Ecosystems of Hope

GLOBAL MANGROVE ALLIANCE

THE STATE OF THE WORLD'S MANGROVES 2022

The State of the World's Mangroves 2022

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The Global Mangrove Alliance

The Global Mangrove Alliance is currently coordinated by members Conservation International, The International Union for the Conservation of Nature, The Nature Conservancy, Wetlands International and World Wildlife Fund.

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1.1 Foreword

Prepared by the High Level Champions appointed under UN Climate Convention:

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Dr. Mahmoud Mohieldin
(COP27 High Level Climate Champion)

Building resilience to climate change

Healthy mangrove ecosystems are critical for global climate action – playing a key role in carbon storage and in building resilience to a rapidly warming world.

Mangroves stabilize coastlines, reduce erosion, foster biodiversity growth and protect coastal communities by building their adaptive capacity and making them more resilient to the impacts of climate change, such as sea-level rise, storms and coastal erosion, Mangroves prevent more than US$65 billion in property damages and reduce flood risk to some 15 million people every year.

Beyond coastal protection, mangroves also help secure livelihoods and food security for communities around the world. They provide a critical home and breeding ground for sea creatures such as fish, oysters crabs and shrimps.

Additionally, mangroves sequester carbon at up to four times the rate of terrestrial forests, making them indispensable allies in the race to a net zero world. The return of restorable areas could support sequestration and ensure the maintenance of 0.35 gigatonnes (350 million megagrams) of carbon, stored in both aboveground biomass and soil carbon.

There is a need for acceleration

Despite some progress in recent years, actions must be scaled up to turn the tide on conserving and restoring these vital trees to put a stop to severe depletion of mangrove forests.

To contribute to delivering on the goals set by the Race to Zero and Race to Resilience, we are committed to mobilize action that supports the work of the Global Mangrove Alliance (GMA) to ensure that mangrove conservation, restoration and management is delivered at pace and at scale.

The GMA, a Partner of the Race to Resilience, represents a remarkable worldwide collaboration between NGOs, governments, academics and communities, sharing information, experience, opportunities and funding in order to accelerate action on conservation and restoring mangroves beyond what any one country or organization can do alone. The GMA is a catalyst for accelerating change and building a host of opportunities for coastal communities and biodiversity around the planet.

The UN Climate Change High Level Champions are working closely with the GMA as we approach COP27. Our aim is to raise global ambition on mangrove conservation and, in particular, to unlock public, private and philanthropic finance, at scale, that complements state action on the conservation and restoration of mangrove ecosystems.

Evidence to compel stakeholders to act

Last year, the GMA released the inaugural State of the World's Mangroves report. This year, the report provides an update on continued progress as well as new research and tools. Once again, the GMA has brought together leading experts in mangroves and climate to provide a clear vision and path to put mangroves at the forefront of climate adaptation and mitigation actions.

Mangroves stabilize coastlines, reduce erosion, **foster biodiversity growth** and protect coastal communities.

Although covering a relatively small area of our planet, the report outlines the mammoth potential of mangroves, not only on a global scale, but in their significance for people and entire communities that depend on them. The science and figures in this report provide undeniable evidence that we hope will compel stakeholders to act immediately and mobilize capital where current commitments fall short.

This scientific report is clear: if we want to implement the promises made at COP26 and raise the level of ambition to meet the Paris Agreement, we must look to mangroves. The adaptive capacity and resilience of millions of people living on the coasts depend on it.

1.2

Executive summary

Ecosystems worth investing in

Mangroves are now widely valued, for their biodiversity and for their contribution to human society, both locally and globally. The Global Mangrove Alliance (GMA) is striving to increase visibility of these essential ecosystems and to set ambitious goals for their conservation and restoration.

Our inaugural publication, The State of the World's Mangroves 2021 highlighted remarkable new science and described critical policy approaches and on-the-ground actions for mangrove conservation. In so doing it helped to increase GMA membership, to catalyze further conservation activities, and to unlock new funding opportunities for mangrove restoration. This year, our report highlights the GMA members and describes the revised goals of our Alliance. We describe important new research findings and policy developments. We also shine a spotlight on mangrove restoration, including research, tools, and stories from the field.

The Global Mangrove Alliance has generated a revised goal for 2030, to ensure the long-term security of mangroves and the people who depend on them. It can be summarized in six words:

Halt loss, restore half, double protection.

Halting loss means bringing losses to zero by 2030, equating to 168km^2 of avoided loss of mangroves. Restoring half refers to the recorded losses (since 1996), and equates to some 4,092km^2 of restoration.

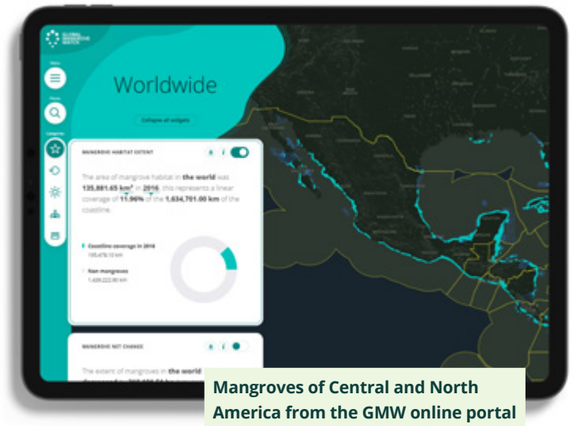
Doubling protection refers to the area of mangroves that are managed in protected areas or have equivalent levels of protection, equating to a further 40% of mangroves, or 61,000km^2 secured for a long-term future by 2030.

Mangroves and coral reefs in Tanzania, critical resources for coastal peoples © Mark Spalding

The state of mangroves

Central to this report are the newly completed global maps from the Global Mangrove Watch (GMW) team, offering more extensive and more reliable maps than before, updated to 2020. The new maps show 147,000km^2 of mangroves globally, an apparent increase on previous estimates, but based on improved maps rather than real gains.

The same maps allow changes to be detected over time. They indicate losses of 11,700km^2 since 1996, but also considerable gains, mainly in river mouths and deltas, leading to an estimate of net loss since 1996 of 5,245km^2. Rates of loss have also greatly diminished, with averaged losses over the last decade of just 66km^2 or 0.04% of all mangroves per year.



Mangroves of Central and North America from the GMW online portal

Losses are likely driven by a combination of direct human impacts such as clearance and conversion, but also by harder to manage changes driven by erosion or inundation or storms.

Developing a better measure of the threats to mangroves in different places provides a tool for effective management, and so there are growing moves to develop threat categorizations under the framework of the IUCN Red List of Ecosystems (RLE). In this report we highlight where this approach has already been applied to mangroves from continental to local scales, and we highlight the calls for a global assessment.

The dynamic nature of mangroves is also highlighted by independent research on Global Tidal Wetlands Change which has looked at change over time in mangroves, mudflats, and tidal marshes. In many cases apparent losses of one particular ecosystem represent transitions to another ecosystem.

Recognizing the interconnectedness, indeed the interdependence, of coastal ecosystems may greatly help our ability to manage them more holistically, and to increase their resilience.

The new mangrove maps provide a baseline for updated models of carbon storage in both aboveground biomass and mangrove soil. These updates confirm the importance of mangroves as carbon stores while

highlighting the enormous spatial variation in this value. They have also been used to show that restoration of losses since 1996 could safeguard carbon in soil and aboveground biomass equivalent to 1.27 gigatons of CO_2.

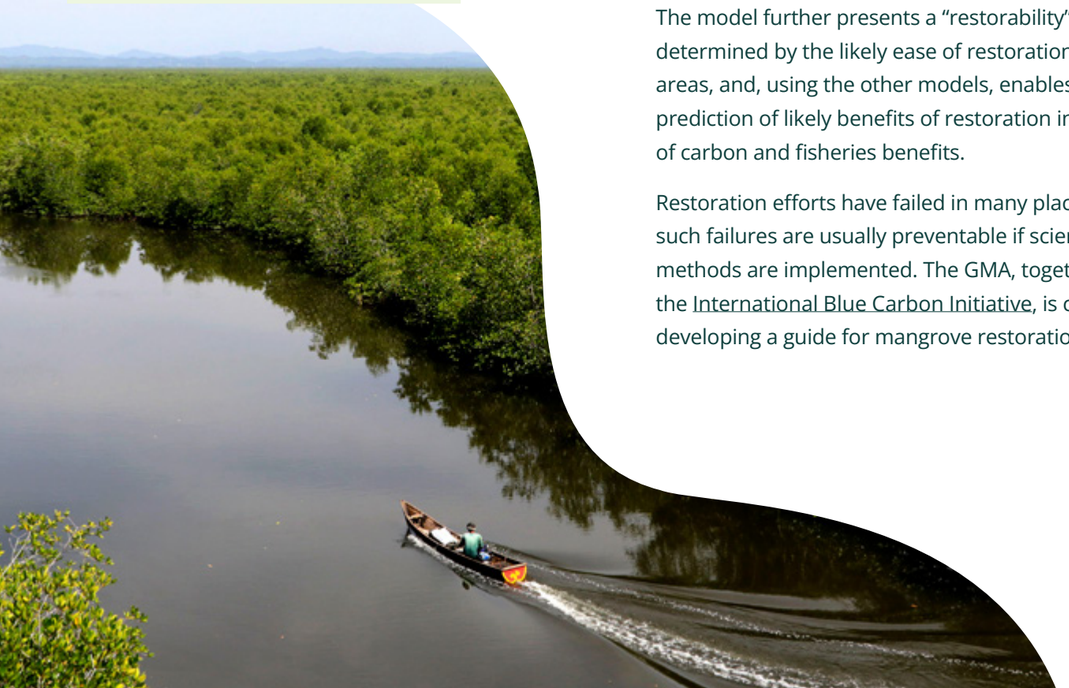
Another key benefit from mangroves is the production of commercially important fish, crustaceans and molluscs. Last year's report highlighted that 4.1 million fishers depend on mangroves. In a new model presented here, it is estimated that mangroves support the production of nearly 600 billion young of shrimp and fish species, as well as 100 billion individuals of crabs and bivalves.

The GMW map has been the **basis and starting point of much of the analyses** that have provided us such valuable insights into the world of mangroves.

A focus on restoration

Aside from protecting mangroves, restoration provides an opportunity to regain lost benefits to coastal communities and beyond. Not all lost mangroves are restorable: some lie in areas where the threats cannot be reversed.

4.1 million fishers benefit from the production of billions of young fish each year in the mangroves. Aceh Province, Indonesia © Junaidi Hanafiah, TNC Photo Contest



Equally, restoration is not always easy, although our understanding on how to restore has greatly improved.

The new map of mangrove restoration potential described here builds on the GMW extent and change maps, identifying all areas of loss from 1996 to 2020, and from these determining those areas that are restorable, a total of 8,183km^2, with particular concentrations of such areas in Southeast Asia.

The model further presents a "restorability" score determined by the likely ease of restoration in these areas, and, using the other models, enables the prediction of likely benefits of restoration in terms of carbon and fisheries benefits.

Restoration efforts have failed in many places, but such failures are usually preventable if science-based methods are implemented. The GMA, together with the International Blue Carbon Initiative, is currently developing a guide for mangrove restoration featuring a decision tree structure. Broadly it highlights three key stages: pre-implementation (funding, planning and identifying goals), implementation (using best practices, and targeting local needs), and post-implementation (monitoring and learning).

In parallel to these guidelines, other GMA supported work is developing a Mangrove Restoration Tracker Tool (MRTT). With input from over 80 practitioners and scientists, this tool will encourage and support restoration practitioners to track vital information across the lifetime of a project. It will further enable learning and information exchange between practitioners, facilitating the scaling up of restoration efforts to meet ambitious global targets.

Cattle egret, Jamaica © Tim Calver

Mangrove seedlings ready for a restoration project in Haiti © Tim Calver

Another project supported by the GMA will be a set of guidelines to support the utilization of Local Ecological Knowledge (LEK) in mangrove conservation and restoration. Local peoples often have a deep understanding and an unparalleled historical knowledge of their mangroves, and can provide vital local context to research on animals, plants, and interactions between humans and the environment.

Progress and policy

The determination to safeguard mangroves is growing at all levels from international to local. Coastal ecosystems are central in many global forums such as the recent Glasgow Climate Pact and 2022 UN Ocean Conference. Reliable, broad-scale science of the type described here provides a bedrock and a baseline in encouraging and supporting such policy development.

At the same time, all practical implementation of mangrove conservation and restoration depends on action on the ground, and legal frameworks and management approaches must be tailored to a local context. Here too, the supportive work of the GMA, in providing tools, models and case-studies is vital in enabling planning, implementation, and reporting.

Soon we will be entering the UNFCCC Global Stocktake process, whereby countries will report on their progress towards meeting their goals towards achieving the Paris Agreement and where new ambitions may be set. Several GMA members were involved in developing a guidance document to help countries translate how ocean-relevant actions can contribute to the Stocktake process. Similarly, the GMA has been a partner in developing a guidance document for mangrove inclusion into the Post-2020 Global Biodiversity Framework.

Two major UN Decades run through 2030: the UN Decade on Ecosystem Restoration and the other on Ocean Science for Sustainable Development.

Mangrove Side Event at COP23 in Bonn © Dominik Ketz

The GMA is an official implementing initiative of the UN Decade on Ecosystem Restoration, working to raise ambition on mangrove restoration and track and monitor progress through the Global Mangrove Watch.

The GMA is also supporting more ambitious goals for mangrove protection. Almost 42% of the world's mangroves are already in protected areas, but their value is enough to merit stronger commitments. There are also disparities: some important mangrove countries protecting less than 5% of their mangroves, and some existing protected areas are poorly managed and fail to prevent mangrove loss and degradation.

Future ambition from the GMA to double protection includes the need to recognize and include Other Effective Area-Based Conservation Measures (OECMs) that can offer de facto protection alongside more traditional protected areas.

The online GMW platform is being continually improved to support all those interested in mangroves, and new tools have been developed that may aid policy development and tracking progress. In relation to the Global Stocktake process, for example, users can now see which protected areas in their countries contain mangroves, and this data can be paired with the change and loss data.

The forthcoming Climate and Policy Dashboard will also display policy data, illustrating how mangrove restoration and conservation could help individual countries to meet key policy goals. This will include a list of the countries' NDC targets for mitigation and adaptation, alongside information on the mitigation potential of different management actions. The platform also includes a Mangrove Tree Species widget showing the mangrove species native to each country.

Another new feature will soon allow users to draw around areas of interest and to generate associated statistics, opening the door for monitoring of specific project sites.

The GMA continues to be a rapidly growing alliance of key partners and practitioners, enabling remarkable work for the future of mangroves at all scales. Matching this growth, the GMA has developed a new initiative, with the creation of National GMA Chapters that bring together GMA members and local partners on the ground in interested countries. The collective voice of a GMA national chapter can have more influence on national and local policies, as well as a larger impact through joint strategies and projects, and increased opportunities for fundraising. The national chapters also benefit from access to the GMA resources and team of experts.

Mangroves are vital ecosystems. In this review we offer multiple points of hope: declining losses, better understanding of values, a vision for restoration, growing political commitments, and ever stronger partnerships and alliances.

The tide has yet to turn, but we believe it will. The benefits will be global, and they will reach beyond mangroves – supporting the growing efforts to halt irreversible climate change, and the wider biodiversity crisis. It is essential to maintain the momentum and to keep growing our efforts and collaborations. Together we are making great strides.

Local knowledge for mangrove restoration

Elizabeth Wamba (Wetlands International)

The Matondoni Tarazak Women's Group in Lamu County, Kenya established a mangrove nursery in 2021. Although they have sold seedlings for restoration to two stakeholders, they know that this alone will not guarantee successful restoration.

Training is essential to help clarify misconceptions about mangrove restoration. Working with the Mangrove Action Project and Wetlands International, the Women's Group have undergone training in Community-Based Ecological Mangrove Restoration (CBEMR) techniques. These help enhance biophysical and socioeconomic conditions, and then allow nature to do the rest. This method helps to optimize species-to-site matching, leading to better restoration outcomes. See the full story here.

Image: Abdulrahman Lali checking salinity levels as Mwanahamisi Jillo looks on

1.3
Setting the scene

Mark Spalding (TNC)
Marice Leal (TNC)

Ecosystems of hope

In this rapidly changing world, mangroves are ecosystems of hope. While recent history has seen vast losses, impacting millions of people and large areas of critical biodiversity, things are changing.

Rates of mangrove loss have decreased dramatically, while our knowledge of their value and importance has shifted from a broad sense of importance to a very real and quantified inventory. Mangroves are not only places of great beauty offering opportunities for solace or adventure to local peoples and travellers, they are also fish factories, carbon stores and seawalls.

Now, over 40% of remaining mangroves are formally protected for conservation purposes, and efforts to restore mangroves have surged, along with the tools and knowledge to support such restoration efforts.

Mangroves are also remarkably resilient and opportunistic. Give these ecosystems half a chance and they'll take it – rapidly settling on newly deposited coastal settlements, or recolonizing former strongholds whenever they are re-connected to the shifting tides.

United for conservation

Recognising both their importance and their resilience, communities, governments, social networks, and non-profits are increasingly investing in the opportunities that mangroves present.

Uniting many of these efforts is the Global Mangrove Alliance, a remarkable worldwide collaboration uniting NGOs with governments, academics and communities by sharing information, experience, opportunities and funding.

The GMA represents a phase-shift in conservation opportunities for mangroves. With our global vision, we are providing a catalyst for accelerating change and building a host of opportunities for coastal peoples and biodiversity around the world.

The Global Mangrove Alliance – a goal for the future of mangroves

In 2022, the GMA revised its Goal, an ambitious plan for turning the tables on the world's mangroves. The plan contains three critical strands to be achieved by 2030:

1. **Halt loss.** Reduce net mangrove losses driven by direct human actions to zero
2. **Restore half.** Put back mangroves to cover at least half of all recent loss
3. **Double protection.** Ensure long-term secure protection is increased from 40% to 80% of remaining mangroves

Achieving these goals will generate considerable benefits for people across the planet, while new and ongoing studies by GMA partners and researchers are allowing us to constantly improve our ability to assess these.

Strand 1: Halt Loss

Rates of mangroves loss have already slowed considerably in recent years. This presents an opportune moment to raise our ambition. While we can aspire to halt all losses, our target refers to direct, and therefore directly manageable, human-driven loss.

It is estimated that human-driven loss represents 62% of total losses[1]. Over the decade from 2010 to 2020, some 600km^2 of mangroves were lost, and we can estimate that 373km^2 of this was due to direct human impacts.

To bring such losses to zero by 2030 we need to start to reduce loss rates now. Assuming a linear rate of reduction in human driven losses, this would save approximately 168km^2 by the end of 2030.

Goal for avoided loss:
168km^2 by 2030

Some of the highest losses come from Southeast Asia, and these areas will present considerable challenges. At the same time, they represent some of the most diverse mangrove ecosystems on Earth, acting as rich providers to coastal populations.

While this goal focuses on preventing further direct loss, in recognizing that mangroves are dynamic ecosystems, we also draw attention to the possibility of making further gains as mangroves naturally colonize new locations[2]. Any such gains offer additionality to the gains made by halting losses of remaining cover.

[1] Goldberg, L., D. Lagomasino, N. Thomas, and T. Fatoyinbo. 2020. *Global declines in human-driven mangrove loss*. Global Change Biology **26**:5844–5855. https://onlinelibrary.wiley.com/doi/abs/10.1111/gcb.15275
[2] D. Lagomasino, T. Fatoyinbo, S. Lee, E. Feliciano, C. Trettin, A. Shapiro, M.M. Mangora, Measuring mangrove carbon loss and gain in deltas, Environmental Research Letters 14(2) (2019) 025002. 10.1088/1748-9326/aaf0de.

Local men tend mangrove seedlings in a nursery at the Rio Platano Biosphere Reserve, Honduras. © Nicole Balloffet

Strand 2: Restore Half

Over 11,700km² of mangroves have been lost since 1996, the year that sets the baseline for our definition of "recent" loss. However not all of these mangroves are restorable: we exclude areas that have changed to open water or urban use as effectively unrestorable.

Approximately 8,183km² are considered restorable and the goal seeks to restore half of this area by 2030. This is a deeply ambitious goal. Even though the target excludes effectively unrestorable areas, the challenge of restoration in the remaining areas is likely to be highly variable.

