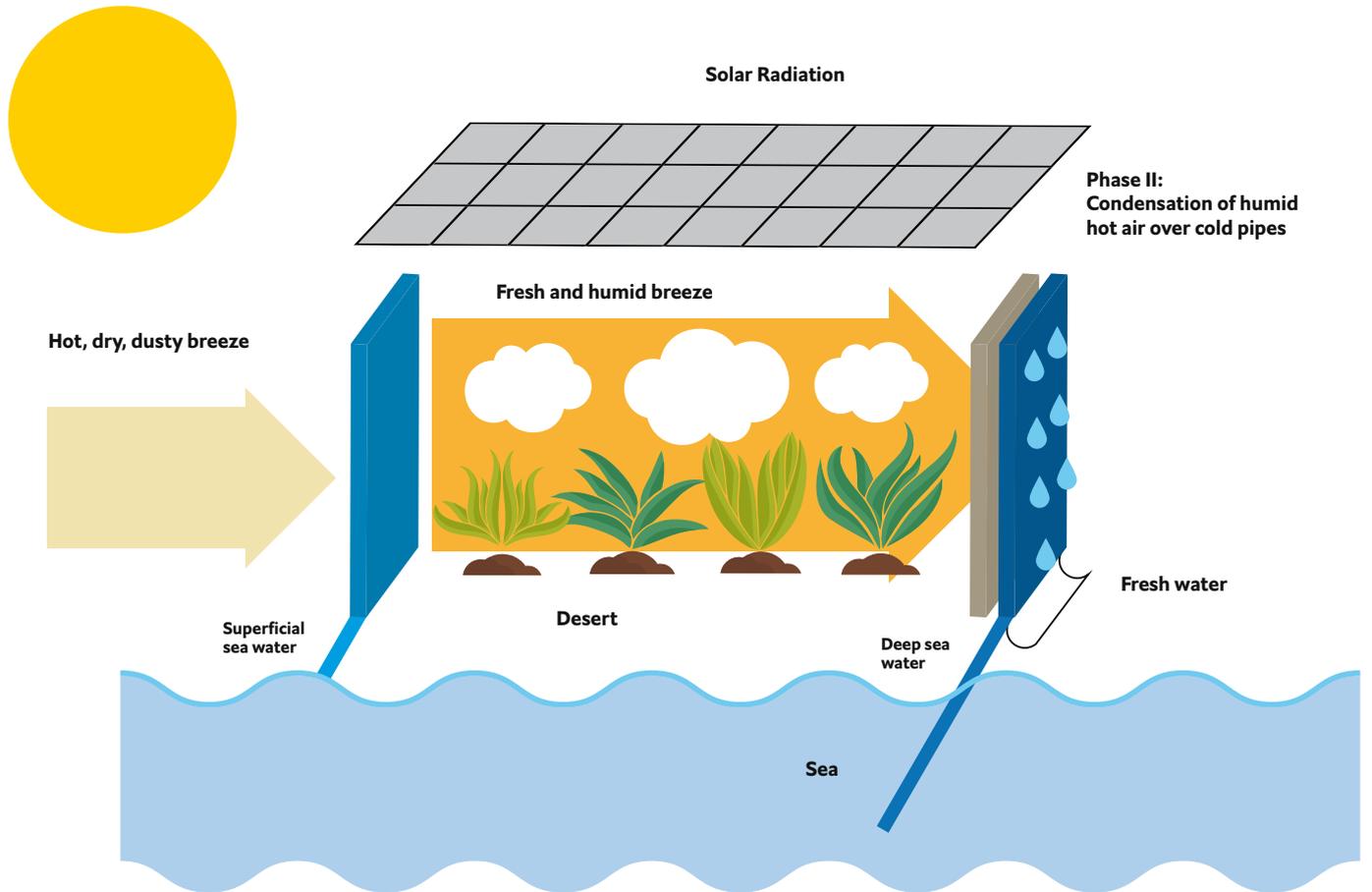
**“Seawater Greenhouse planned to convert these two seemingly intractable problems—a shortage of fresh water and brine discharge from desalination—into an elegant solution for crop cultivation, realising the value chain of salt, minerals and nutrients from seawater,”**

**Charlie Paton, founder and director of Seawater Greenhouse**

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Through this project, Seawater Greenhouse are attempting to demonstrate that desalination does not have to mean rising water salinity and, more importantly, that drought does not have to mean famine. Greater adoption of this technique that enables salt and agricultural production across the most water-stressed regions can enhance self-sufficiency, Mr Paton believes, and provide smallholder farmers with livelihoods largely resistant to climate change, while managing ocean health.

**A low-cost, rugged and modular farm**



Source: Mother Nature Network. <https://www.mnn.com/your-home/organic-farming-gardening/blogs/innovative-greenhouses-boost-agriculture-worlds-harshes-environments>

# Conclusion

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The Indian Ocean is at an exciting juncture where combining economic growth with marine ecosystem resilience is not only viable, but also fruitful. While at times the challenges can appear overwhelming, the preceding chapters have shown that these can be reframed as opportunities for the blue economy. In a southern state in India, plastics in the ocean are being collected and repurposed to build roads; in the Seychelles, a focus on ocean sustainability is creating new opportunities to raise finance for economic development; and in Thailand, seagrass conservation is strengthening conch production in some villages.

Thus, ignoring pressing ocean issues such as plastic pollution and unsustainable fishing not only increases the risks to the environment and people, but also means that opportunities for economic diversification and sustained, inclusive growth may be overlooked. “Nature and economic gain are no longer considered incompatible,” asserts Simon Dent, partner at Althelia Ecosphere, an impact investment fund.

In this concluding chapter we tie in the key learnings from the preceding chapters and present important steps on the road to ocean prosperity across three pillars—innovation, finance and governance. These need to come together to push through significant and broad-ranging interventions that will ensure resilience, competitiveness and sustained growth in this vast and varied region.

## Innovation

Organisations across the Indian Ocean Rim countries are addressing sustainability challenges in innovative ways.

Importantly, many of them recognise that land-based initiatives can also go a long way in addressing ocean issues: brine from desalination plants is being diverted into aquaculture and agriculture in the UAE<sup>1</sup> and being used for salt production in Somaliland;<sup>2</sup> Evoware, a social enterprise in Indonesia, has developed biodegradable food packaging made from seaweed to replace plastic packaging that often ends up in the ocean.

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**Importantly, many governments and organisations recognise that land-based initiatives can also go a long way in addressing ocean issues.**

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At community and individual levels, projects are incentivising behavioural change: micro-loans are given to women in Sri Lanka in exchange for protecting and replanting mangrove forests; health insurance in exchange for garbage in Indonesia; and shopping vouchers dispensed by garbage ATMs in Nairobi, Kenya.

Although these innovative approaches are encouraging, their impact is only likely to be significant if scaled to the national and international level. Information technology innovations can help to accelerate this. Illegal fishing is being dramatically reduced across Indonesia with open-source satellite data; and GPS technology significantly lowered the cost of

1 ICBA, <https://biosaline.org>

2 Seawater Greenhouse, Low-cost, rugged and modular, <https://seawatergreenhouse.com/somaliland/>

3 Coastal Oceans Research and Development (CORDIO), <http://cordioea.net>

mapping mangrove forests across Sri Lanka. Information technology also facilitates public engagement. CORDIO<sup>3</sup> has involved dive operators to record coral bleaching events through their online portal, and social media galvanised political will for the ban on plastic bags in Kenya.

Many of these solutions are being developed in the absence of formal policy frameworks and government incentives, arising purely to address a genuine need or challenge. But to foster innovation in the blue economy, a few critical gaps need to be plugged.

One is the information gap. Whether it is combating illegal fishing or plastic pollution in the ocean, data allow resources to be more targeted. Educational institutions and research organisations support data collection and provide the capacity base for innovations, spurring new developments. In the UAE, an initiative supported by Total, an oil and gas company, in association with the Convention on Migratory Species, has created a global dugong, seagrass, and communities research toolkit to help standardise international datasets and research methodologies, in the efforts to monitor and conserve dugongs and seagrasses. Fish-i Africa<sup>4</sup> allows Western Indian Ocean countries to share real-time intelligence on illegal fishing and target enforcement efforts. In India's National Institute of Ocean Technology (NIOT), crawler-based vehicles are being developed to harvest minerals for more sustainable deep-sea mining. These, in turn, have wider implications for other sectors to build on these innovations as they pursue ocean sustainability, suggests MA Atmanand, director of NIOT. "Similar to space exploration, deep-sea exploration has many spin-off technologies benefiting other sectors." Peter Myles, chairperson of the Nelson Mandela Bay Maritime Cluster (NMBMC), also recognises the opportunities of an academic service sector: "Nelson Mandela University has now formed a top-class Ocean Sciences Campus which is relevant for the whole of Africa."