Goal for restoration:

4,092km² by 2030

New work by Worthington and colleagues (see section 3.1) nonetheless shows that there is enormous potential for restoration, both by estimating the restorability, and by highlighting the considerable side benefits for local populations and the global community.

Strand 3: Double protection

With 42% of the world's mangroves currently in protected areas, mangroves are already well covered compared to many other ecosystems. However, the urgency to halt all loss is fundamental. One of the key approaches to prevent further loss is the incorporation of mangroves into permanent forms of protection. These include traditional protected areas, but also Other Effective Area-based Conservation Measures (OECMs), which could encompass indigenous lands and areas of sustainable use where mangroves are protected from clear-felling and conversion.

Goal for doubling protection:

Secure a further 61,000km² under conservation measures

Pulau Dua Nature Reserve, Java, Indonesia © Mark Spalding, TNC

...and in return

Mangroves are providers of food, security, income, and leisure benefits, while also hosting vast stocks of carbon, acting as highly effective carbon sinks.

When considering the challenges of halting losses and restoring vast areas it is valuable to think of the benefits that will come from meeting the GMA goals.

If we assume global average values, the avoided loss of 168km² of loss by 2030 will:

- **Avoid 0.026 gT CO_2 emissions**[3]
- **Secure the continued supply of 800,000,000 commercially important fish and shellfish every year**

Restoration impacts are not immediate and benefits accrue as restored systems mature. Our vision for benefits is thus a projected vision where we estimate that the restoration of 4,092 km² of mangrove will:

- **Avoid further emissions from soil and eventually lead to the securing of combined biomass and soil carbon of some 0.635 gT CO_2 equiv**
- **Provide additional habitat which will generate over 25 billion commercially important fish and shellfish every year**

[3] The numbers for carbon are simple totals of carbon that would be contained in mangrove ecosystems. In almost all cases what replaces mangroves, including areas for potential restoration, still contain carbon, although in much lower concentrations than in mangrove ecosystems.

Managing mangroves, from Senegal to Benin

Bara Top (IUCN)

The PAPBio EU funded 'Mangrove forest management from Senegal to Benin' project is working in 9 coastal countries in West Africa, led by IUCN with Wetlands International and 5Deltas as implementing partners.

The project has provided small grants – a total of €10m – to local partners for mangrove restoration, alternative livelihoods and training. In addition, the project promotes drafting or revision of coastal protected areas with mangroves, and organizes exchange visits between stakeholders, cultural visits and educational events.

Image: Mangroves in Saloum Delta, Senegal
Photo: Lammert Hilarides

Conservation

While not all unprotected mangroves are threatened with loss, it remains valuable to account for the security provided by long term conservation commitments. Again, using global average estimates doubling the current protected area coverage would increase the long-term security of:

- **9.14gT of CO_2 equivalent**
- **Commercial fish productivity equivalent to 291 billion commercially important fish and shellfish every year**

Above and beyond the benefits from carbon capturing and fisheries will be benefits from coastal protection, securing lives, infrastructure, and economic security. The global values of annual flood risk reduction for 15 million people and over $65 billion worth of property[4] give some indication of how such values play out, although current models are insufficient to generate more exact values from specific locations or restoration actions.

Protected mangroves from above, Colombia © Mariana Rivera-Uribe, Mangrove Photography Awards 2021

[4] P. Menéndez, I.J. Losada, S. Torres-Ortega, S. Narayan, M.W. Beck, The Global Flood Protection Benefits of Mangroves, Scientific Reports 10(1) (2020) 4404. 10.1038/s41598-020-61136-6.

The State of the World's Mangroves 2022

In 2022, our knowledge of mangroves continues to surge, and the opportunity to invest in these critical ecosystems is being rapidly strengthened.

In this publication we highlight the latest information on the global extent of mangroves, with a greatly enhanced and updated global map provided by Global Mangrove Watch. Linked to such information, our understanding of values is also enhanced, including a new carbon map and a new estimate of fisheries enhancement.

Restoration is a critical focus of this volume, and new maps and tools are rapidly improving our understanding of what can be done, and where it can best be done. Our partnerships with the GMA have supported all of this work and represent critical channels for the diffusion and application of everything we are learning. This includes the sharing of science, but equally the critical peer-to-peer communications where practitioners on the ground can access the experience of others anywhere in the world.

Policy opportunities continue to expand. Likewise, economic and market-based tools may begin to transform future interventions to protect or expand the world's mangrove heritage. The path is clear and exciting, but we need to continue our focus, maintain our drive, and seize opportunities where they occur.

Competition for conservation

Emma Barnes (WWF)

Communities in northern Madagascar depend on their marine resources and so are spearheading local management. The MIEZAKA community organization in Ambolikapiky village, Ambanja district, has done so well managing their mangroves – providing conservation training, and promoting sustainable livelihoods, such as beekeeping – that they came first out of 36 other local organizations in 'Fagnoesa', a community management competition supported by WWF.

With their grand prize speedboat, the community group has improved patrols of their local mangroves and can better ensure sustainable resource use. Meanwhile, engagement and interest in conserving mangrove ecosystems has grown across the region as a result of the competition.

Image: Finalists during the award ceremony with VOI Miezaka
Photo: Mialisoa Raharimamama, WWF Madagascar

2.1

The world of mangroves

Pete Bunting (Aberystwyth University), **Ake Rosenqvist** (soloEO),
Lammert Hilarides (Wetlands International),
Richard Lucas (Aberystwyth University)

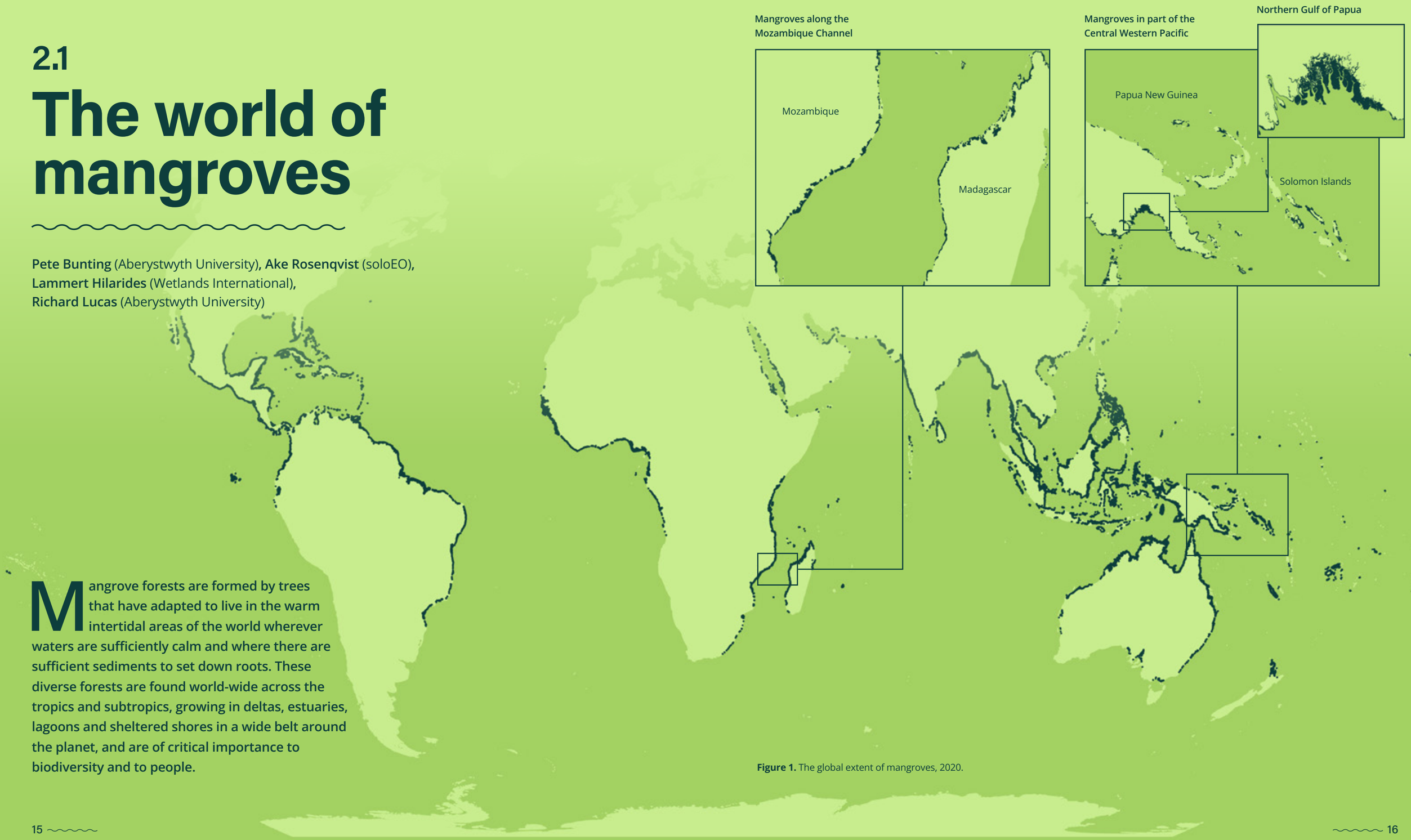


Figure 1. The global extent of mangroves, 2020.

Mangrove forests are formed by trees that have adapted to live in the warm intertidal areas of the world wherever waters are sufficiently calm and where there are sufficient sediments to set down roots. These diverse forests are found world-wide across the tropics and subtropics, growing in deltas, estuaries, lagoons and sheltered shores in a wide belt around the planet, and are of critical importance to biodiversity and to people.

A major update to the extent of global mangroves

In 2022, an updated view of the distribution of mangrove forests was released in the Global Mangrove Watch (GMW) Version 3.0. This map includes a detailed historical census, and shows some 147,000km^2 of mangroves[1] in 2020.

This new estimate is some 11,000km^2 more than the estimate for 2016 described in the 2021 State of the World's Mangroves (which was based on GMW version 2.0), although this apparent change represents improvements to the map rather than an increase in the extent of mangroves. Now, mangroves that were missing from the previous version are incorporated – notably in Bangladesh, Benin, Colombia, Fiji, India, Indonesia, Nigeria and the USA – as well as smaller areas, particularly certain small island states.

Mangroves around the world

The most extensive area of mangroves is found in Southeast Asia, with Indonesia alone comprising one fifth of the global total (**Figure 2**). Together, Indonesia, Brazil, Australia, Mexico and Nigeria host almost half of the world's mangroves.

By contrast, many small island nations have comparatively small or isolated areas of mangrove, but in all places, mangroves provide essential ecosystem services and play a key role in maintaining the local ecosystem integrity.

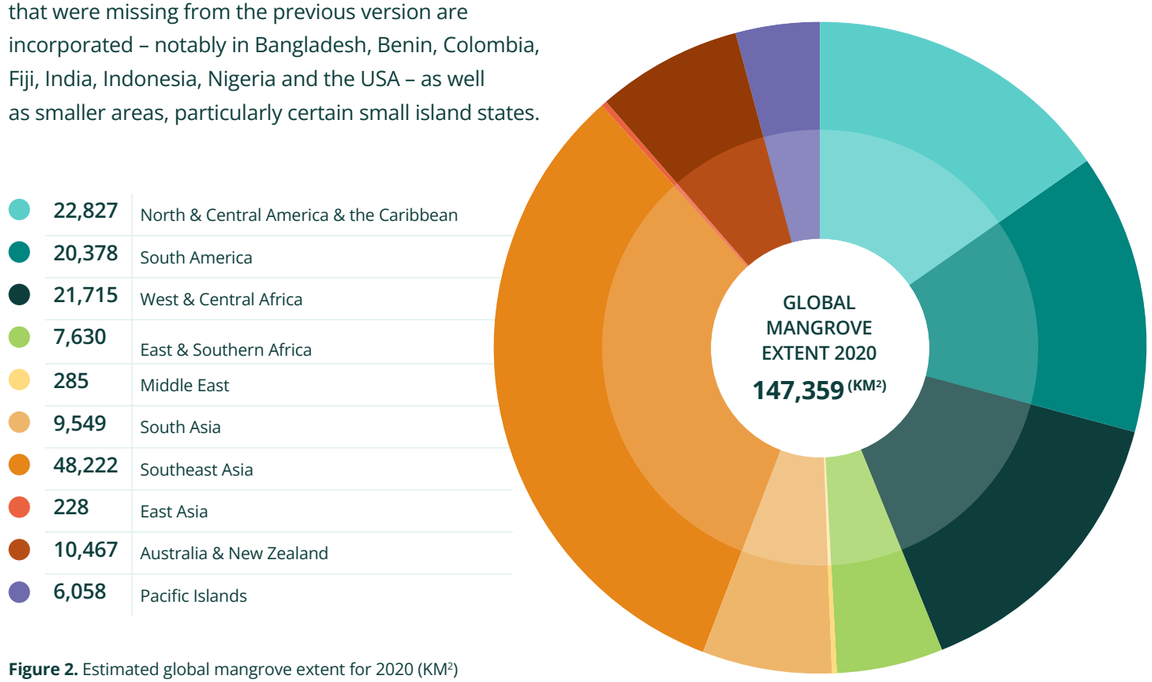


Figure 2. Estimated global mangrove extent for 2020 (KM^2)

[1] 147,359 km^2 in 2020 (Figure 2), with a 95th confidence interval of 127,925 – 168,895 km^2 (Bunting et al., 2022b).
[2] Bunting, P., A. Rosenqvist, L. Hilarides, R. M. Lucas, and N. Thomas. 2022. Global Mangrove Watch: Updated 2010 Mangrove Forest Extent (v2.5). Remote Sensing 14:1034.
Bunting, P., A. Rosenqvist, L. Hilarides, R. M. Lucas, N. Thomas, T. Tadono, T. A. Worthington, M. Spalding, N. J. Murray, and L.-M. Rebelo. 2022. Global Mangrove Extent Change 1996-2020: Global Mangrove Watch Version 3.0. Remote Sensing 14:3657.
Bunting, P., A. Rosenqvist, R. M. Lucas, L.-M. Rebelo, L. Hilarides, N. Thomas, A. Hardy, T. Itoh, M. Shimada, and C. M. Finlayson. 2018. The Global Mangrove Watch—A New 2010 Global Baseline of Mangrove Extent. Remote Sensing 10:1669.

Mapping accuracy

Originally published in 2018 and updated in 2022, the GMW maps were generated from satellite sensor data at approximately 25m resolution. By using the same satellite sensor types and applying a consistent global classification approach, the maps allow for comparison between regions and countries, and over time. Through a rigorous assessment process, the estimated accuracy of the 2010 baseline has been determined as 95%. This map represents the most complete, reliable and up to date spatial representation of global mangrove extent[2].

Observation notes

Whilst a global map, there is regional variability in the accuracy of the mangrove maps, with this attributed to mangroves being less distinct from other aquatic intertidal habitats such as salt marshes or rainforests. Likewise, there is some loss of accuracy in spatially complex and heterogeneous landscapes, including those fragmented by aquaculture development.

An essential resource

The GMW map provides an essential resource supporting our understanding of mangrove distribution and how this is changing over time. It also provides a starting point for a host of other studies focused on understanding mangroves in terms of their benefits to people, and how human activities are impacting mangroves.

This includes positive influences through sustainable management, protection, or restoration, or negative impacts such as losses through deforestation or urban expansion, themes that are explored in later sections.

The importance of user feedback

The improvements in the GMW Version 3.0 maps can be attributed to use of a more spatially complete Earth observation dataset.

However, user feedback has also been critical in helping to improve the maps. Local knowledge of a region has been key to identifying areas missed, poorly defined, or incorrectly identified as mangroves. To continue improvement of GMW mapping products, we welcome all user feedback.

Mangrove field data collection and drone training in Senegal as part of the Mangrove Watch Africa Project © Lammert Hilarides

Mangroves are increasing in some areas, including through restoration. Saloum, Senegal
© Lammert Hilarides

Greatest net losses were in Southeast Asia (4.8%) and North and Central America and The Caribbean (4.7%).

2.2

Changes & losses

Pete Bunting (Aberystwyth University)
Ake Rosenqvist (soloEO)
Lammert Hilarides (Wetlands International)
Richard Lucas (Aberystwyth University)

Dynamic ecosystems

Mangrove ecosystems show great dynamism, rapidly colonizing new sediments, but also sometimes giving way to forces of nature such as storms and coastal erosion. Such changes have been greatly increased by the impact of humans clearing mangroves and modifying coastlines over vast areas for decades, even centuries.

Understanding these changes is a vital component of decision-making for the future, helping with conservation, restoration planning, and deciding interventions to halt further losses. The GMW Version 3.0 maps have been generated as a series of maps – not a single snapshot – enabling changes to be detected over time.

Currently, 11 annual global extent maps cover single years from 1996 to 2020 (**Table 1**). Overall, the total mangrove area was estimated to be 152,604km^2 in 1996, decreasing to 147,359km^2 in 2020 – a net loss of 5,245km^2 (3.4%).[1]

Between 1996 and 2010, the average loss rate was estimated to be 327km^2 (0.21%) per annum, falling to 66km^2 (0.04%) per year between 2010 and 2020.

Prior to 1996, it's thought that the rate of change was significantly higher (**Table 1**)[2], although global estimates of mangrove extent are less certain at this time. Information prior to 1996 is largely based on individual country estimates, derived from different methodologies[2].

The UN Food and Agriculture Organization (FAO) provided global estimates of 198,090km^2 loss for 1980 (26%), and 163,610km^2 for 1990 (10%)[2], with the net extent loss decreasing from approximately 2% per year in the 1980s and 1.4% per year from 1980 to 1996.

Gains and losses

Behind these net losses are complex changes, including gains. Mangroves are often opportunistic, and changes can occur relatively fast. While a small part of these gains may be due to restoration projects, it seems likely that many are natural gains. Further, only some are in areas where mangroves had previously been lost.

[1] Total loss – defined as the sum of all areas that had mangrove at any point prior to 2020 but did not have mangrove in 2020 – is more than double this, or some 11,700km^2, a number that is masked in the net loss statistics due to the very dynamic nature of mangroves and with many losses offset by considerable gains in many other areas.
[2] FAO. 2007. The world's mangroves 1980-2005. A thematic study prepared in the framework of the Global Forest Resources Assessment 2005. 153, Forestry Department, Food and Agriculture Organization of the United Nations (FAO), Rome.

Mangroves in Mexico

Valeria López Portillo, Sarai Rodríguez (WRI Mexico)

WRI Mexico's RE3CO works in partnership with the Small Grants Programme, with financing from HSBC.

RE3CO is aiding community-driven mangrove restoration across three key sites in Mexico, promoting sustainable ecosystem management actions that support the economic development of local communities, ecosystem health and increased carbon storage.

The initiative seeks to identify key lessons and models that will serve to scale the restoration of mangroves in other regions of the country, thus contributing to the fulfillment of national goals of restoration, adaptation and mitigation of the impacts of climate change.

Photo: Sarai Rodríguez

The greatest gains appear to be associated with river mouths and deltas such as the Amazon in Brazil, the Indragiri River in Sumatra and the Amacura Delta in Venezuela, where there has been extensive inland deforestation, generating widespread sedimentation at the coast to be colonized by mangroves. While the losses in extent have decelerated, the health of remaining mangrove regions has not been considered. The Niger Delta, for instance, experienced significant degradation of mangroves yet they are still represented in the map.

Global disparities

Across their range, mangrove changes are not uniform.The greatest losses have occurred in Southeast Asia, which lost 2,457km^2 (4.8%) of mangroves from 1996–2020, driven by commodities development, particularly aquaculture[1]. North and Central America and the Caribbean also saw significant mangrove loss, with erosion and extreme events like cyclones being major drivers behind total losses of 1,122km^2 (4.7%)[3].