Maritime clusters, or "blue clusters", such as the NMBMC, can also facilitate knowledge sharing and foster innovation.

"We're akin to a maritime incubator allowing sectors to cluster around a theme and collectively work to increase competitive advantage," says Mr Myles.

Critically, maritime clusters not only act as incubators for innovation, but they can also identify investable pipelines of projects. One of their main goals, Mr Myles explains, is to "build up what we have to offer in the way of bankable projects." However, the financing gap poses a broader challenge and our research has uncovered some valuable lessons for the Indian Ocean Rim countries.

## Finance

Government sources of finance have been the first port of call for sustainable ocean projects. But gaining traction on this front has proved difficult, as it not only required leadership from environment ministries but also the buy-in of the finance ministry. Sean Kidney, CEO of Climate Bonds Initiative, reiterates this point, "In my view, it is when these things are taken seriously that the Ministry of Finance is involved." Higher attendance from the finance ministry at climate change or ocean sustainability events is the signal to watch out for, he says.

But even with government finance, countries in the Indian Ocean Rim are experimenting with new and exciting blue financing. The blue bond issued in the Seychelles is expected

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**"In my view, it is when  
[sustainable ocean projects]  
are taken seriously that the  
Ministry of Finance is involved."  
Sean Kidney, CEO, Climate Bonds Initiative**

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4 Fish-i Africa, <https://fish-i-africa.org>

to drive sustainable fisheries projects. In Indonesia, the Blue Abadi<sup>5</sup> fund supports much of the work needed to maintain the marine ecosystem.

Yet private-sector-led blue finance is still a drop in the ocean and needs to encompass three key characteristics—scalability, leverage and security. To get large institutional investors interested, there need to be big ticket items, explains Mr Kidney, those that scale nationally or even regionally. “These are folks that run US\$10bn to US\$1.5trn funds.” With the scale of ocean issues increasing rapidly, even in the best-case climate change scenario, there are some large-scale projects that need to be financed. “In terms of capital expenditure, the biggest investment areas in Indian Ocean sustainability are urban development,” claims Mr Kidney, such as infrastructure to protect low-lying areas against rising sea levels. To create an investable pipeline, this needs a strategic view across a country or region, not limited to thinking in terms of individual projects.

Secondly, credit enhancement is critical to achieve the scale of investment that’s needed. “Stop lending and start leveraging,” is Mr Kidney’s message to local and regional development banks. “Take a junior position as guarantor in lots and lots of deals and you’ll be able to get the whole thing funded with private capital.” Rob Weary, treasurer at SeyCCAT backs this up, “Credit enhancement is pretty much limited to World Bank loan guarantees. We need more bilateral and multilateral entities providing leverage.”

In addition to leverage, a key ingredient for blue finance to succeed is security. One aspect of this is “security on assets,” says Mr Dent, for example, guaranteed access to a fishing quota or a formal commitment to a management plan. Another aspect refers to monitoring—it requires adequate capacity on the ground to implement and track projects to ensure they are generating both an economic and environmental benefit. With limited resources, this can be challenging, and so Mr Kidney recommends following a system where only projects meeting certain specifications are allowed to proceed, ones that can more easily be assumed to

have a positive impact. “We want to move away from having to require people to justify impact and use a procurement list model approach that is very specific about the kinds of assets included,” he says.

A key takeaway from our research is that, despite growing interest in the social impact of investments, investors hold ocean sustainability projects to the same standard as others and so blue finance needs to be approached in the same way as conventional project finance. Melanie Siggs, director of strategic engagements at Global Aquaculture Alliance, explains: “All the same sorts of questions apply: Are there markets? Is there labour available? Have we got access to sustainable inputs? Is there political will? What are the impacts: social, environmental and otherwise?”

While ocean sustainability projects will have unique considerations, experts we interviewed conclude that blue finance does not need to be treated differently from the “green finance” market. “The green bond market is established, which presents advantages, including liquidity. You don’t want to have to pay a premium to park your ‘blue bond’ in a separate envelope, so call it a blue/green bond, that’ll do,” advises Mr Kidney.

Projects also need to have an economic model that provides a return on the investment and a real sustainability benefit.

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**There is a skills gap in packaging propositions that are easy for investors to digest, says Mr Kidney. “Investors still need to have sustainability opportunities presented to them in a way that’s investable, but if they do, they’re incredibly enthusiastic.”**

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5 Supported by Conservation International: <https://www.conservation.org/gef/projects/Pages/Blue-Abadi-Fund.aspx>

User-pays marine protected areas<sup>6</sup> or concession fees in fisheries can achieve this. There is a skills gap in packaging propositions that are easy for investors to digest, says Mr Kidney. “Investors still need to have sustainability opportunities presented to them in a way that’s investable, but if they do, they’re incredibly enthusiastic.”

Blue finance, especially in the form of bonds or loans, offers the chance to break the grant cycle. As Mr Dent explains, “Previously projects would get US\$200,000 for two years, and would then have to go back out and re-pitch for grants.” Instead, financing can become self-sustaining as money used to repay a loan can be reinvested in new projects, resulting in a shift in mindset towards the longer-term. As Jennifer Howard, marine climate change director at Conservation International, says of the Blue Abadi fund, “We’re seeing fantastic results because of the feeling of ownership that comes with it.”

Another barrier to securing finance for blue economy projects has been challenges assessing and insuring against project risk. Insurance companies are in a unique position to use existing risk assessment tools to develop ones that can better assess and mitigate against exposure to ocean risk. New models of insurance and assurance “ensure projects are operating to a certain level and can significantly reduce risk in the system,” says Ms Siggs. But while these models are under development, pioneers must forge ahead, such as by “investing in a high-risk situation to show others that it works,” explains Ms Howard.

## Governance

Effective governance is imperative to meet sustainability objectives by ensuring that blue finance is used for the right purposes and “blue innovation” is supported. But governance of the oceans, and particularly the high seas, is challenging not only because it is difficult to draw national boundaries but also because ocean issues in one jurisdiction (be it land or sea) impact another. “You can’t draw an arbitrary line between the

dirt and the water,” explains Ms Howard. Plastics, sediment and nutrient run-off from land all significantly impact the sea on one hand; on the other hand, rising sea levels and extreme events impact mangroves, coral reefs and low-lying coastal communities. Increasingly we need to think of a blue umbrella rather than a blue bubble. As Mr Dent explains, “A lot of the time people are looking at too small a part of the chain. With fisheries for instance, you can actually invest at a point above in the supply chain and heavily influence what happens to the resource.”

For this, inter-governmental and inter-sectoral co-operation and collaboration are a must. “We have great capacity across the region in terms of knowledge and expertise but what we’re really missing is a mindset shift and the ability of institutions to take it seriously and actually act on it,” says Mr Kidney. “This is where you need visionary leadership.”

Strong political will is the engine for blue economic growth, and there are many examples within the Indian Ocean where this leadership is shining through. In South Africa, Operation Phakisa (which, literally translated, means “hurry up”) provides the drive to unlock the potential of the ocean economy, keeping sustainability in mind. Likewise, in India, the prime minister, Narendra Modi, has made a case for the blue economy and spearheaded the Deep Ocean Mission, which encompasses developing innovative and sustainable ocean technologies. The Seychelles is the first country in the world to issue a blue bond. “For a country of 92,000 people, it’s amazing the sort of leadership [the Seychelles] has been able to provide globally,” says Mr Weary. “The lesson learned from the Seychelles’ case was the importance of securing high-level support.”

Only in such an environment will sustainability objectives be considered as a non-negotiable component of economic development plans. This extends to providing the oversight necessary to ensure that resources for sustainable ocean projects are directed towards achieving these objectives.

Setting assertive targets captures the imagination and provides a clear checklist for countries and partners to get

6 MPAs in which fees are charged for access or specific activities

behind: Sri Lanka's vision to protect 100% of its remaining mangrove forests; Seychelles' target of putting 30% of its exclusive economic zone towards an integrated network of marine protected areas; and Oman's strategy to make aquaculture a US\$500m-990m industry<sup>7</sup> provide examples of inspirational targets within the region. Linking these to the Sustainable Development Goals (SDGs) could further strengthen them. As Ms Howard suggests, "If a country improved management of its coastal and marine space, it would be able to hit 11 out of 12 of the SDGs including reducing poverty, increasing nutrition and addressing women's issues."