Region	FAO[2]		GMW v3.0[4]										
	FAO ~1980	FAO ~1990	1996	2007	2008	2009	2010	2015	2016	2017	2018	2019	2020
North & Central America & the Caribbean	29,508	25,922	23,949	23,438	23,167	23,094	22,947	22,728	22,684	22,757	22,885	22,913	22,827
South America	22,223	20,733	20,516	20,274	20,210	20,219	20,205	20,200	20,251	20,331	20,377	20,395	20,378
West & Central Africa	27,060	24,854	22,090	22,038	21,937	21,947	21,931	21,906	21,816	21,812	21,805	21,793	21,715
East & Southern Africa	9,642	9,422	7,902	7,809	7,733	7,721	7,708	7,699	7,681	7,690	7,703	7,690	7,630
Middle East	557	499	344	338	331	327	308	292	284	285	287	290	285
South Asia	12,893	11,433	9,818	9,723	9,647	9,623	9,596	9,616	9,661	9,679	9,715	9,660	9,549
Southeast Asia	63,893	55,191	50,679	49,254	48,664	48,572	48,441	48,116	47,965	47,953	47,983	48,046	48,222
East Asia	350	291	257	237	231	226	224	228	232	233	230	230	228
Australia & New Zealand	14,860	14,810	10,945	10,752	10,618	10,618	10,562	10,478	10,426	10,451	10,497	10,518	10,467
Pacific Islands	6,954	6,095	6,104	6,110	6,107	6,106	6,098	6,082	6,070	6,069	6,072	6,070	6,058
Total	187,940	169,250	152,604	149,973	148,645	148,453	148,020	147,345	147,070	147,260	147,554	147,605	147,359

Table 1. Estimated global mangrove extent over four decades in km^2. Note that the FAO figures are based on mixed sources and cannot be considered fully reliable.

[3] Goldberg, L., Lagomasino, D., Thomas, N., Fatoyinbo, T., 2020. Global declines in human-driven mangrove loss. Global Change Biology 26, 5844–5855. https://doi.org/10.1111/gcb.15275.
[4] Bunting, P., A. Rosenqvist, L. Hilarides, R. M. Lucas, N. Thomas, T. Tadono, T. A. Worthington, M. Spalding, N. J. Murray, and L.-M. Rebelo. 2022. Global Mangrove Extent Change 1996-2020: Global Mangrove Watch Version 3.0. Remote Sensing 14:3657.

Degraded mangroves adjacent to a fertilizer plant in Indonesia. © Budi Yuwono, TNC Photo Contest 2022

Urban and industrial expansion along many coasts, such as Bahrain, has led to large reductions in mangrove area © Mark Spalding

A dead mangrove forest resulting from being cut off from water circulation by a road and railroad, Salt River, Jamaica © Tim Calver

Layering data over time

The current GMW data set consists of annual maps based on historical satellite data, recording past changes using a consistent approach. Prior to this date, historical estimates were provided by the FAO **(Table 1)** but these were obtained from multiple sources and were, at best, indicative only.

A significant amount of change is thought to have occurred prior to 1996, and therefore effort should focus on improvements to provide more certainty. Understanding the different reasons for change will help to support on-going conservation efforts.

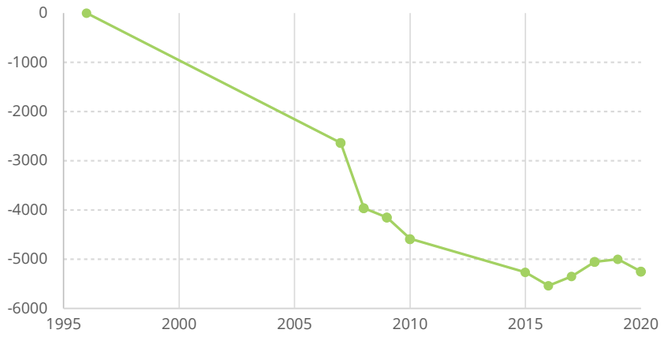


Figure 3. Cumulative net change.

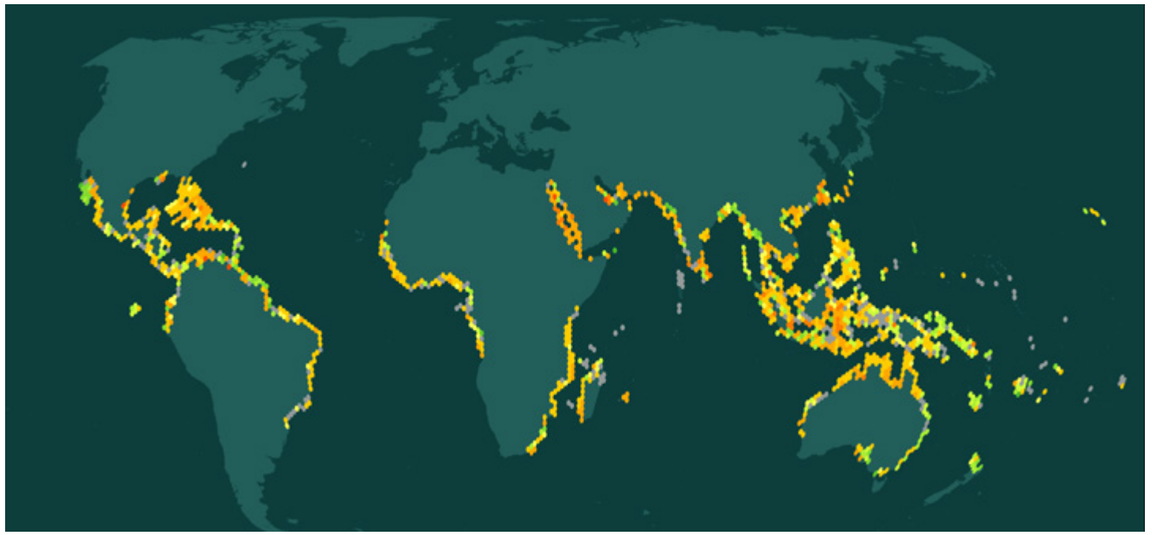


Figure 4. Net change in mangrove area from 1996 to 2020.

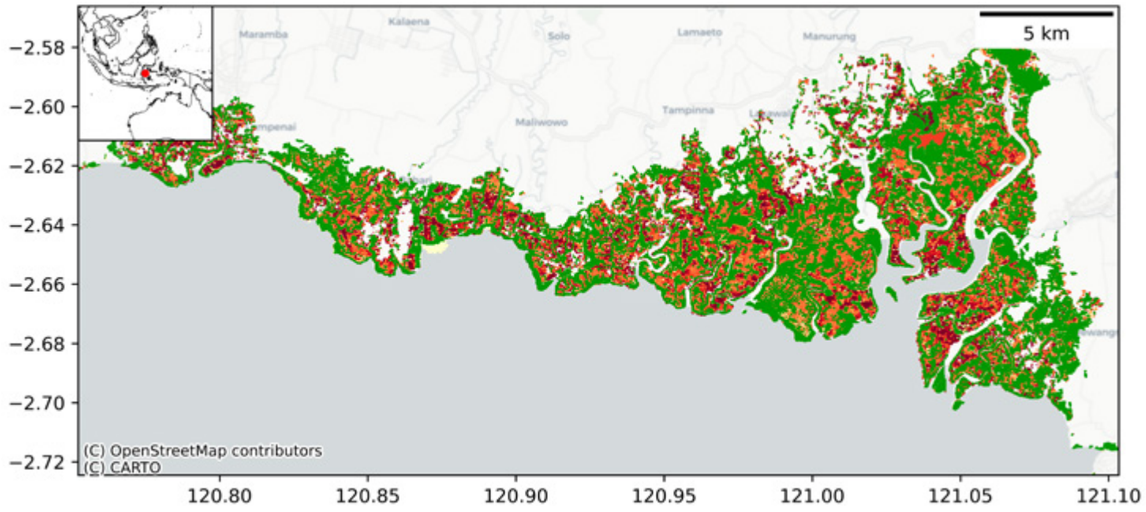


Figure 5. Mangrove losses over time at the head of the Gulf of Boni, South Sulawesi, Indonesia.

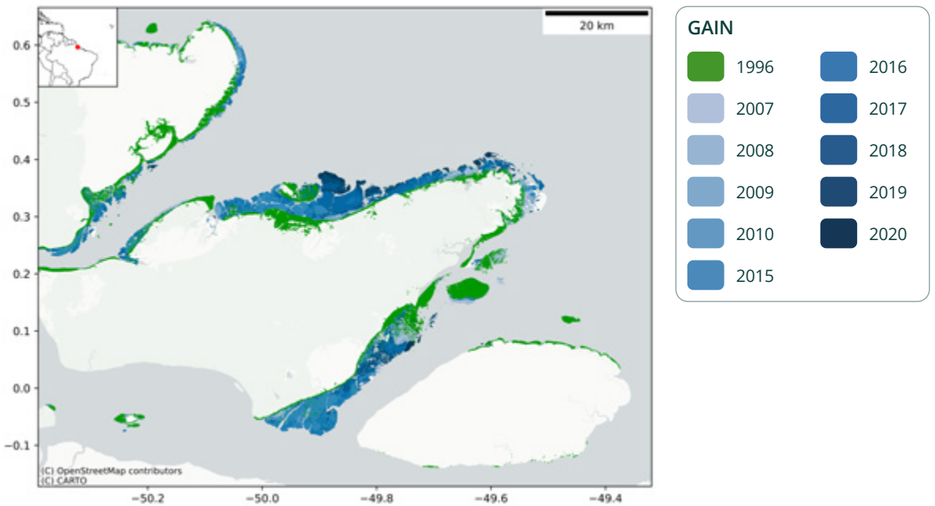


Figure 6. Extensive mangrove gains have been recorded on island margins in the Amazon Delta.

2.3

Beyond the forests

Nicholas Murray (James Cook University), **Lindsey Smart** (TNC),
Thomas Worthington (University of Cambridge)

Mangroves never exist in isolation. They are often found interconnected with other tidal wetland systems, as well as with nearby terrestrial, freshwater and marine habitats, including coral reefs and seagrass beds. The distributions of all of these habitats are influenced by a combination of terrestrial, coastal and marine processes, and extensive biological and physical linkages build complex interdependent relationships between them. Getting a grasp of these connections, and the dynamics that exist between ecosystems, is becoming a focus of global-scale research.

Nurse Sharks and seagrass in coastal waters at the Exuma Cays Land and Sea Park, Bahamas. Credit: © Jeff Yonover

Ever-changing environments

Coastal wetlands can play a critical role in trapping and holding sediments, enabling the formation of new habitats. This same process can ensure that adjacent offshore waters are clearer, enabling seagrass and coral reefs to thrive. Likewise, coral reefs can protect shores from wave action, enabling coastal wetlands to establish even in relatively high energy coastal areas. Offshore species from shrimp to parrotfish use coastal mudflats and mangroves as nursery grounds, with their young migrating to coral reefs and offshore waters as they mature.

Such systems are not static: changes in river sediment flux can lead to changes in delta structure, a process which can result in shifts between mangrove ecosystems, mudflats and tidal marshes. Similarly, as sea levels rise, the extent of saltwater exposure increases, facilitating the landward movement of more salt-tolerant wetland species. Emerging efforts to monitor these tidal wetland transitions are critical to better understand the net effects of global environmental change on highly dynamic coastal ecosystems.

Figure 7. Representative examples of coastal ecosystem types.

Photos: Mark Spalding, TNC

The dynamic distribution of tidal wetlands

Paralleling the mapping of mangroves, other work is rapidly advancing for global mapping of coral reefs, tidal flats and tidal marshes. The new Global Tidal Wetlands Change analysis focuses on three tidal wetlands – tidal marshes, tidal flats and mangroves – and the transitions between them over time[1].

Utilizing more than 1.1 million images from the Landsat Archive from 1999 to 2019, the analysis detected and characterized changes in wetlands over 20 years.

Every tidal wetland 'pixel' detected to have been lost or gained was assigned to an ecosystem, enabling users to understand (i) where tidal wetlands have been lost or gained over this time span, (ii) the types of wetland ecosystems being lost or gained, and (iii) the timing of these changes. The analysis provides the most information-rich data record of changes of Earth's tidal wetlands to date.

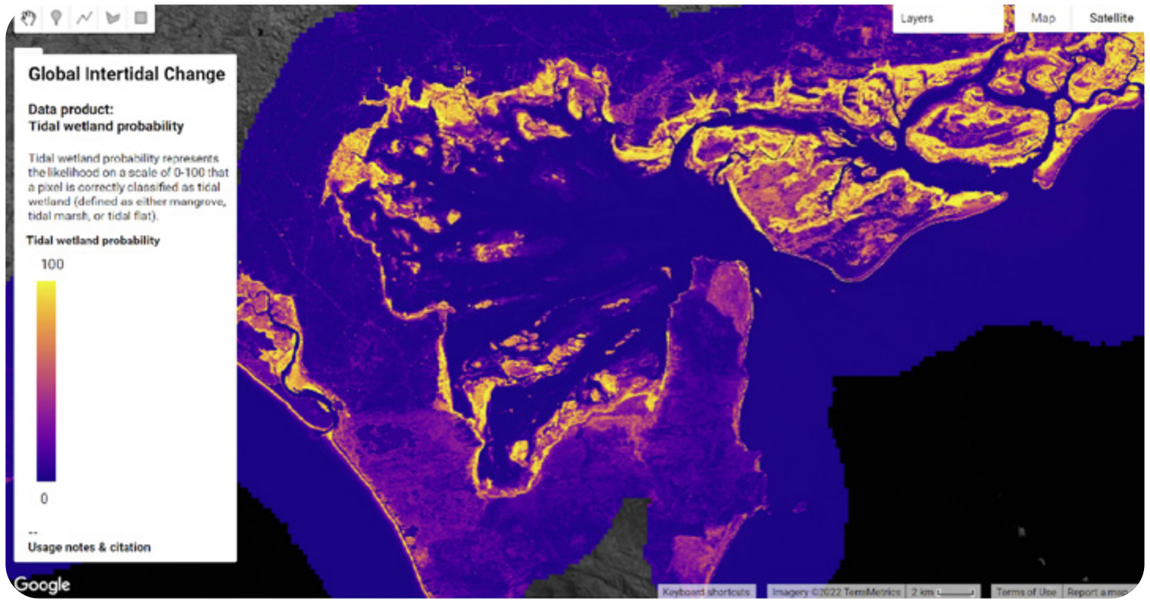


Figure 8. The Global Tidal Wetland Change Analysis used a large volume of training data points to develop predictive algorithms describing the likelihood that any particular 30m pixel was a coastal wetland. Here in Corner Inlet, Victoria, Australia such wetland pixels could include mangrove, tidal marsh or mudflats. Subsequent geoprocessing gives a similar indication of 'likelihood' of which of these systems any location would likely be.

[1] Murray, N. J., T. A. Worthington, P. Bunting, S. Duce, V. Hagger, C. E. Lovelock, R. Lucas, M. Saunders, M. Sheaves, M. Spalding, N. J. Waltham, and M. B. Lyons. 2022. High-resolution mapping of losses and gains of Earth's tidal wetlands. Science, 376 (6594), 744-749.

A dynamic world

The Global Tidal Wetland Change analysis has highlighted the highly dynamic nature of the world's tidal wetlands. While more than 13,700 km^2 of tidal wetlands were lost over the study period, most of these losses were offset by nearby gains of some 9,700km^2 of new tidal wetlands.

Losses and gains tend to co-occur, often in places rapidly changing due to large-scale processes, such as large deltas, or along coastlines that have been transformed by extensive human activities, such as in East and Southeast Asia.

Unsurprisingly, mangroves suffered the greatest net losses globally, confirming the concerning loss estimates first quantified by Global Mangrove Watch. Of the three ecosystems assessed, tidal flats were shown to be the most dynamic, with a large proportion of losses offset by gains nearby.

Transitions between ecosystems were a particular interest: over 20 years, nearly 2% of the world's tidal wetlands switched between wetland types (6,700km^2), which is greater than their global net loss. These were predominantly transitions from non-vegetated tidal flat ecosystems to mangroves or saltmarshes and are typically indicative of changing physical and climatic factors, such as sea level, temperature and rainfall.

Hen Mpoano of Esiama, Ghana

Gilbert Muvunankiko (Global Restoration Initiative, WRI)**, Neil Stein** (Terramatch, WRI)

With support from TerraFund for AFR100, and in partnership with local communities, non-profit organization Hen Mpoano is restoring more than 50 hectares of degraded mangrove forests in southwestern Ghana.

These efforts will support the livelihoods of more than 12,000 coastal residents, improving the abundance and diversity of fin fish and shellfish, and enhancing coastal protection and climate resilience. Local communities also rely on mangroves for fuel wood and dye for fishing nets.

Image: Hen Mpoano
Photo: Daniel Doku Nii Nortey

The implications of change

A single ecosystem view could lead to unnecessary concerns, or to inappropriate management interventions. Calculations of ecosystem services which influence policy and investments may similarly be misleading if they only account for single ecosystems. By considering these systems together, and by including the ability for tidal wetlands to undergo transitions in planning and management, we could increase opportunities for conservation success, allowing these systems to self-regulate, and increasing their resilience to pressures such as sea level rise.

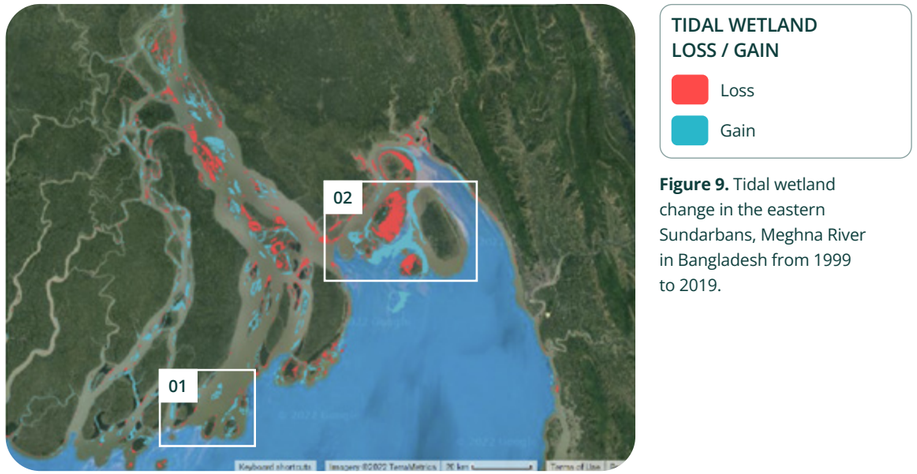


Figure 9. Tidal wetland change in the eastern Sundarbans, Meghna River in Bangladesh from 1999 to 2019.

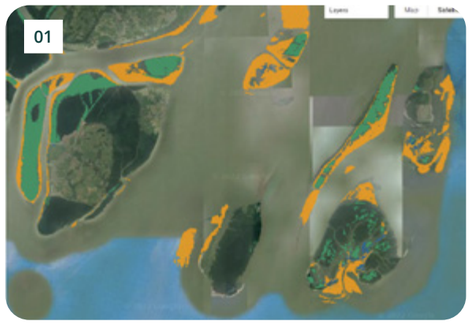


Figure 10. New tidal wetlands include areas of mudflat, tidal marsh and mangrove.

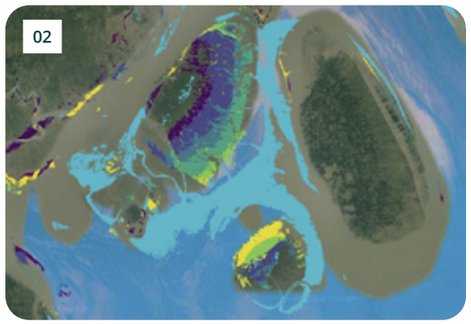


Figure 11. Patterns of loss showing steady progression of loss over 3-year time intervals. (Gains in the same area are shown in pale blue).

Working together

The Global Tidal Wetland change analysis provides critical insights into the dynamism and the interconnectedness of coastal and tidal ecosystems.

Rapid progress is also being advanced in our understanding of the patterns and the values of other coastal ecosystems, such as the Allen Coral Atlas, but more work is needed on developing holistic approaches.

We need to be able to combine and share research approaches in order to develop a more joined-up vision of these ecosystems in relation to one another.

Open access data sharing should be a minimum standard, but building common data standards, collaborative models, and common tools for data exploration and analyses will only strengthen our opportunities to conserve, restore and sustainably manage these critical ecosystems.

sea4soCiety © Carolina Hortúa Romero

sea4soCiety

Martin Zimmer (ZMT)

sea4soCiety coordinates carbon sequestration research with stakeholders in Germany, Colombia and Malaysia. Their main activity is to compare the blue carbon stocks in coastal vegetated ecosystems (CVE: mangrove forests, saltmarshes, seagrass beds, kelp forests), and the co-benefits and potential risks (ecological, economic and societal) of expanding current CVE.

sea4soCiety aims to develop sustainable, ecologically feasible, societally acceptable, legally sound and ethically approved concepts for fostering the capacity of CVE to contribute to climate change mitigation and adaptation. Currently focusing on background data, sea4soCiety will implement findings into concrete projects of (re)establishing mangroves and other CVE in a second project phase in 2024–2027.