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**"If a country improved management of its coastal and marine space, it would be able to hit 11 out of 12 of the SDGs including reducing poverty, increasing nutrition and addressing women's issues."**

**Jennifer Howard, marine climate change director, Conservation International**

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In the region, the Indian Ocean Rim Association<sup>8</sup> is the most prominent regional body and provides the structure to bring together leaders from around the region. The organisation has already set a regional vision for the blue economy within the Jakarta Concord of 2017. Specifically in fisheries, the Indian Ocean Tuna Commission (IOTC), an intergovernmental organisation responsible for the management of tuna and tuna-like species in the Indian Ocean, allows access to countries that sign up to its fisheries management regime. "If you want to fish for the 16 species that are under the mandate

of the IOTC you have to participate in the Commission," explains Chris O'Brien, executive secretary of the IOTC. A sustained effort of in-country capacity building by the IOTC has resulted in a sharp increase in compliance with sustainable fisheries management regulations from 25% in 2010 to 66% in 2017. "If you get more participation and better implementation, management is going to be stronger and sustainability is going to be more attainable."

On the research side, the recently reinvigorated IOC Regional Committee for the Central Indian Ocean<sup>9</sup> facilitates scientific collaboration. Knowledge exchange is not just an attractive add-on, but a necessity to address some of the immediate challenges. Mr Kidney explains with an example, "The East African states need Singapore's engineers to help make their ports resilient. We really need the [wealthier and more influential] folks to support their neighbours: that's India, the Arabian Gulf states and Australia."

However, regional collaboration with the private sector is lacking. As Mr Myles explains, "In my research, I've seen there is good collaboration between governments and very good collaboration on the ocean sciences; but I've not seen any evidence of business-to-business collaboration." To fill this gap, maritime clusters (such as the Nelson Mandela Bay Maritime Cluster in South Africa)<sup>10</sup> are adopting the Quadruple Helix Innovation Model, representing governments, scientists, businesses and civil society.

Across sectors and ministries, effective coordination, better planning and knowledge sharing can give birth to innovative approaches and promote growth in a blue economy. In India, the plastic-to-roads initiative gained rapid momentum with contributions across government ministries and industries (fisheries and infrastructure). However, all too often this is missing: "for example, in an EEZ, you can get a situation where an environmental ministry may agree to close a patch of ocean which a fishing or mining ministry is getting ready to exploit, and this can

7 <https://www.export.gov/article?id=Oman-Fisheries-and-Aquaculture>

8 IORA, <http://www.iora.int/en>

9 UNESCO, IOCINDIO: IOC Regional Committee for the Central Indian Ocean, [http://portal.unesco.org/en/ev.php-URL\\_ID=13826&URL\\_DO=DO\\_TOPIC&URL\\_SECTION=201.html](http://portal.unesco.org/en/ev.php-URL_ID=13826&URL_DO=DO_TOPIC&URL_SECTION=201.html)

10 Examples include the Maritime Singapore Green Initiative and the eThekweni Maritime Cluster in Durban, South Africa

result in sustainability issues, uncertainty for prospective investors and lost opportunities,” explains Mr O’Brien.

Marine spatial planning (MSP) is the principal tool enabling cross-sectoral co-ordination, and has been adopted by Australia, Indonesia, South Africa, the Seychelles and Thailand, and in the UAE details of the plan are expected to be announced in upcoming months, but MSP needs to be adopted more widely in the Indian Ocean region. It provides security for investments and is useful in effectively governing the ocean space, protecting key natural assets and managing conflicts.

But without an enabling environment, innovations can flounder or fail to take off, and as in many sectors “opportunities are often thwarted by policy,” explains Ms Siggs. Conversely, policies and regulations can drive sustainable innovations. “In the same way that in Japan earthquake resilient buildings are the only ones that qualify, governments can pass planning regulations that require infrastructure to be sustainable,” says Mr Kidney. Here, insurance and financiers can also play a role in setting parameters for investments.