Photo: Carolina Hortúa Romero

2.4 Storing carbon

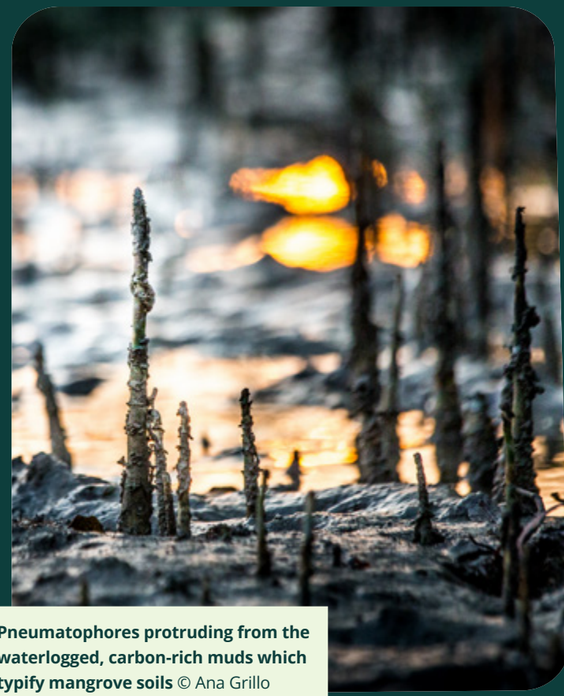
Tania L. Maxwell (University of Cambridge), **Pete Bunting** (Aberystwyth University), **Tom Hengl** (EnvirometriX / OpenGeoHub), **Leandro Parente** (EnvirometriX / OpenGeoHub)

Critical long-term carbon stores

Like all vegetated systems on Earth, mangroves capture carbon from the atmosphere for growth. Part of this carbon is stored in living biomass - leaves, trunks and roots - and part is sequestered in the soil.

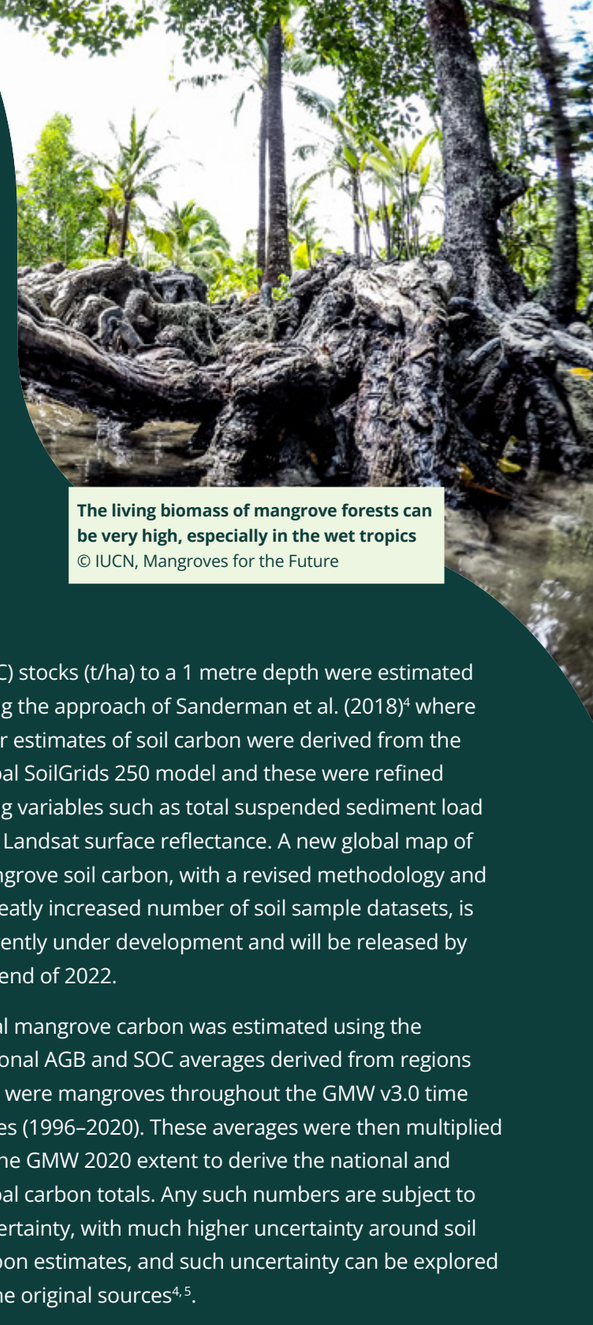
Dead mangrove material decomposes very slowly due to waterlogging of the soils with the tides and thus accumulation of carbon in the soil is a process that occurs over hundreds or thousands of years. Additionally, soil carbon can be built up by mangrove roots which trap additional suspended organic matter in the water during tidal flooding.

Largely due to this waterlogged soil environment, mangroves are estimated to hold up to four times the amount of carbon as some other forested ecosystems[1], such as temperate and boreal forests.



Pneumatophores protruding from the waterlogged, carbon-rich muds which typify mangrove soils © Ana Grillo

Due to the large amount of carbon stored in mangroves, it is **crucial to conserve the current areas** in order to prevent future potential CO_2 emissions.



The living biomass of mangrove forests can be very high, especially in the wet tropics © IUCN, Mangroves for the Future

Estimating carbon storage and production globally, using up-to-date mangrove extent maps and improved methods, is essential to better understand the value of this ecosystem. Such information can support future climate scenario testing, enable more objective climate change mitigation interventions, like protection and restoration, and provide an important data resource for those working in mangroves.

An update to our carbon knowledge

Using the new GMW v3.0 mangrove map[2], an update to the aboveground carbon and soil carbon estimate provided in the previous edition of the State of the World's Mangroves has been developed.

Aboveground carbon measurements were estimated using the method of Simard et al.,[3] where the Shuttle Radar Topography Mission (SRTM) elevation model was used to estimate mangrove heights and allometric equations were used to estimate the above ground biomass (AGB). Additionally, the soil organic carbon (SOC) stocks (t/ha) to a 1 metre depth were estimated using the approach of Sanderman et al. (2018)[4] where prior estimates of soil carbon were derived from the global SoilGrids 250 model and these were refined using variables such as total suspended sediment load and Landsat surface reflectance. A new global map of mangrove soil carbon, with a revised methodology and a greatly increased number of soil sample datasets, is currently under development and will be released by the end of 2022.

Total mangrove carbon was estimated using the national AGB and SOC averages derived from regions that were mangroves throughout the GMW v3.0 time series (1996–2020). These averages were then multiplied by the GMW 2020 extent to derive the national and global carbon totals. Any such numbers are subject to uncertainty, with much higher uncertainty around soil carbon estimates, and such uncertainty can be explored in the original sources[4, 5].

[1] Donato, D. C., J. B. Kauffman, D. Murdiyarso, S. Kurnianto, M. Stidham, and M. Kanninen. 2011. Mangroves among the most carbon-rich forests in the tropics. Nature Geoscience. 2011;4(5):293-7.
[2] Bunting P, Rosenqvist A, Hilarides L, Lucas RM, Thomas N, Tadono T, Worthington TA, Spalding M, Murray NJ, Rebelo L-M. Global Mangrove Extent Change 1996–2020: Global Mangrove Watch Version 3.0. Remote Sensing. 2022; 14(15):3657.
[3] Simard M, Fatoyinbo L, Smetanka C, Rivera-Monroy VH, Castañeda-Moya E, Thomas N, Van der Stocken T. Mangrove canopy height globally related to precipitation, temperature and cyclone frequency. Nature Geoscience. 2019;12(1):40-5
[4] Sanderman J, Hengl T, Fiske G, Solvik K, Adame MF, Benson L, Bukoski JJ, Carnell P, Cifuentes-Jara M, Donato D, Duncan C, Eid EM, Ermgassen Pz, Ewers C, Glass L, Gress S, Jardine SL, Jones T, Macreadie P, Nsombo EN, Rahman MM, Sanders C, Spalding M, Landis E. A global map of mangrove forest soil carbon at 30 m spatial resolution. Environmental Research Letters. 2018;13:12
[5] Hengl, T., MacMillan, R.A., (2019). Predictive Soil Mapping with R. OpenGeoHub foundation, Wageningen, the Netherlands, 370 pages, www.soilmapper.org, ISBN: 978-0-359-30635-0.

Reasons for variable carbon concentrations

Five countries hold 50% of the total world mangrove carbon: Indonesia, Brazil, Nigeria, Australia, and Mexico (**see Figure 12**). This is mainly due to their large mangrove areas, however variations in carbon concentrations between regions is also strongly influenced by environmental conditions, such as between the wet tropics and the temperate and arid regions. In this way, Nigeria's rich soil carbon places it third in the global rankings, although both Australia and Mexico have considerably more mangroves by area. Similarly, while Madagascar and Mozambique have mangrove areas similar to the Philippines, they have much lower carbon concentrations, resulting in their having around 40% less of the amount of stored carbon (**see Figure 13**).

Crucial conservation

World-wide, mangrove forests store some 6.23 (+/- 2.3) gigatonnes of carbon, equivalent to 22.86 gigatonnes of CO_2, with 87% of that being soil carbon. The loss of even just 1% of remaining mangroves could lead to the loss of 0.23 gigatons of CO_2 equivalent, equating to over 520 million barrels of oil, or the annual emissions of 49 million cars in the USA. Due to the large amount of carbon stored in mangroves, it is crucial to prevent future potential CO_2 emissions and to conserve remaining mangroves.

In parallel, the revised mangrove restoration potential map (**see section 3.1**) estimates that over 8,183km² could be restored to mangroves. While carbon burial processes take time, this could mean securing future storage of an estimated 1.27 gigatons of CO_2 equivalent.

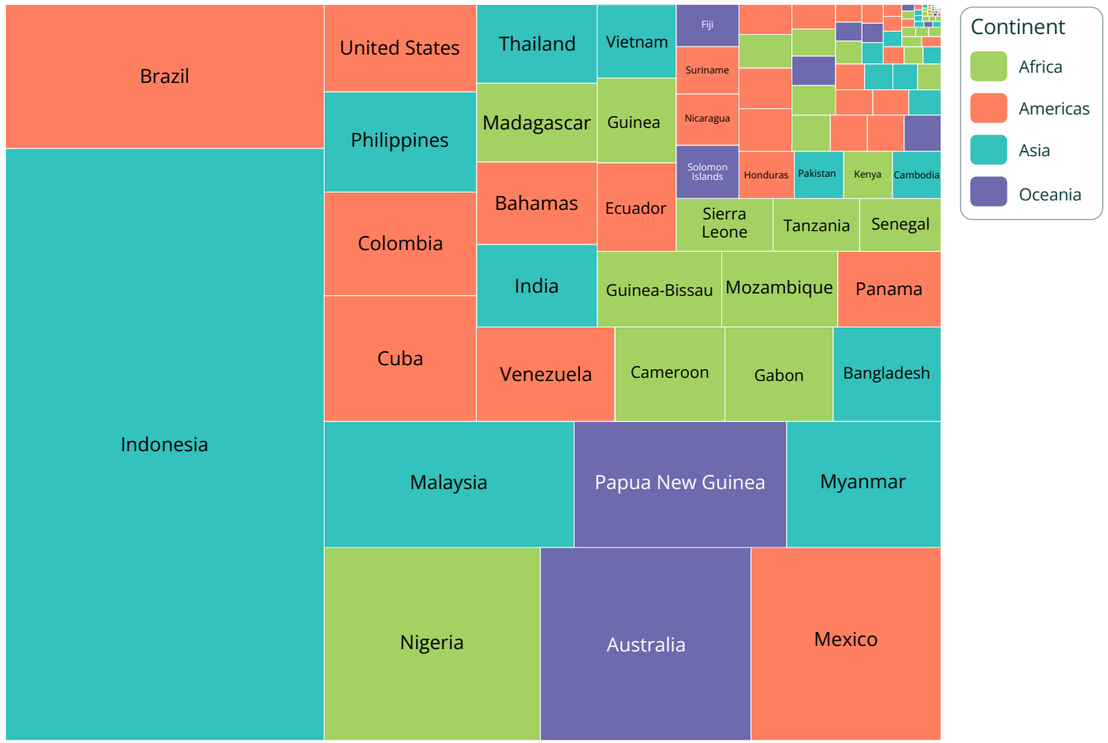


Figure 12. Treemap chart of carbon by country and continent with areas scaled to total carbon.

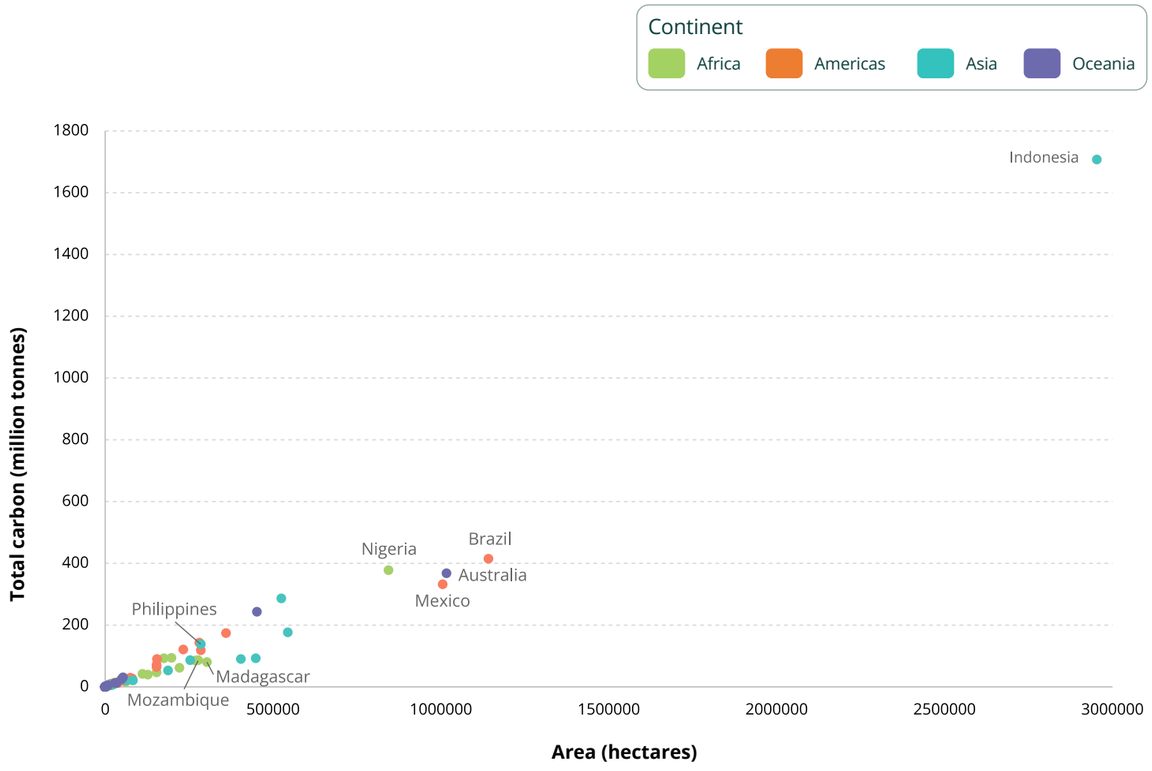


Figure 13. Total mangrove carbon stocks (millions of tonnes) plotted against total mangrove area, by country and continent.

Mangroves provide a critical food source for residents of Mousuni Island, in the Indian Sundarbans
© Simon Rawles, WWF

2.5 Mangrove fisheries

Philine zu Ermgassen (University of Edinburgh)
Thomas Worthington (University of Cambridge)

Mangroves are a critical ecosystem for both fish and fisheries. The complex three-dimensional habitat they create sustains the production of commercially important fish, crustaceans and molluscs that supports an estimated 4.1 million small scale fishers globally. They provide an important source of protein in many tropical coastal communities, as well as being the foundation for several high value commercial fisheries.

Mangroves support rich food webs. Across the diverse geomorphological settings in which mangroves are found, they trap sediments and input carbon and nutrients into the surrounding system. This substrate, combined with the complex root structures of the trees themselves, which are typically overgrown with molluscs and algae, provides food and shelter for vast numbers of small fish and shrimps.

Mangroves essentially form an underwater jungle, generating a vast abundance of aquatic life. The edges of mangrove creeks are safe havens for young fish, providing protection from predation and ample food. Simultaneously they provide rich feeding grounds for predatory fish, which visit the mangrove fringes to prey on those individuals unlucky enough not to have secured a good hiding place. Deeper into the mangroves, the intervening mudflats are home to large numbers of clams and crabs, which burrow in the nutrient rich soft sediments.

Mangroves as fish factories

A new analysis for just 37 commercially important mangrove – affiliated species (fish, crustaceans and molluscs) estimates that, in some places, mangroves can support the production of over 70 individuals per m^2 of mangroves every year. This model was developed using field-derived densities of these species for which mangroves are known to play an important role, and accounted for differences resulting from environmental factors such as mangrove geomorphic setting, salinity, temperature and primary productivity[1].

When mapped onto the 2020 Global Mangrove Watch extent, the model estimates that the presence of mangroves world-wide supports the production per year of nearly 600 billion young-of-year for the 32 modeled commercial fish and shrimp species alone.

Three shrimp species of the genus *Penaeus* represent over half (56%) of that total, with the 29 species of fish contributing the rest. The model also predicts that mangroves support the production of over 100 billion individuals of four species of crab and a single bivalve, *Anadara tuberculosa*. These findings are powerful, but it is also important to note that, as totals, they are highly conservative: many other species of fish and shellfish are harvested from mangroves, which were insufficiently documented for inclusion in these models[2].

At national levels, the model predicts mangrove fish production is highest in those countries with large mangrove tracts in southeast Asia, such as Indonesia, Malaysia, Myanmar and Papua New Guinea. Outside Asia, production is also high in Brazil, Mexico and Australia.

[1] The new model of mangrove fish production will be shared on Global Mangrove Watch and will be submitted for peer reviewed publication. We are deeply grateful to the many colleagues who have supported this work and who will be co-authors in the final output.

[2] This is particularly the case for West Africa where, in the absence of field data, only a small number of globally distributed species are modelled.

Mangrove worms

Mazzella Maniwavie (TNC)

On World Mangrove Day in 2021, TNC worked closely with the local community in Dogura, Papua New Guinea, to plant close to 1,000 seedlings at their mangrove rehabilitation site.

A total area of 3.1 hectares of degraded mangrove was identified and mapped for rehabilitation.

They found that the most significant driver for mangrove destruction at the Dogura site is worm harvesting for fishing bait. Bloodworms are gathered by cutting at the above ground roots of mainly the *Rhizophora* species of mangrove and digging holes as deep as a meter. This destructive harvesting method makes mangroves unstable, which eventually succumb to their own weight and moving tides.

Image: Mangrove bloodworm fish bait

Mangrove fisheries

Fishing in mangroves is typically dominated by small-scale fishers (see State of the World's Mangroves, 2021). It is estimated that of the 52 million marine small-scale fishers globally, 4.1 million fish in mangrove areas[3]. Many of these fishers are artisanal, with their mixed species catches, providing a critical source of both jobs and protein to the coastal communities.

A smaller number of mangrove fisheries, such as those for mud crabs, fetch a high commercial value and may be traded across national or even international markets.

Mangroves are particularly important to fisheries in countries with large tracts of mangroves and large coastal communities. Mangroves are critical to an estimated 893,000 small scale fishers in Indonesia alone, while an estimated 82% and 89% of fishers in Bangladesh and Nigeria respectively fish predominantly in and around mangroves.

In addition to supporting small-scale fisheries, mangroves are widely understood to be important nursery grounds for many commercially important species of shrimp, such as banana prawns.

Mangrove fisher in Nevis, Eastern Caribbean © Mark Spalding

Mangrove fisheries represent a critical resource for coastal peoples world-wide.

These are fished offshore, and supply global markets. For example, mangrove ecosystems in the Hunter and Clarence rivers in Australia are estimated to support commercial fisheries harvests of between AUD $100,000 and AUD $3.5 million per year[4].

Carefully managed, mangrove fisheries represent a critical resource for coastal peoples world-wide.

Supporting local communities, including many who have few economic or livelihood alternatives, they provide a lifeline for food security, especially in times of uncertainty and change.

They may also play a pivotal role in climate change adaptation in the face of future instability in patterns of food security.

[3] Zu Ermgassen, P. S. E., N. Mukherjee, T. A. Worthington, A. Acosta, A. R. d. Rocha Araujo, C. M. Beitl, G. A. Castellanos-Galindo, M. Cunha-Lignon, F. Dahdouh-Guebas, K. Diele, C. L. Parrett, P. G. Dwyer, J. R. Gair, A. Frederick Johnson, B. Kuguru, A. Savio Lobo, N. Loneragan, K. Longley-Wood, J. T. Mendonça, J.-O. Meynecke, R. N. Mandal, C. N. Munga, B. G. Reguero, P. Rönnbäck, J. Thorley, M. Wolff, and M. Spalding. 2020. Fishers who rely on mangroves: Modelling and mapping the global intensity of mangrove-associated fisheries. Estuarine, Coastal and Shelf Science:106975.

[4] Taylor, M. D., T. F. Gaston, and V. Raoult. 2018. The economic value of fisheries harvest supported by saltmarsh and mangrove productivity in two Australian estuaries. Ecological Indicators 84:701-709.

Green July campaign

Enrico Marone (Rare)

Coinciding with World Mangrove Day, Green July is a campaign celebrating the importance of the mangrove ecosystems along Brazil's Amazon Coast – the largest mangrove continuum in the world.

Recognizing the role coastal communities play as guardians of the maretório (tide territory), the campaign mobilizes fishers, youth, and women in these communities to support, promote, and adopt key fishing behaviors to ensure the protection of the mangroves. Partnering with fishing associations, local leaders, and government agencies, Rare has helped make Green July part of the official government's agenda.

Photo: Rare Brazil

2.6

Assessing the threat to mangroves

Marcos Valderrábano (International Union for Conservation of Nature, IUCN), **Nicholas Murray** (James Cook University), **Alix Sauve** (French National Committee of IUCN)

Mangroves are in jeopardy. Direct losses are driven by agriculture, aquaculture and rapid urban expansion. Indirect pressures include natural processes, but are often exacerbated by human actions, include changing sedimentation rates, rising sea levels, changes in temperature and precipitation levels, and increases in harmful pollutants. Often, multiple threats interact to cause an even greater impact.

Developing a clear framework to reliably estimate the risks to mangroves is invaluable, allowing comparisons with other threatened ecosystems.

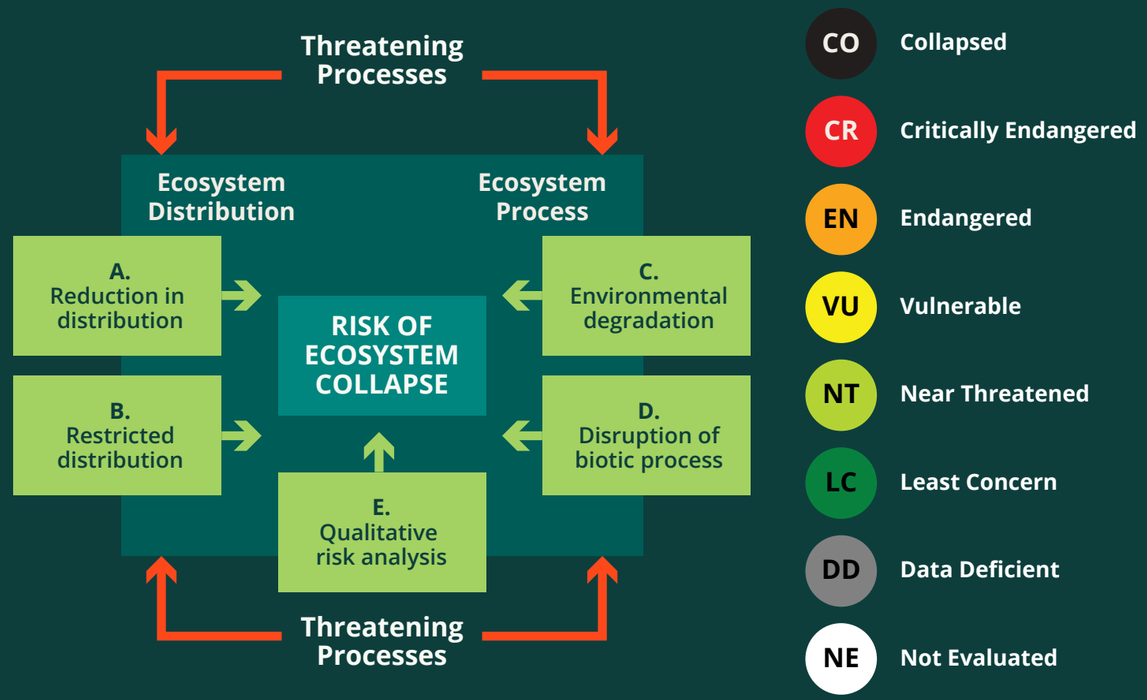
The global standard for assessing risk

The IUCN Red List of Threatened Species (RLTS) uses globally accepted criteria for assessing extinction risk for species, and has become a global standard for quantifying and communicating threats. The Red List of Ecosystems (RLE) takes a similar approach, enabling the reliable classification of the status to any of the Earth's ecosystems.

The RLE takes a standardized approach, evaluating five criteria (A–E), to estimate risks associated with spatial or functional ecosystem degradation. Ecosystems are categorized on a scale from Collapsed (CO), the highest category, through three threatened categories – Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) – to the non-threatened categories[1].

[1] Valderrábano, M., C. Nelson, E. Nicholson, A. Etter, J. Carwardine, J. G. Hallett, J. McBreen, and E. Botts. 2021. Using ecosystem risk assessment science in ecosystem restoration: A guide to applying the Red List of Ecosystems to ecosystem restoration. IUCN, Gland, Switzerland.

Figure 14. Schematic outline of the five criteria used to assess threats to ecosystems (left) and the categories of threat status used in the RLE.



Importantly, the RLE provides diagnostic information on the ecological processes that are critical to ecosystem integrity, plus detailed information on the extent and intensity of threats that contribute to the risk of collapse of an ecosystem.

More than 4,000 ecosystems have been assessed, with the findings having a significant influence on ecosystem management, conservation, and policy: supporting national conservation policies, identifying key degradation pathways and priority actions, and helping to design and monitor restoration plans[2].

Real life applications of the RLE

The IUCN RLE has been applied to mangroves at the continental scale for the Americas, at national levels in countries such as Myanmar and Colombia, and for smaller mangrove areas such as Mayotte and the Indian Sundarbans.

[2] Bland, L. M., E. Nicholson, R. M. Miller, A. Andrade, A. Carré, A. Etter, J. R. Ferrer-Paris, B. Herrera, T. Kontula, A. Lindgaard, P. Pliscoff, A. Skowno, M. Valderrábano, I. Zager, and D. A. Keith. 2019. Impacts of the IUCN Red List of Ecosystems on conservation policy and practice. Conservation Letters 12:e12666.

Vast expanses of mangroves in Southeast Asia have been converted to aquaculture ponds. Many become unproductive and are abandoned © Mark Spalding

Myanmar

In Myanmar[3], four mangrove ecosystems were identified – Tanintharyi mangrove forest, Ayeyarwady delta mangrove forest, Dwarf mangrove on shingle and Rakhine mangrove forest on mud. Each was distinguished by its unique geographic and geomorphic settings, species composition and a range of other factors.

The assessment revealed that three of the four systems were endangered, with the Dwarf and Rakhine mangroves listed as Critically Endangered, putting them among Myanmar's most threatened ecosystems.

Mayotte

A small island territory of France in the Indian Ocean, Mayotte only has limited mangroves, but they are very important. In such settings, finescale data sources are needed to undertake red list analyses. Mayotte's mangrove ecosystems were classified according to their coastal zone – external, internal, and back mangroves – with the assessment revealing that both seaward and back mangroves were threatened.

The French National Committee of IUCN is now starting the assessment of mangroves in the French Antilles, building on its recent finescale coastal ecosystem mapping in Guadeloupe, Saint-Martin and Saint-Barthelemy, with assessments of New Caledonia and Wallis and Futuna in the Pacific region to follow[4].

A global red list of mangrove ecosystems

The standardized approach, provided by the Red List of Ecosystem process, ensures that the results of these individual studies are already useful for comparison with other ecosystems. Efforts are underway to develop a global assessment of the status of the world's mangrove ecosystems.

Mangroves of Dzoumogné, Mayotte © Caroline Cremades

[3] Murray, N. J., D. A. Keith, A. Duncan, R. Tizard, J. R. Ferrer-Paris, T. A. Worthington, K. Armstrong, H. Nyan, H. Win Thuya, O. Aung Htat, Y. Kyaw Zay, and H. Grantham. 2020. Myanmar's terrestrial ecosystems: Status, threats and conservation opportunities. Biological Conservation 252:108834.
[4] UICN France, 2017. La Liste rouge des écosystèmes en France - Chapitre Mangroves de Mayotte, Paris, France, 72 p

A newly cleared mangrove forest, converted to a shrimp pond in Berau, Indonesia © Mark Spalding

A group of experts from SSC Mangrove Specialist Group have described some 39 mangrove biogeographic regions, based on existing bioregionalization work, which will form the spatial units to underpin this global assessment.

This approach will allow comparisons of the status of mangrove systems worldwide, identifying those most at risk of collapse. This will further underpin efforts to report progress towards global targets such as the post 2020 biodiversity framework of the Convention on Biological Diversity.

Mangrove nurseries

Mazzella Maniwavie (TNC)

In Papua New Guinea, the Mangoro Market Meri Program (MMM, described in the 2021 State of the World's Mangroves report), set up to support women and the realization of benefits from mangrove conservation, is moving from strength to strength. It established its first two mangrove nurseries in March 2022 – in Tubusereia Village and at Tahira in the Central Province. Working in partnership with Bootless Lavadae Mangrove Reforestation Association Inc, a local community-based organization, and Motupore Island Research Center, the marine research arm of The University of Papua New Guinea, their shared objective is restoring degraded mangrove areas within the Bootless Bay area. Each nursery will hold 10,000 mangrove seedlings to supply their Dogura Mangrove Rehabilitation site, also located within the Bootless Bay Marine Sanctuary – Papa New Guinea's first declared marine protected area.

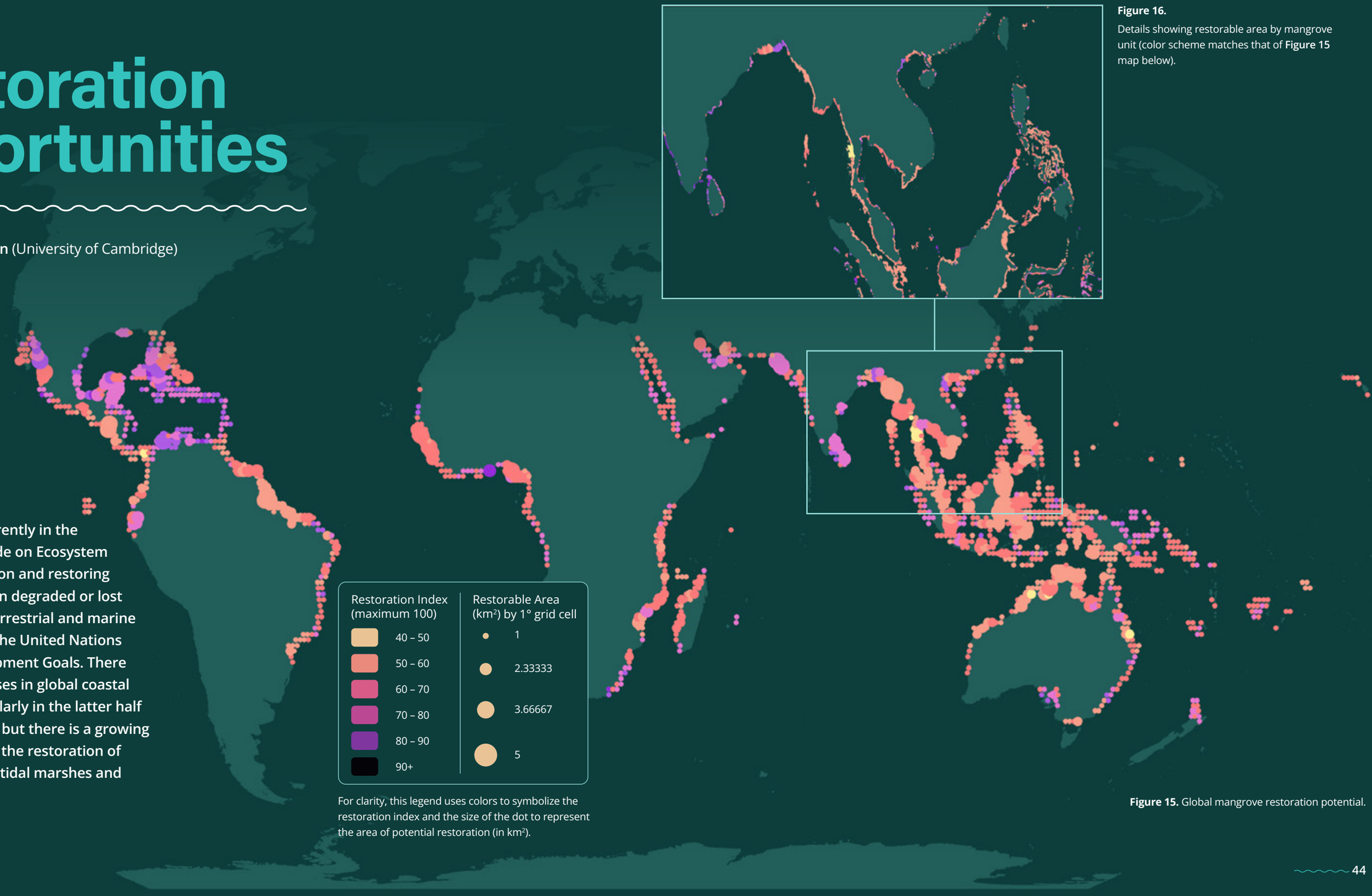
Image: Mangrove nursery
Photo: Eugene Wemin

3.1

Restoration opportunities

Thomas Worthington (University of Cambridge)

We are currently in the UN Decade on Ecosystem Restoration and restoring areas that have been degraded or lost is a key target for terrestrial and marine ecosystems within the United Nations Sustainable Development Goals. There have been huge losses in global coastal ecosystems, particularly in the latter half of the 20th century, but there is a growing impetus to scale-up the restoration of seagrass meadows, tidal marshes and mangrove forests.



For clarity, this legend uses colors to symbolize the restoration index and the size of the dot to represent the area of potential restoration (in km²).

Figure 15. Global mangrove restoration potential.

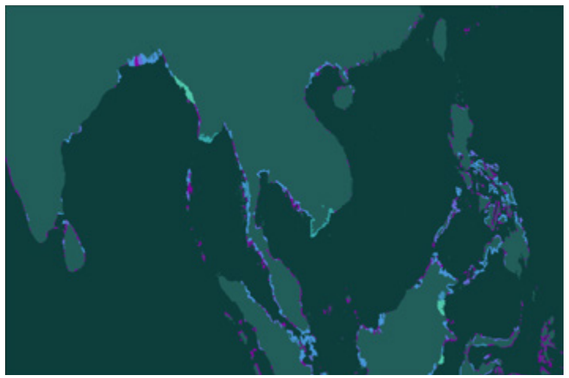
Figure 16.
Details showing restorable area by mangrove unit (color scheme matches that of **Figure 15** map below).

Restoring coastal ecosystems can be challenging but approaches to successful restoration are now well described and are increasingly being shared (**see section 3.2**), and growing calls to share information between practitioners will likely support further learning and understanding (**see section 3.3**).

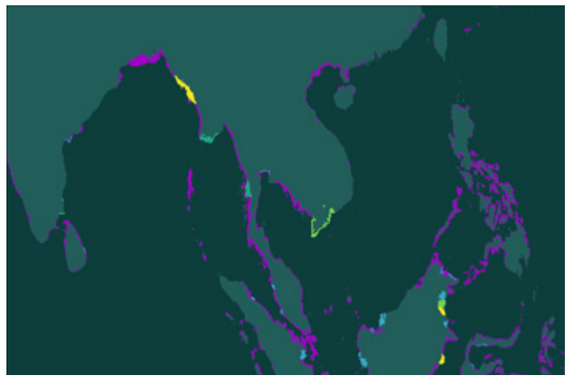
The recent surge in restoration is driven by recognition of the many benefits that arise – to nature, people and the climate. Functioning coastal ecosystems are a haven for a range of plants and animals and provide social and economic benefits, particularly for low-income coastal communities.

Despite covering a relatively small area, mangroves store large volumes of carbon and restoration can play a part in mitigating climate change. Likewise other benefits – including coastal protection, timber and fuelwood production, fisheries enhancement and tourism and recreation support – can support livelihoods and further improve opportunities for climate change adaptation.

Global carbon restoration potential



Global fish restoration potential



[1] The model and summary information will be submitted for peer reviewed publication in late-2022. We are deeply grateful to the many colleagues who have supported this work and who will be co-authors in the final product.
[2] Goldberg, L., D. Lagomasino, N. Thomas, and T. Fatoyinbo. 2020. Global declines in human-driven mangrove loss. Global Change Biology 26:5844–5855.

Where will restoration be most effective?

In a major update to the work described last year, GMA-funded scientists have developed a new global model and map of mangrove restoration potential. Findings shared here will be placed on the GMW portal and published in the coming months[1].

To fully maximize the outcomes of investment in mangrove restoration, we need to understand where it is most likely to be successful and what the benefits will be at different scales.

Using the latest version of the Global Mangrove Watch extent and change maps (**see section 2**), we identified areas of mangrove loss between 1996 and 2020, giving us a footprint for potential restoration. Taking this as a base map, we used data on the key drivers of mangrove loss[2], removing areas of loss that had been eroded or converted to settlements, as these would be too challenging or too costly to restore.

The resulting map highlights some 8,183 km^2 of restorable mangrove areas, centered on areas that have been cleared, converted for agriculture or aquaculture or impacted by extreme weather events. At the national level, Indonesia had the largest potential restoration area, with over 2,000 km^2 available for restoration. Large extents are also found in Mexico, Australia, and Myanmar.

Community restoration on the Indian Coast

Kathiresan Kandasamy
(Annamalai University, India)

The Center of Advanced Study in Marine Biology, attached to Annamalai University in India, has developed and demonstrated success with techniques for restoration of mangroves on degraded coastline along the southeast coast, with the help of students and local communities. The Center proved that these restored mangroves saved many human lives and property during the tsunami of December 26th, 2004. They also proved the mangroves increased fishery resources and fishermen's economic gains. The Center is also training local communities in sustainable livelihoods.

Image: Experimental site after 2 years of mangrove restoration with *Rhizophora mucronata* along the Vellar Estuary, southeast coast of India in 2017.
Photo: Kathiresan Kandasamy

An index for restorability

Mangrove restoration is not simple (see examples throughout this chapter), and in developing this map we also sought to quantify the 'restorability' of mangroves in different places across the world. For this, we asked experts from around the world to rank the importance of different environmental parameters that might influence the ease of restoration, such as tidal height, risk from sea level rise and patch connectivity. This produced a relative index, allowing comparison, at broad scales, of areas which are more or less restorable.

The index suggests that restoration potential was highest throughout Southeast Asia, the north coast of South America and northern Australia. Certain countries were identified that had significant restoration opportunities.

For instance, we estimate that there are over 600 km^2 of restorable mangroves within Myanmar, equivalent to over 10% of its current area, with the majority scoring very highly on the restoration index. In addition, whilst only supporting limited areas of mangrove, many small island nations such as Palau, American Samoa and Comoros had consistently high restoration index scores.

Quantifying the benefits of restoration

The potential benefits from restoration can be broadly assessed by linking the maps of restoration potential with the models of ecosystem services values (**see section 2**).

Restoration potential was highest throughout Southeast Asia, the north coast of South America and northern Australia.

For example, if the entire 8,183km^2 restorable area of mangroves was restored this would potentially result in the addition of over 50 billion individuals per year of 37 commercial marine species of fish, crabs, shrimps and bivalves, and the maps show where such benefits may be maximized.

With its large restorable area, Indonesia had the highest potential fisheries gain from restoration, with Pakistan and Myanmar also featuring highly.