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**“In my research, I’ve seen there is good collaboration between governments and very good collaboration on the ocean sciences; but I’ve not seen any evidence of business-to-business collaboration.”**

**Peter Myles, chairperson,  
Nelson Mandela Bay Maritime Cluster**

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## Concluding remarks

The global blue economy is set to grow faster than the general economy, possibly doubling by 2030. Yet it is a time-limited opportunity. Without co-ordinated action it will not achieve its full potential: natural capital will be lost at the expense of future populations and, without future-proofing, millions of dollars will be wiped off the balance sheet. “I have not lost faith yet in what we’re able to do,” concludes Ms Howard, “but I also don’t want to undercut the size of the challenge.” Efforts towards ocean sustainability must marry efforts towards climate adaptation and curbing global temperature increases, which contribute to rising sea levels. Rising sea levels, combined with massive urban population growth, creates conditions for a perfect storm, but also motivation for change. “All of this can be made investable,” suggests Mr Kidney.

The urgency with which action must be taken was underscored consistently by experts, but so was the scale and interconnectedness of the benefits to be reaped by simultaneously conserving and leveraging the huge, natural asset of the Indian Ocean. This paper invites the Indian Ocean Rim countries to grasp the opportunities, scale innovations and approaches already present within the region, and take strategic action against future threats.

## Roadmap to ocean prosperity in the Indian Ocean Rim

1. Cluster around the SDGs as a policy vehicle to drive national policies and regional collaboration.
2. Think big, show leadership: develop a vision and set ambitious targets for the blue economy at the regional level, led by a regional governance entity. Suggested targets:
  - marine protected areas (percentage of ocean area)
  - sustainable aquaculture
  - managing land-based pollution and biodiversity threats such as plastic pollution
  - resilience of coastal cities to climate change
  - skills development
3. Extend the blue economy priority areas to coastal infrastructure (the biggest capital expenditure item), tourism and natural resource management.
4. Encourage countries to build on their own blue master plans and design enabling policies and marine spatial planning that drive innovation.
5. Invite multilateral and regional development banks to get behind the scale and ambition of the targets to leverage further private-sector funding.
6. Invite investor countries<sup>11</sup> outside of the region to sign up to the sustainable blue economy master plans or strategies set up at the national or regional levels.
7. Encourage involvement within IORA of existing members and those yet to join through capacity building programmes and financial support.
8. Task the Working Group on the Blue Economy with encouraging private-sector-led maritime clusters<sup>12</sup> throughout the region that can build investment pipelines for the region and further build capacity through cluster-to-cluster events.
9. Develop blue economy protocols and standards (akin to a regional blue spatial plan) to cover the high seas;<sup>13</sup> and unite countries in the region to give regional bodies the influence to implement these.<sup>14</sup>

11 Dialogue Partners of the IORA

12 In collaboration with the Regional Centre for Science and Technology Transfer (RCSTT) of IORA

13 In collaboration with the Eastern Africa Regional Seas Programme: <https://www.unenvironment.org/nairobiconvention/>

14 Consistent with the UN Convention on the Law of the Sea (UNCLOS)

## Membership of Indian Ocean Rim countries in regional institutions and conventions

	Indian Ocean Rim Association (IORA)	Indian Ocean Tuna Commission (IOTC)	International Seabed Authority (ISA)	Commission for the Conservation of Southern Bluefin Tuna (CCSBT)	Cruise Indian Ocean Association (CIOA)	South African Development Community (SADC)	Partnership in Environmental Management for the Seas of East Asia Programme (PEMSEA)	Red Sea & Gulf of Aden (Jeddah Convention)	ROPME Sea Area (Kuwait Convention)	South Asian Seas Action Plan	Coordinating Body on the Seas of East Asia	Eastern Africa Regional Seas Convention (Nairobi Convention)
<b>Australia</b>												
<b>Bangladesh</b>												
<b>Comoros</b>												
<b>India</b>												
<b>Indonesia</b>												
<b>Iran</b>												
<b>Kenya</b>												
<b>Madagascar</b>												
<b>Malaysia</b>												
<b>Mauritius</b>												
<b>Mozambique</b>												
<b>Oman</b>												
<b>Seychelles</b>												
<b>Singapore</b>												
<b>Somalia</b>												
<b>South Africa</b>												
<b>Sri Lanka</b>												
<b>Tanzania</b>												
<b>Thailand</b>												
<b>UAE</b>												
<b>Yemen</b>												
<b>Pakistan</b>												
<b>Myanmar</b>												
<b>Reunion</b>												



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