Likewise for carbon, the full restoration of 8,183km^2 offers the potential to increase the amount of carbon stored in aboveground biomass by almost 0.05 gigatonnes, and would also safeguard and restore some 0.3 gigatonnes of soil carbon.

Mangrove restoration in the Rufiji Delta, Tanzania © Menno de Boer, Wetlands International

Combined these would equate to 1.27 gigatonnes of CO_2 equivalent, equal to the emissions from burning over 2.94 billion barrels of oil[3]. Models of other services, such as coastal protection, will add further impetus to the drive for restoration as these become available.

Mapping future restoration

Global maps are a critical tool in driving policy and generating support for scaling up sustainable mangrove restoration. They highlight the important opportunities that mangrove restoration provides, including enormous benefits to society, globally and locally. They provide a broad-scale overview of which areas offer the greatest potential for restoration and the possible returns, in terms of carbon and commercial fisheries, from that restoration.

Practical application of such maps and models, as a means to fully benefit from conservation actions, requires more detailed local understanding of the underlying conditions behind restoration success at finer scales. Such conditions include many social-ecological factors, such as land tenure[4], which are not mappable at global scales.

The global maps provide a starting point – highlighting a remarkable opportunity for what can be achieved – and a jumping off point for a new wave of mangrove restoration which is already underway in many areas, and which is benefitting from a surge in our understanding of approaches and in many new partnerships and projects being forged by GMA members and others around the world.

Urban mangroves are spreading through planting and natural recruitment in Dohat Arad Lagoon in Bahrain © Mark Spalding, TNC

Young saplings at Mawanda restoration site, Senegal © Elizabeth Wamba/Wetlands International/DOB Ecology

[3] The numbers for carbon are simple totals of carbon that would be contained in mature restored mangrove ecosystems. In most cases their current converted condition still contains carbon, although in much lower concentrations than in mangrove ecosystems.
[4] Lovelock, C. E., and B. M. Brown. 2019. Land tenure considerations are key to successful mangrove restoration. Nature Ecology & Evolution 3:1135-1135.

3.2 Restoration guidelines

Jennifer Howard (CI)
Celine van Bijsterveldt (Wetlands International)
Clint Cameron and Catherine Lovelock
(University of Queensland)

Restoration in Ambaro Bay, Ambilobe, Madagascar
© Nick Riley, WWF-Madagascar

The importance of restoration

Restoring mangroves is a transformative nature-based method of mitigating climate change and increasing coastal resiliency.

Healthy mangrove ecosystems capture and store carbon at much higher rates than most terrestrial forests and act as natural infrastructure that provides vital protection from storms, coastal flooding, and erosion. Simultaneously, mangroves can boost economic resilience by increasing access to sustainable livelihoods and food sources.

Why projects fail

Despite their importance, investments in ambitious mangrove restoration projects have been slow. Investors are concerned that many mangrove restoration efforts fail, yet such failures are preventable.

Whether large scale or small, most projects are hindered by weaknesses in conception and execution. Local NGOs and communities often head small-scale efforts without the technical expertise to design restoration projects effectively. Governments usually conduct large-scale restoration efforts, but are largely focused on reducing costs and maximizing project area.

Many projects are conceived without addressing the underlying causes of loss, resulting in failure to sustain any initial gains in mangrove coverage. Other projects fail due to techniques which are at odds with the established science – like planting the wrong species, or in the wrong areas.

Typically, restoration has focused on planting single-species, often selecting fast-growing species, or easily planted seedlings that may not be suited to local conditions. While effective mangrove restoration approaches have been developed and implemented, this capacity and knowledge is still not broadly available.

Failed restoration efforts represent lost opportunities to re-establish the many benefits that mangroves provide, but they also represent a tremendous waste of resources and undermine confidence in the restorability of mangroves.

Mangrove planting in Dili, Timor Leste © Jürgen Freund, WWF

Ecological workshops in Lamu

Laura Michie (Mangrove Action Project)

Mangrove Action Project and Wetlands International – Eastern Africa (WI-EA) ran a highly successful 'community-based ecological mangrove restoration' (CBEMR) workshop in Lamu, Kenya, in March 2022. This workshop supported WI-EA's 'Mangrove Capital Africa' program and taught best practice mangrove restoration techniques to community members, government staff and local NGOs.

Many previous restoration attempts had failed, so the workshop aimed to improve knowledge of mangrove ecology and biology; encourage the mitigation of mangrove stressors; and facilitate natural regeneration. Participants are now implementing what they learned in the workshop to restore their mangroves and bring back healthy and biodiverse forests.

Image: Communities learning CBEMR techniques, Kenya
Photo: Leo Thom

A new approach

Successful mangrove restoration requires an end-to-end approach targeting three key stages:

1. **Pre-implementation: setting the objectives for restoration e.g., carbon sequestration, coastal protection**
2. **Implementation: utilizing best practices that account for specific local conditions, while addressing the objectives**
3. **Post-implementation: monitoring, evaluation, and learning from conducted activities**

The Global Mangrove Alliance, along with the International Blue Carbon Initiative, is developing a guide to restoration, building upon years of existing work establishing science-based restoration techniques.

The guide will highlight key questions and decisions for each project phase, with detailed advice linked to restoration targets, such as carbon credit development, coastal protection, and/or combined land use.

To support the reporting and monitoring of restoration, and to aid the sharing of critical information, the Global Mangrove Alliance is also launching a Mangrove Restoration Tracker Tool (MRTT) (**see section 3.3**). When combined, these tools and guides will increase successful mangrove restoration outcomes through (i) identifying and tracking success from past, present, and future mangrove restoration activities and (ii) motivating best practice mangrove restoration activities globally, leading to long-lasting change.

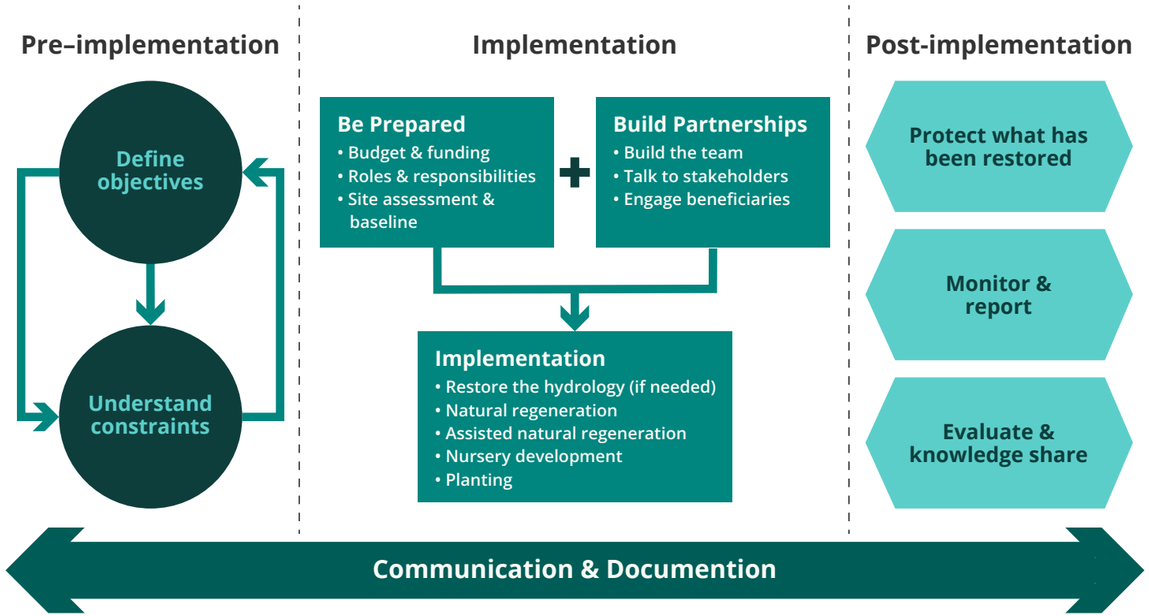


Figure 16. Stages of mangrove restoration best practices.

Restored mangroves provide defense against erosion from boat wakes. Indian River, Florida © Mark Spalding, TNC

Mangrove restoration guide

Most mangrove restoration manuals produced in recent years focus on small-scale efforts, and rarely consider the broader objectives and benefits of restoration. The new guide will draw from the wealth of literature on mangrove restoration to guide practitioners to the information that fits with their goals.

Identifying and articulating goals is critical because they will influence the decisions around planning and implementation. For example, if you intend to develop a restoration project to generate carbon credits, planning and implementing will come with specific requirements, including establishing a quantified baseline and selecting a reputable carbon methodology, such as Verra's VM0033[1].

Projects where the main goal is to restore coastal wetlands for fisheries habitat, biodiversity enhancement or fuelwood collection may have very different planning and design requirements. There are also considerations related to scale: choices that make sense for smaller-scale projects may simply not work for larger-scale initiatives.

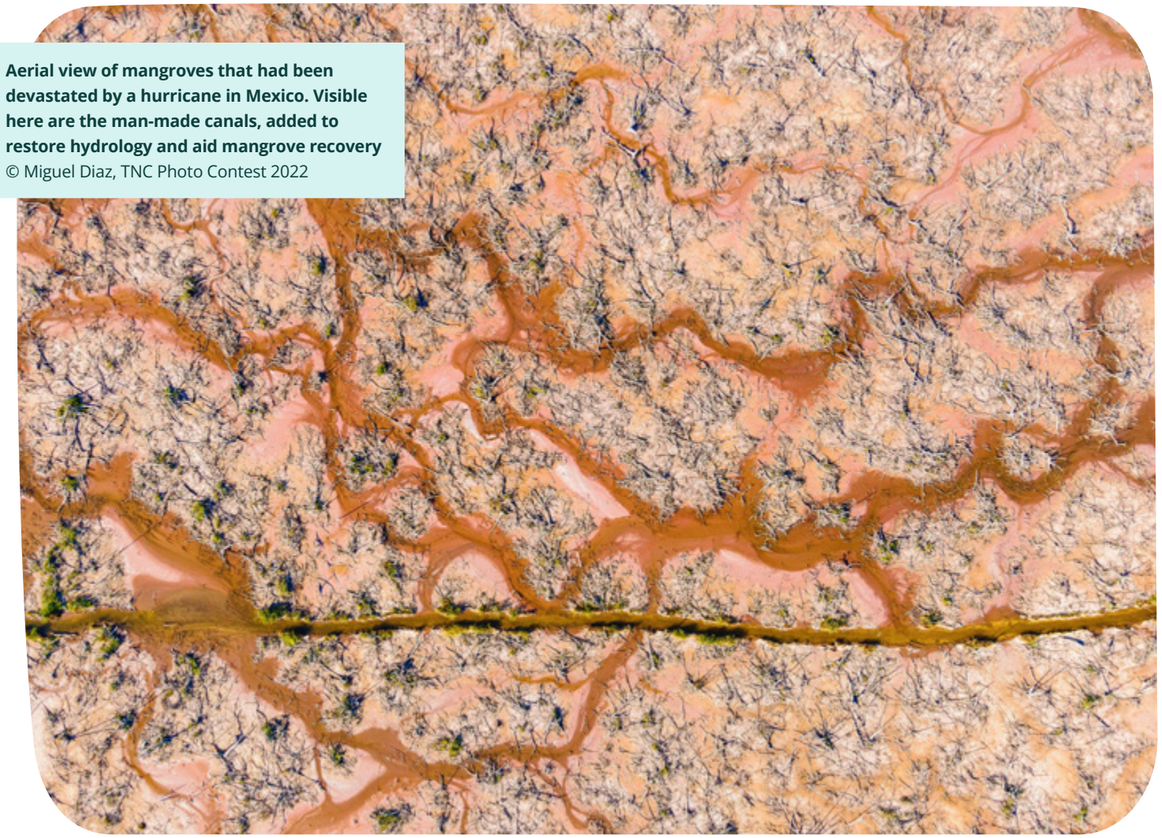
Alongside goals, it is critical to **identify possible constraints**. These typically include the available funding levels, implementation costs, social and policy conditions, and biophysical constraints. Advance consideration of constraints allows the identification of risks and uncertainties in terms of project outcomes and can help guide decisions on how the project should progress.

[1] J Baldock, T Cannard, J Kelleway, C Lovelock, A Steven and M Vanderklift, 2019. Technical assessment of the Verified Carbon Standard – 'VM0033 Methodology for Tidal Wetland and Seagrass Restoration.' CSIRO Final report prepared for the Department of Environment and Energy, Canberra, Australia. 25 October 2019, 65 pp.

How to use the guide

The role of this guide is not to replicate existing work, but to build upon it. By combining past work with the broad experiences from GMA members and partners, the new guide should help to prevent future restoration failures and will present opportunities for new projects to have the greatest possible impact.

Failed restoration efforts represent **lost opportunities to re-establish** the many benefits that mangroves provide.



Aerial view of mangroves that had been devastated by a hurricane in Mexico. Visible here are the man-made canals, added to restore hydrology and aid mangrove recovery
© Miguel Diaz, TNC Photo Contest 2022

The guide will primarily support project practitioners, providing pathways to decide appropriate methods depending on the project goals. It will also function as a one-stop shop, where users can easily find all the information needed to successfully restore mangroves, pointing to existing guidance where available and filling gaps as needed.

The overall structure will be a modular document with:

1. **An overarching component, taking the reader step by step through the process of scoping, planning, designing, implementing, and monitoring mangrove restoration, pointing to relevant existing guidelines and tools along the way.**
2. **Modular extensions related to specific goals that users may have. Modules in development will include local ecological knowledge, blue carbon, coastal protection, and combined land use. The modular setup allows for other extensions in the future.**

Using simple questions, the guide will allow readers to determine best practices for their project context and goals. In addition, this decision tree structure will be designed for quick and easy updating as new protocols and science become available.

'The Mangrove Restoration Guidance' will be a living document and available on the GMA Knowledge Hub late in 2022. The Guidance will continue to evolve as new topics are explored and in 2023 we plan to create an interactive 'clickable PDF' with links to source documents, videos, and other resource materials.

Partnering to restore in Mumbai

Ajay Govale (United Way Mumbai)

As of May 2022, United Way Mumbai has planted and maintained 149,845 mangroves on 33 hectares of wetlands with the help of 29 corporate partners and 2,798 volunteers. For successful restoration, the planting was carried out using the fishbone style, with an array of channels running out from the main creeks to ensure sufficient tidal water flow to the plants. This rejuvenation helped enrich the forest biodiversity and improve livelihoods for local communities.

United Way Mumbai managed to raise awareness in 9,329 individuals through nature trails, classrooms and virtual sessions. They have also cleaned up 5.67 tons of waste and pollution from the wetlands through volunteer-led clean-up drives.

Image: Aerial view of the fishbone style mangrove plantation
Photo: United Way Mumbai

Drones can be used for finescale site mapping © Tim Calver, TNC

3.3

Tools for scaling & success

Rowana Walton (University of Cambridge)
Dominic Andradi-Brown (WWF)
Yasmine M. Gatt (National University of Singapore)
Thomas A. Worthington (University of Cambridge)

Huge advances are being made in restoration projects around the world, often overcoming many financial, ecological and social challenges. At the same time, opportunities are being missed to track restoration efforts, to learn from them, and to share this information with others.

The Challenge

Despite large inputs of time and resources into the restoration of mangroves worldwide, there is a scarcity of information available on their effect. Project outcomes are often not reported, and when they are, there is a bias towards projects that have been successful. Because of this, the restoration community loses a valuable opportunity to learn from its past mistakes.

Information on mangrove restoration projects is scattered across websites, gray literature and published papers making it challenging and time-consuming to find and to use this evidence to influence decision-making. Furthermore, the types and accuracy of data reported are extremely variable, with information on key aspects such as costs or measures of success largely lacking, making holistic assessments of conservation success challenging[1].

Scaling up

If we want to scale-up mangrove restoration to meet the ambitious global targets of the Global Mangrove Alliance or other commitments (such as the Bonn Challenge or the UN Decade on Restoration, (**see Section 4.2**), then we need to improve the documentation of restoration aims and approaches as well as the monitoring and evaluation of interventions and outcomes, both positive and negative. Such information needs to be documented, but also shared.

A rich supply of information on restoration efforts world-wide will enable the continuing improvement of all aspects of restoration, from funding and planning, to application, benefits-sharing and reporting.

Easy access to such information would provide practitioners with a critical tool for cross-project learning, enabling peer-to-peer support and information exchange, with the potential to facilitate new restoration efforts and promote the efficient use of limited funding.

Reporting on restoration

As a means to encourage better documentation and data sharing on restoration projects world-wide, researchers at the University of Cambridge and WWF, working with conservation practitioners and scientists from across the Global Mangrove Alliance, have been developing a globally accepted standard reporting framework to record and track objectives and outcomes from mangrove restoration projects.

[1] Gatt, Y. M., D. A. Andradi-Brown, G. N. Ahmadia, P. A. Martin, W. J. Sutherland, M. D. Spalding, A. Donnison, and T. A. Worthington. 2022. Quantifying the reporting, coverage and consistency of key indicators in mangrove restoration projects. Frontiers in Forests and Global Change 5.

From abandoned fishpond to mangrove greenbelt

Jurgenne Primavera (ZSL)

The success story of the Leganes Integrated Katunggan Ecopark (LIKE) in Iloilo, central Philippines showcases pioneering pond-to-mangrove reversion, coastal greenbelts, and good governance underpinned by science-based protocols, assisted natural regeneration (ANR), volunteer planting, and networking. ANR, also known as managed regrowth, is the human protection of natural tree seedlings, which typically involves the removal of barriers to natural regeneration.

Over the 4-year collaboration between ZSL and the Leganes, Iloilo municipal government, ~90,000 wildings were outplanted in 9.5 hectares of abandoned fishponds by thousands of students, government employees, local communities and other volunteers. Project achievements include passage of a municipal ordinance protecting mangroves, creation of a Municipal Environment and Natural Resources Office, and the Disney Conservation Hero Award granted to a local champion. The Ecopark has provided protection via a 200-meter-wide greenbelt.

Engineering meets mangroves

Emma Cummings-Krueger (CI)

The ecological mangrove restoration of the Puntarenas Estuary in Costa Rica is the largest coastal engineering initiative in Central America.

To restore hydrological connectivity, over 5,000m of channels have been excavated or rehabilitated, helping to restore mangroves.

Efforts are also being made to promote additional conservation of close to 5,200 hectares of mangroves to positively impact local communities.

Image: Puntarenas mangrove restoration
Photo: Jorge Pineda & Danilo Torres

Over 80 conservation practitioners and scientists from around the world have so far participated, with virtual workshops, interactive feedback sessions, and field trials.

From this, a framework has been developed for recording current and historical projects, and to guide current and future practitioners to consider the range of data that is important to collect.

Mangrove Restoration Tracker Tool (MRTT)

This work is now being built into a Mangrove Restoration Tracker Tool (MRTT), which will complement and support field-based data collection. With a flexible structure it will be suitable for all different restoration approaches, and for projects covering single or multiple outcomes across the full array of ecological and socio-economic benefits mangrove forests provide.

There are three critical components to reporting across the lifetime of a project:

1. **Pre-restoration site baseline**
2. **Restoration interventions**
3. **Post-restoration monitoring**

The MRTT will allow users to complete these components at different time points throughout a project, even allowing for multiple and ongoing entries to continue monitoring projects over time.

Each section consists of several questions with multiple choice responses, with the intention that data providers can rapidly, yet comprehensively, describe their project.

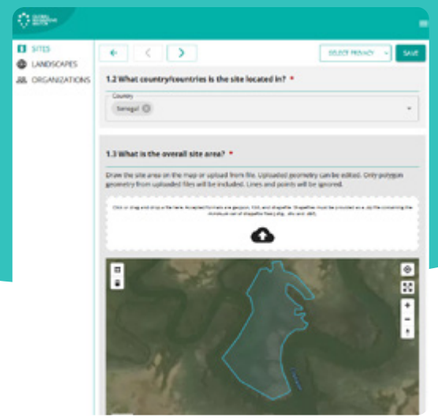
Generating successful interventions

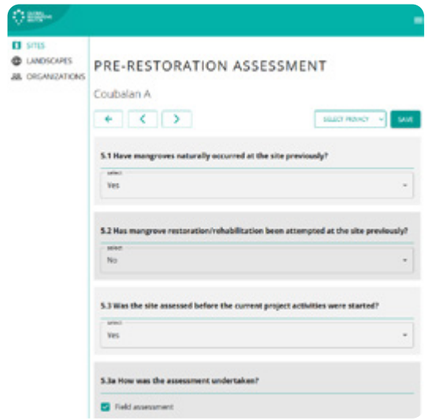
The MRTT is being designed as an online interactive tool, with a PDF version available for field data collection. It will be accessible in several languages, and will be linked to other best-practice guidance (**see section 3.2**).

The MRTT will:

- **Support practitioners, identifying the key steps for consideration when doing mangrove restoration and the key indicators required to track outcomes**
- **Simplify the recording of project outcomes**
- **Highlight the benefit of long-term monitoring, encouraging documentation of a wider range of ecological and social outcomes**
- **Enable data visualization and comparison with other projects that have similar underlying conditions**
- **Provide a means to communicate positive restoration stories**
- **Allow rapid synthesis of restoration efforts at national and international levels, providing data on our ability to meet national and global conservation and restoration targets**
- **Help to identify areas for further evaluation or identify gaps in mangrove restoration program activities**

The MRTT is nearing completion. It will initially be 'populated' by an array of data from sample projects, helping to give it immediate utility not only as a reporting framework but as an information source. It will be hosted on the Global Mangrove Watch portal, and linked to the GMA website.





Communities restoring hydrology for mangroves in El Salvador © Diego Vivanco

3.4

Including local ecological knowledge in mangrove conservation & restoration

Kate Kincaid (University of Cambridge), **Kerry Grimm** (Northern Arizona University), **Farid Dahdouh-Guebas** (Université Libre de Bruxelles), **Dominic Wodehouse** (Mangrove Action Project), **Mark Spalding** (TNC), **Thomas Worthington** (University of Cambridge)

The importance of local knowledge

Having a broader and more detailed understanding of the local conditions and history of a particular site can greatly improve successful protection and restoration of mangroves. For many areas, however, there are huge data gaps, including information on past conditions, local human uses, the fauna and flora, and physical and hydrological settings.

To fill knowledge gaps, scientists often rely on estimates from large-scale, low-resolution datasets, but such information rarely captures the local context. Collecting local data can be challenging, costly, and time-consuming. Nevertheless, local peoples can provide a critical route to addressing data deficiencies and knowledge gaps[1].

Local people are a critical source of ecological information © Ana Grillo

Using local knowledge to track mangrove ecosystems

Local ecological knowledge (LEK) is a broad term encompassing the information any local people have on animals, plants, and the environment with which they are familiar. This broad definition includes, but extends beyond, traditional ecological knowledge (TEK), which is often multi-generational and rooted in a cultural framework. LEK can provide information on the organisms present, the interactions between humans and the environment, and changes in the ecosystem through space and time.

For mangroves, LEK has provided information and context in a range of settings:

- **In India's Godavari mangrove forest, local perceptions of change in mangrove areas differed from GIS maps and information from both approaches was used to inform management**[2]
- **Through participatory mapping, a local community in the Philippines identified mangrove patches that were not identified in global mapping efforts**[3]
- **In Madagascar, LEK provided comprehensive bird inventories, with local people adding 18 species that were not found in formal field surveys**[4]

Such examples underline the depth and breadth of information available. Gathering such information requires sensitivity to ethical considerations and procedures, such as ensuring LEK holders are fully informed and have consented to the study[5]. But gathered correctly, such information can strengthen our understanding of mangrove ecosystems and support effective protection, restoration, and management of these areas.

Local peoples can provide **a critical route** to addressing data deficiencies and knowledge gaps.

[1] Rist, S., & Dahdouh-Guebas, F. (2006). Ethno Sciences––A step towards the integration of scientific and indigenous forms of knowledge in the management of natural resources for the future. Environment, Development and Sustainability, 8(4), 467-493.
[2] Dahdouh-Guebas, F., Collin, S., Lo Seen, D., Rönnbäck, P., Depommier, D., Ravishankar, T., & Koedam, N. (2006). Analysing ethnobotanical and fishery-related importance of mangroves of the East-Godavari Delta (Andhra Pradesh, India) for conservation and management purposes. Journal of Ethnobiology and Ethnomedicine, 2(1), 1-22.
[3] Francisco, R. R. T., Blanco, A. C., Manalili, M. A. G., Gatdula, N. B., Songcuan, A. J. G., Landicho, K. P. C., ... & Apura, R. J. A. (2019). Mapping of Blue Carbon Ecosystems: Effect of Proximity, Activity Types and Frequency of Visits in the Accuracy of Participatory Maps. The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, 42, 83-88.
[4] Gardner, C. J., Andriamahenina, Z., Carro, A., Jones, T. G., & Jasper, L. D. (2017). Rapid assessments and local knowledge reveal high bird diversity in mangroves of north-west Madagascar. Wetlands Ecology and Management, 25(1), 45-58.

Making use of LEK effective

To expand our understanding of LEK in mangrove conservation, a team of partners, with support from the Global Mangrove Alliance, are developing tools and guidelines to support the uptake and effective and equitable use of LEK in mangrove forest research, conservation, and restoration. This will support practitioners looking to include LEK alongside quantitative survey data.

Combining different types of data and knowledge can greatly strengthen decision-making, while meeting global policy calls to include LEK[6]. It can provide essential support to conservation and restoration outcomes, both by generating a more holistic understanding of local ecosystems, and through supporting the involvement and engagement by local people.

Villagers near Sittwe, Myanmar using a map of their village printed onto vinyl from to check a shared understanding of local resources, activity plans and tenure © Dominic Wodehouse, MAP

Baseline ecological surveys can be greatly helped by local people. Rufiji Delta, Tanzania
© Julie Mulonga, Wetlands International

Fishers in the Godavari Mangrove Forest in India use mangrove bark used for dyeing fishing nets
© Sarah Collin in Dahdouh-Guebas et al., (2006)

[5] Free Prior and Informed Consent – An Indigenous Peoples' right and a good practice for local communities – FAO. 2016. https://www.fao.org/3/i6190e/i6190e.pdf
[6] The United Nations Decade on Ecosystem Restoration Strategy. Strategy document.

Beekeeping in Thailand

Leo Thom (Mangrove Action Project)

In the village of Nai Nang in Southern Thailand, community members are restoring their lost mangrove forests and using beekeeping to provide sustainable livelihoods.

Mangrove restoration provides a habitat for bees and beekeeping encourages a reduction in the use of pesticides and herbicides, as well as helping to pollinate the mangrove trees.

With the success of this innovation, Mangrove Action Project and Nai Nang villagers are working to train other communities along the Andaman coast to restore their mangroves and keep bees.

Image: Bee keeping workshops
Photo: Leo Thom

4.1
Mangrove recognition on the world stage

Emily Goodwin (IUCN), **Lisa Schindler Murray** (Rare), **Emily Landis** (TNC), **Karen Douthwaite** (WWF), **James Hardcastle** (IUCN), **Swati Hingorani** (IUCN), **Carole Saint-Laurent** (IUCN), **Anete Berzina-Rodrigo** (IUCN), **Victoria Romero** (IUCN)

The international importance of mangroves

In addition to their local benefits, mangrove forests are of considerable global importance. International dimensions of mangrove ecosystems include their role in safeguarding coastal biodiversity, storing carbon, helping the world adapt to the impacts of climate change, protecting our coastlines, and the flow of mangrove products including fisheries products, timber and fuelwood. The successful protection of mangrove forests therefore requires coordination across national boundaries and up to global scales.

Mangrove fisherwoman in Thailand © Ana Grillo

Mergui Archipelago, Myanmar
© Ethan Daniels, TNC

International policy agreements can enable collective action on global challenges, while also encouraging and strengthening national and local efforts. For mangrove ecosystems, coordinated global, national and local action is critical to successfully tackling the loss of mangroves and supporting restoration.

Recent policy advancements are rallying governments around the critical need to protect and restore mangroves: from the inclusion of ocean and coastal ecosystems in the Glasgow Climate Pact; to the incorporation of mangrove indicators and targets as part of the upcoming adoption of the Post-2020 Global Biodiversity Framework; and to the recent 2022 UN Ocean Conference outlining priorities for accelerated investment in nature-based solutions in coastal ecosystems.

Collective global progress through local action

International policy frameworks on global challenges such as climate change, biodiversity loss, and sustainable development offer an opportunity for national policymakers to come together to set global targets and share how their national and local action contributes to global change.

However, in order to realize these global agreements, countries have to step up and make commitments to contribute towards these collective goals.

Scientific developments and the increasing availability of mangrove data provide a valuable starting point for policymakers. New or improved data – such as some of the information described here on above and below ground carbon stocks and on the socio-economic value of mangrove ecosystems – can be used to strengthen national biodiversity, development, and climate policies by including ecosystem-based approaches and re-shaping the pressures of coastal development and other threats to mangroves.

Policymakers also must work together to share case studies of protection successes. In June 2022, the UNFCCC Ocean and Climate Change Dialogue served as an opportunity for governments and implementation partners to share examples of how coastal ecosystems, like mangrove forests, serve as valuable resources vital for climate action in their country and communities, and how these local actions contribute to collective global action.

Protecting mangroves through policy

There is no one-size-fits-all approach to mangrove policy. Tailored legal frameworks and management approaches must be designed based on local contexts to address the threats to mangrove ecosystems. For example, mangroves can be protected through the establishment of protected areas and Other Effective Area-based Conservation Measures (OECMs)[1] (**see section 4.3**).

Coastal land use planning, permitting, and environmental impact assessment processes can be used to regulate development activities within and around mangrove forests; species native to mangrove ecosystems can be placed under protection; restrictions can be placed on activities that affect hydrology, and more.

These different legislative paths can all have positive impacts on the health of mangrove ecosystems without completely restricting their usage or access.

For more information on options for local policies for mangrove protection, see section 5.2 'Engaging the World' in the 2021 State of the World's Mangrove Report.

Mangrove dieback following coastal road construction. Baja California, Mexico © Mark Spalding/TNC

Mothers of Mangrove

Enrico Marone (Rare)

In northern Brazil, a territory home to the world's largest continuous area of mangroves, the Mothers of the Mangroves (Mães do Mangue) campaign is inspiring and engaging communities to defend and protect this critical ecosystem. In the extractive reserves, fishing communities depend on healthy ecosystems for their food security and livelihoods.

In Partnership with Purpose, a social movement incubator, Rare captured the stories of several women from the area for a web video series, revealing the fundamental role these women play in advocating for the protection of the mangroves, and their ability to help communities adapt to climate change. The campaign also featured the publication of a cookbook, containing recipes native to the Amazonian mangrove forests in Brazil's Pará state.

Photo: Rare Brazil

[1] An OECM is defined by the CBD as a geographically defined area other than a Protected Area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the in situ conservation of biodiversity, with associated ecosystem functions and services and where applicable, cultural, spiritual, socio–economic, and other locally relevant values' (CBD/COP/DEC/14/8). OECMs recognize de facto long-term conservation outside of formally designated protected areas, such as lands managed by indigenous peoples and local communities. See examples of mangrove protection through OECMs in Indonesia at https://www.sciencedirect.com/science/article/pii/S0308597X21005509 and in India at https://www.undp.org/sites/g/files/zskgke326/files/2022-06/OECM_criteria%20and%20guidelines_India_May%202022_.pdf.

Fiddler Crab, St Lucia © Mark Spalding, TNC

4.2

Mangroves in climate & biodiversity policy

Emily Goodwin (IUCN), **Lisa Schindler Murray** (Rare), **Emily Landis** (TNC), **Karen Douthwaite** (WWF), **James Hardcastle** (IUCN), **Swati Hingorani** (IUCN), **Carole Saint-Laurent** (IUCN), **Anete Berzina-Rodrigo** (IUCN), **Victoria Romero** (IUCN)

Recognition of the value of healthy ecosystems for mitigating global climate change, safeguarding biodiversity, reducing disaster risks, and achieving sustainable development goals, is woven across many international frameworks. Commitments from national governments to these collective global targets serve as a reflection of the level of ambition to reverse degradation and deforestation in mangrove areas.

The latest high-resolution map data from GMW (**section 2.1**) can be used to support policymakers in reporting on their mangrove progress towards international targets and goals.

Simple summary information on the GMW online platform can be used by national policymakers to assess restoration potential (**section 3.1**), see how much of their mangroves are under protection (**section 4.3**), and calculate the national carbon storage of their mangrove stock (**section 2.4**).

The GMA is also finalizing a Mangrove Restoration Tracker Tool (MRTT) (**section 3.3**) which will help practitioners to record and monitor restoration efforts while enabling a ground-up synthesis of restoration progress, aggregating site level community or NGO led progress with larger government initiatives and enabling the sharing of lessons learned. Global opportunities to assess progress and discuss experiences may provide a useful platform to demonstrate how local action on mangrove protection is vital for progress on global goals like climate change and biodiversity.

As mentioned in the 2021 edition of this report, 2030 is cited as a milestone year for many of the targets in various international frameworks. Some of these key upcoming targets include:

1. Mangroves in the Paris Agreement

Under the UNFCCC's Paris Agreement, countries are responsible for making strong commitments for national action on climate change mitigation and adaptation through Nationally Determined Contributions (NDCs) and National Adaptation Plans (NAPs).

Countries are required to periodically report their national progress towards meeting their goals and update their NDCs to ratchet up ambition towards meeting collective global targets such as keeping global warming under 1.5°C. Including nature-based climate solutions such as mangrove protection or restoration in these commitments sends a strong signal of national policy and investment priorities to the international community.

Proboscis monkeys combing a creek for food in North Kalimantan, Indonesia
© Ryan Hidayat, TNC Photo Contest 2022

The ongoing UNFCCC Global Stocktake is a process that assesses the world's collective progress towards achieving the Paris Agreement and serves as a means to inform countries on how to raise their ambitions in NDCs. GMA partners have developed a guidance document outlining how ocean-relevant topics and themes, including mangrove protection actions, can be assessed as a contribution to achieving the goals of the Paris Agreement during the 2023 Global Stocktake process[2].

There are numerous further UNFCCC processes, bodies and ongoing negotiations where countries may advance efforts to address ocean-climate challenges and strengthen recognition of the role of coastal and marine nature-based climate solutions. This document by GMA partners summarizes many key entry points.

[2] Schindler Murray, L., Romero, V. and Herr, D. (2021): Unpacking the UNFCCC Global Stocktake for Ocean-Climate Action. IUCN, Rare, Conservation International, WWF, and Ocean & Climate Platform.

Action in Belize

Nadia Bood (WWF)

In Belize, mangroves are considered coastal guardians and cost-effective nature-based solutions for climate mitigation and adaptation. Belize set ambitious mangrove targets within its 2021 Nationally Determined Contribution to the UNFCCC: restoring 4,000 hectares of mangroves and doubling the area of mangroves under protection by 2030.

In response to these goals, WWF, together with partners, is conducting outreach and training to improve the knowledge and expertise of government staff, NGOs, and local communities in mangrove rehabilitation, and promoting community-based actions to protect and restore mangroves at scale. Stakeholders are learning specific restoration techniques appropriate to low and high intensity coastlines.

Image: Mangroves in Belize

2. Mangroves in the Post-2020 Global Biodiversity Framework

The 2022 UN Biodiversity Conference (CBD COP15) will finalize negotiations to adopt the Post-2020 Global Biodiversity Framework, which will serve as a global 'Paris Agreement for Nature' to set global biodiversity goals and targets to supersede the previous Aichi Biodiversity Targets[3].

Mangroves will play a vital role in delivering this framework, considering their contributions to biodiversity, livelihoods and food security through provision of habitat to fish and other wildlife, in addition to their climate and resilience benefits.

A guidance document developed by GMA partners illustrates the contribution of mangrove ecosystems towards the achievement of multiple goals and targets of the framework, while also demonstrating to policymakers the scientific resources available to set national mangrove targets and support reporting – such as the Global Mangrove Watch[4].

3. Protection Targets

Within the same CBD negotiations, countries are expected to sign a framework that will call for the protection, restoration and sustainable management of 30% of terrestrial and marine ecosystems by 2030, referred to as the 30x30 target.

The GMA supports this global target but notes that for critical natural resources such as mangrove systems, which are already highly diminished from their original extents, 30% protection is far too low.

Further, with protected areas already covering 42% of current mangrove area (**see section 4.3**) this target has already been met for mangrove ecosystems.

Thus, the GMA's ambition exceeds this target – our goal of doubling protection and halting all further loss would see more than 80% of mangroves protected and sustainably managed by 2030.

Experiences by GMA members globally demonstrate that ongoing efforts to protect and restore mangroves can be a model for how 30x30 should be implemented across other ecosystems: via a people-led approach where Indigenous Peoples, local communities and other stakeholders are at the forefront of deciding which areas count under this global goal and collectively designing how they should be managed.

4. Mangroves in the UN Decades of Ecosystem Restoration and Ocean Science

Two major UN Decades run through 2030: one focusing on Ecosystem Restoration and the other on Ocean Science for Sustainable Development. Both of these Decades will be instrumental to protecting people and nature around the world, including tropical and subtropical regions rich with mangroves.

The GMA is an official implementing initiative of the UN Decade on Ecosystem Restoration, working to raise ambition on mangrove restoration and track and monitor progress through the Global Mangrove Watch.

The GMA looks forward to the years ahead as science and sustainable development is prioritized alongside restoration and conservation of mangroves.

Additional resources by GMA partners

There has been significant progress made since the State of the World's Mangrove Report 2021. We've highlighted the major international frameworks, but additional publications to help guide practitioners and policymakers are included below.

Guiding principles on sustainable mangrove ecosystem management

This set of sustainable mangrove ecosystem management principles aims to ensure that mangrove action actively benefits local communities. These principles are designed to provide guidance for national policy decision makers responsible for conservation, restoration, protection and management of mangrove ecosystems.

Integrating technology and nature-based solutions through green-gray infrastructure

To address escalating climate risks in coastal settings, countries must consider adaptation approaches that integrate both nature and technology. This UNFCCC Technology Executive Committee policy brief summarizes recommendations for policymakers to scale up green-gray infrastructure approaches.

[3] https://www.cbd.int/aichi-targets/
[4] Save Our Mangroves Now!, Global Mangrove Alliance, Global Mangrove Watch, and the Mangrove Specialist Group of IUCN's Species Survival Commission 2021. Guidance on Mangrove Indicators in the Post-2020 Global Biodiversity Framework.

4.3
Progress in protection

Mark Spalding (TNC)

Beyond the 30x30 target

At a planetary scale, mangroves are ahead of the curve. Some 42% of all the world's remaining mangroves fall within protected areas recognized by the IUCN.

Thus, while there are growing efforts to set global targets for protection of 30% of all terrestrial and marine areas by 2030 (30x30), it is clear that we can focus a greater ambition towards mangroves.

Part of this success has come from the growing realization that the value of mangroves is so great that ensuring their long-term protection is an investment. One that will pay out dividends immediately and in perpetuity.

Regional patterns of mangrove protection are presented in **Figure 17**, but such patterns become even more stark at national levels.

Some countries have a long way to go – with important mangrove countries such as Myanmar currently with only 3% of its rapidly diminishing mangroves protected, or Saudi Arabia at 12% or Malaysia at 14%.

By contrast, many countries have already protected over 80% of their mangroves, including Tanzania, Bangladesh, Japan, the United States of America and Brazil.

It is, of course, important to realize that being in a protected area does not guarantee protection.

Some losses cannot be prevented, such as those from erosion or storms. Equally, some protected areas are poorly designed or implemented and fail to prevent damage and loss.

Aldabra Atoll is a highly protected remote coral reef with extensive mangroves © Mark Spalding, TNC

The Mankòté or Ma Kôté mangrove forest in St Lucia is one of the few large and protected mangroves in the Eastern Caribbeans © Mark Spalding, TNC

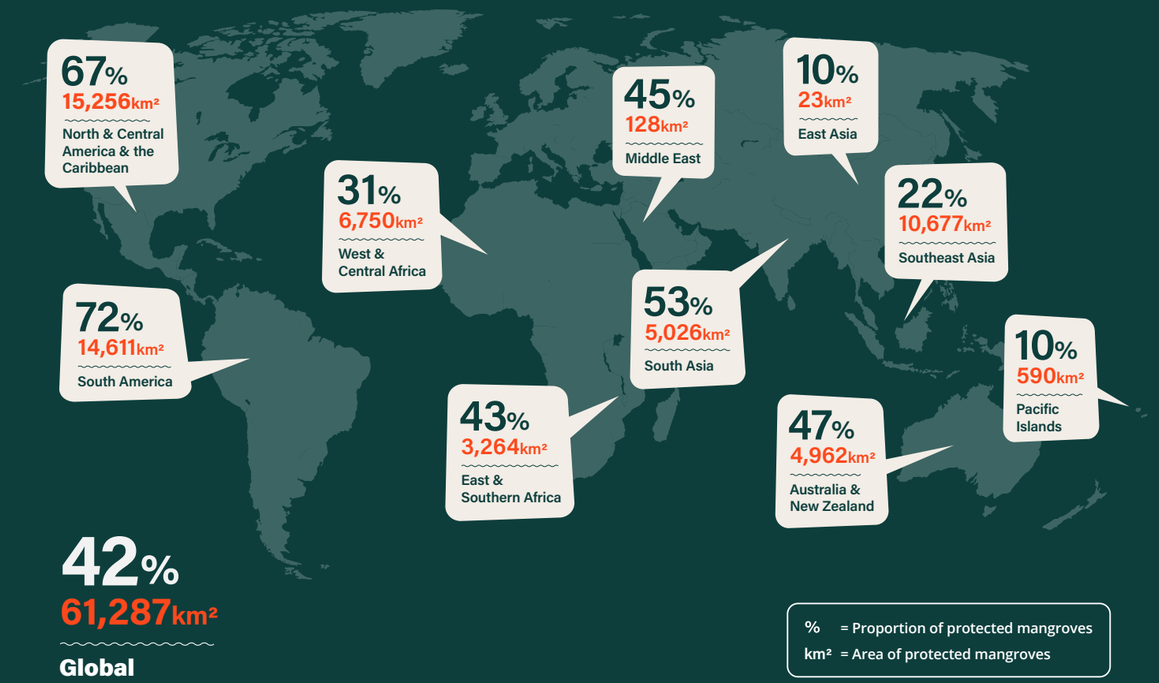


Figure 17. The coverage of mangroves by protected areas by major world regions.

At the same time, protected areas are just one means to secure a long-term future for mangroves.

There are growing efforts to also measure the protection provided by Other Effective Area-Based Conservation Measures (OECMs) which can include indigenous and community-owned spaces or other areas that receive de facto protection as a result of a broad array of legal or traditional controls.

What is critical is that, as we halt loss and catalyze recovery, we set our ambitions high. Every mangrove protected and secured represents an investment, providing security, safeguarding coastal peoples and biodiversity for generations to come.

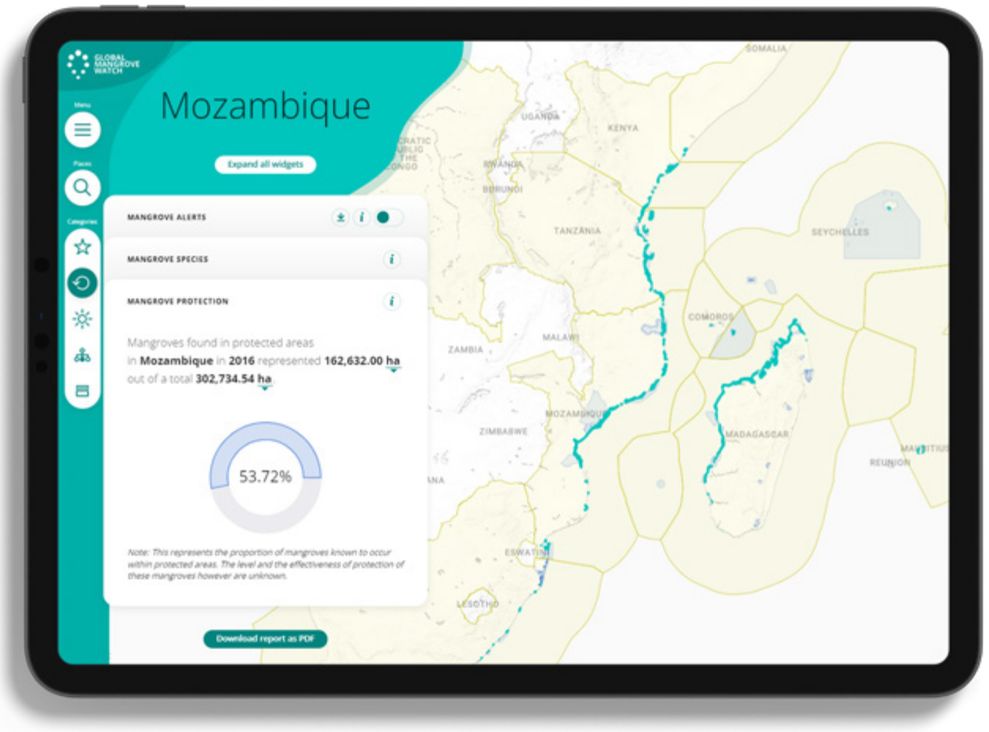


Figure 18. The Mangroves in Protected Areas widget in the Global Mangrove Watch Platform enables users to explore all protected areas registered on the World Database on Protected Areas (UNEP-WCMC/IUCN) (www.protectedplanet.net) as these overlap mangroves, also providing information on the proportion of mangroves protected in every country. Although the designation as a protected area does not guarantee effective conservation, the layer can contribute to an overall proxy for how well mangroves are protected.

Competition for space often leads to mangroves being replaced in the coastal zone. Florida, USA © Carlton Ward, TNC

Locally managed areas, such as this in Papua New Guinea, can form a critical contribution to mangrove protection © Mark Godfrey, TNC

Climate-smart Fisheries podcast

Lisa Schindler Murray, Yasmin Arquiza (Rare)

To reach new audiences, Rare, in collaboration with Puma Podcasts, produced a series of episodes on climate-smart fisheries.

The intention was to share the importance of Asia-Pacific's marine ecosystems in sustaining local communities and protecting us from climate change.

A recent episode features Indonesia's mangroves and explores the critical values these ecosystems offer to local people, and how the protection and restoration of mangrove forests is critical for these 'guardians of the coast'.

Image: Mangroves in Indonesia cover
Photo: Rare

4.4 Global Mangrove Watch

Marice Leal (TNC),
Christopher Sheridan (Wetlands International),
Kathryn Longley-Wood (TNC),
Lammert Hilarides (Wetlands International)

The Global Mangrove Alliance **continuously invests and fosters collaborations** to make the latest science available to all.

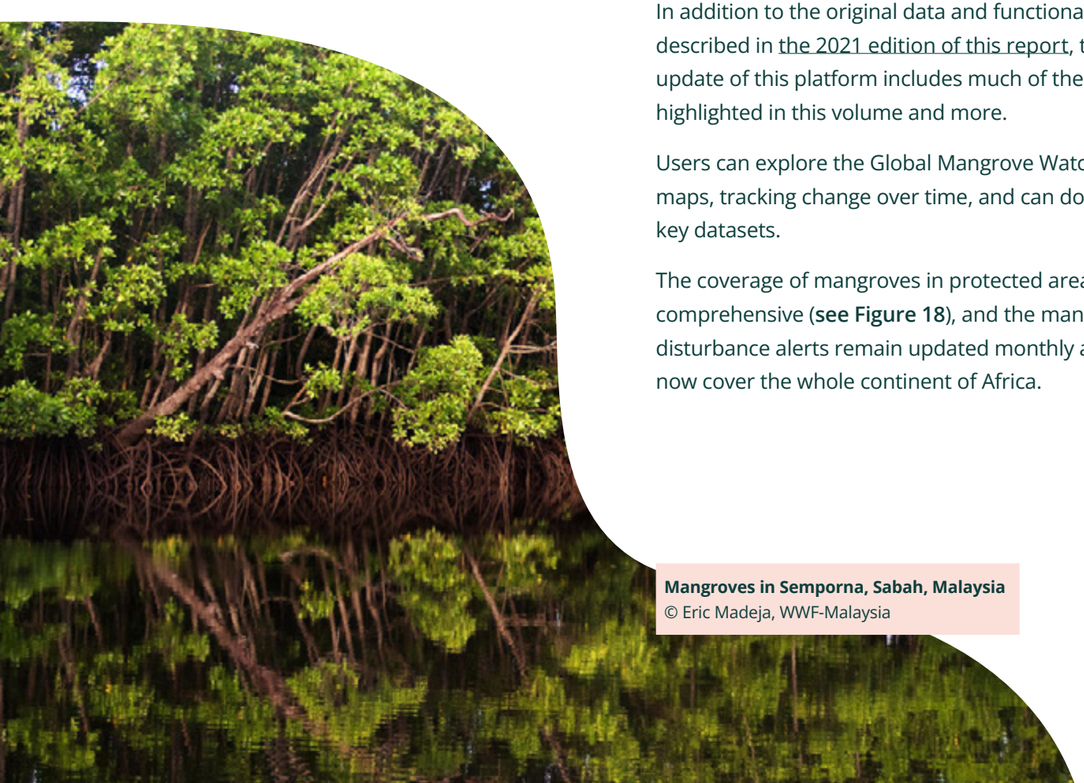
The GMW Platform

The Global Mangrove Watch Platform is one of our main tools in telling the story of mangrove ecosystems and in empowering a host of users with accurate, up-to-date and consistent information.

In addition to the original data and functionalities described in the 2021 edition of this report, the 2022 update of this platform includes much of the data highlighted in this volume and more.

Users can explore the Global Mangrove Watch maps, tracking change over time, and can download key datasets.

The coverage of mangroves in protected areas is now comprehensive (**see Figure 18**), and the mangrove disturbance alerts remain updated monthly and now cover the whole continent of Africa.



Mangroves in Semporna, Sabah, Malaysia
© Eric Madeja, WWF-Malaysia

The Mangrove Tree Species widget

The Mangrove Tree Species widget shows mangrove species native to each country, a valuable baseline for restoration initiatives and practitioners, in support of the selection of species suitable for planting at a national level. The widget also indicates the IUCN Red List category for each species, drawing attention to threatened species.

Black mangrove *Avicennia germinans*, in Humedales de Cabo Rojo, Dominican Republic, showing the radiation of its roots
© Christopher Esquea, TNC Photo Contest 2022

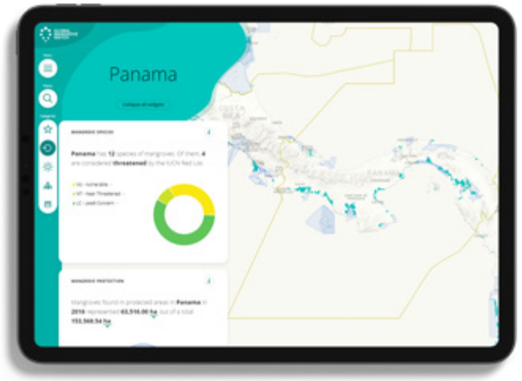


Figure 19. The tree species widget enables users to see what species are native in each country and to see how many are considered threatened under the IUCN Red List.

Zangbéto, guardian of the mangroves

Renaud Bailleux (IUCN)

Due to domestic needs of the local population and the marketing of by-products, the mangroves of Benin are being greatly degraded. In the Bouche du Roy Aire Communautaire de Conservation de la Biodiversité (ACCB, a community conservation area and a UNESCO MAB reserve site), an alternative pathway to decrease anthropogenic pressure on the mangroves was found: sanctification of the mangroves through the deity Zangbéto. This initiative –taken through mutual agreement between the local population, the traditional chieftaincy, elders, leaders, the local associations and NGOs –is respected by all stakeholders. This activity is supported by the EU funded "Mangroves forest management from Senegal to Benin" project through its partner Eco Benin.

Image: Sacralization ceremony of the ACCB Bouche du Roy with the deity Zangbéto
Photo: Eco Benin

Mangrove buffer in Bangladesh

Maksudur Rahman (BEDS)

The mangroves in the periphery of Sundarbans once created a buffer zone that offered coastal protection and also served as habitat for wild animals and birds, but that buffer zone has since been greatly reduced due to climatic and anthropogenic impacts.

To recreate this natural protective infrastructure, BEDS has a goal of creating a 500 hectare mangrove greenbelt through planting and regenerating 500,000 mangrove trees together with local communities. The aim is increased biodiversity, coastal protection, mangrove-based livelihoods promotion, as well as climate change adaptation and mitigation.

Since 2013, BEDS has regenerated 315,770 mangroves in approximately 30 hectares through plantation and restoration in the Sundarbans coastal region of Bangladesh, together with the local community on both public and private land.

Photo: Team BEDS

The Climate and Policy Dashboard

The Climate and Policy Dashboard is a comprehensive dashboard that will aggregate various country-level policy data. The dashboard will provide decision-makers with information that highlights the opportunity for countries to use mangrove conservation and restoration towards meeting key policy goals.

At a glance, users will be able to compare the climate change mitigation potential of mangrove-related interventions (such as restoration or avoided loss) to those of other ecosystems, and further compare that to the emissions reduction target in the country's Nationally Determined Contributions (NDCs). The dashboard will also visualize the area of mangroves within a country that are most eligible or have 'demonstrated readiness' to engage in a carbon market.

In addition, this dashboard will feature policy target data for the given country, such as: a link to their NDC; a list of their NDC targets for mitigation and adaptation and any associated mentions of other coastal and marine nature-based solutions; status of inclusion of the IPCC Wetlands Supplement in GHG accounting noted in the NDC; and the country's Forest Reference Emission Levels (FREL) for those who have one.

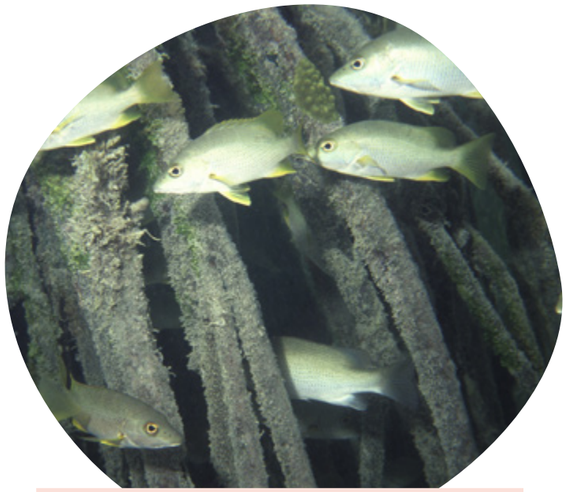
Ensuring robust and updated data and related reporting - for instance, adhering to the latest IPCC guidance and a country's FREL – is important as it enhances overall climate ambition while utilizing existing capacity building efforts in-country, such as the technical expertise gained by implementing REDD+.

Global forum	Key components of relevance to mangroves
CBD	Within the framework of CBD, governments are negotiating a new global framework for managing nature through 2030 expected to be adopted in late 2022. It will guide actions worldwide to preserve and protect nature and its essential services to people en route to living in harmony with nature by 2050. Mangrove ecosystems contribute towards the achievement of multiple goals, targets and associated indicators included in this framework.
UN Decade of Ocean Science for Sustainable Development	Led by UNESCO, it provides a common framework to ensure that ocean science can fully support countries to achieve the 2030 Agenda for Sustainable Development. It uses the period 2021-2030 to rally a shared, global effort to ensure the ocean is clean, healthy and resilient, productive, predicted, safe, accessible, inspiring and engaging. Additional information can be found here: The Ocean Decade - Vision, Mission & Outcomes and associated Decade toolkit on mangroves: Toolkits - The Ocean Agency.
IPCC	The Intergovernmental Panel on Climate Change (IPCC) is the UN body that assesses the latest-available science related to climate change. The IPCC also provides the guidance that countries can use to implement for their National GHG inventories as indicated in the Paris Agreement. For mangroves, the '2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands' is the latest available accounting guidance for blue carbon ecosystems: mangroves, seagrass and tidal salt marshes.
FREL	'Setting forest reference levels (FRLs) and/or forest reference emission levels (FRELs) is one of the first steps countries need to take to benefit from REDD+. As a key component of national forest monitoring systems, FRLs and FRELs provide a baseline against which emission reductions can be measured, and subsequent results-based payments be made.' Mangroves and their underlying soils can be included in a country's FREL in select circumstances, and enables robust and transparent accounting. (quote from https://www.forestcarbonpartnership.org/forest-reference-emission-levels)
REDD+	REDD+ is reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks. REDD+ primarily refers to subtropical or tropical forest developing countries. Depending on the National Forest Definition, mangroves may be considered part of the forests – and thus potentially part of REDD+ - in select countries. The UNFCCC defines REDD+ activities as: reducing emissions from deforestation, reducing emissions from forest degradation, enhancement of forest carbon stocks, conservation of carbon stocks, and sustainable management of forests. (Decision 1/CP16) REDD+ programs may also include an sustainable financing element through a results-based payment mechanism, that could be part of a carbon market or other approach.

To see key components of other processes, please see section 5.2 'Engaging the World' in the 2021 'State of the World's Mangrove Report'

On-the-fly-calculations

Through on-the-fly calculations, users will be able to draw or upload their own polygons to generate basic statistics for areas of interest. Within the limits of resolution that can be provided by remote sensing data, for example, this will enable the monitoring of mangrove development and change within specific project sites, and it could be integrated as a basis for long term monitoring of carbon projects. The Global Mangrove Alliance continuously invests and fosters collaborations to make the latest science available for users of the platform and for supporting mangrove restoration and conservation. We therefore value your input to guide further development of the GMW Platform - so please reach out if you have any suggestions or feedback.



The fisheries enhancement role of mangroves will soon be available on the GMW platform © Mark Spalding

Two new country chapters were officially created in 2022 in Ecuador and the Philippines. Seen here is a proud Philippine sail fin lizard, mostly found in mangrove areas © Dominador Jr Asis, TNC Photo Contest 2021

4.5 GMA national chapters

María Claudia Díazgranados (CI)
Marice Leal (TNC)

New initiatives for mangrove conservation

As the GMA expands its global reach and conservation ambitions, it is increasingly clear that national and local stakeholders will be the catalyst in implementing improved management, conservation, and restoration of mangroves.

Though a new initiative, four GMA national chapters are formally established, four more are in development, and five more countries or regions are showing interest. A national chapter brings together all GMA members in a country, as well as other local groups involved or interested in supporting mangrove conservation and restoration. GMA membership is encouraged, but not a prerequisite for inclusion.

A chapter can facilitate coordination between different actors under a neutral banner, and help connect the broader GMA goals to a more targeted local context.

Specifically, a national chapter benefits from the following opportunities:

- Coordinated agenda setting and strategy development
- Alignment of the partners' individual project portfolios and activities, and opportunities to identify synergies and avoid duplicative work
- Enhanced exchange of knowledge, experience, and skills
- Establishment and management of a shared knowledge base
- Joint program development, including opportunities for fundraising and donor outreach
- Coordinated public outreach and policy dialogue with government and corporate partners

The GMA has a wide array of experts and resources, and the national chapters will be supported by the wider GMA community through:

Best practices

Mangrove restoration guidelines; protected area design and implementation; and restoration guidelines for associated ecosystems, e.g., seagrass.

Alternative livelihoods toolboxes

E.g., mangrove forestry/ silviculture; mangrove apiculture (honey production); and sea cucumber farming.

Policy briefs

That link mangroves to national and international policy frameworks and agreements: e.g., Nationally Determined Contributions.

Links with others

Including other national chapters, both regional and global, for information and knowledge exchange.

Access to tools

To help design successful campaigns around mangrove management, conservation, and restoration.

Rich information resources

Including data held on the Global Mangrove Watch platform, and associated tools such as the Mangrove Restoration Tracker Tool.

Notification of financing opportunities

Potential to leverage existing projects; updates on relevant grant calls (IKI, GEF, GCF, etc.); and links to colleagues that can review grant applications and assist in proposal applications.

Access to a global expert network

Leading mangrove scientists and specialists that can provide technical expertise and assistance in the development of regional strategies and plans for mangrove conservation.

Curieuse Marine National Park, Seychelles © Jason Houston/TNC

Requirements and goals

Each national chapter requires a coordinator from an existing GMA member organization with an expectation that the chapter would convene quarterly. This coordinator/leading organization works with local NGOs, government, academia, community organizations, and civil society to help form the chapter.

Together they can work to take stock of completed and current mangrove projects and identify opportunities to combine forces in upcoming projects. The national chapters act as a bridge connecting country goals and ambition with the global GMA goals, while having the resources and expertise of the full GMA network at their disposal.

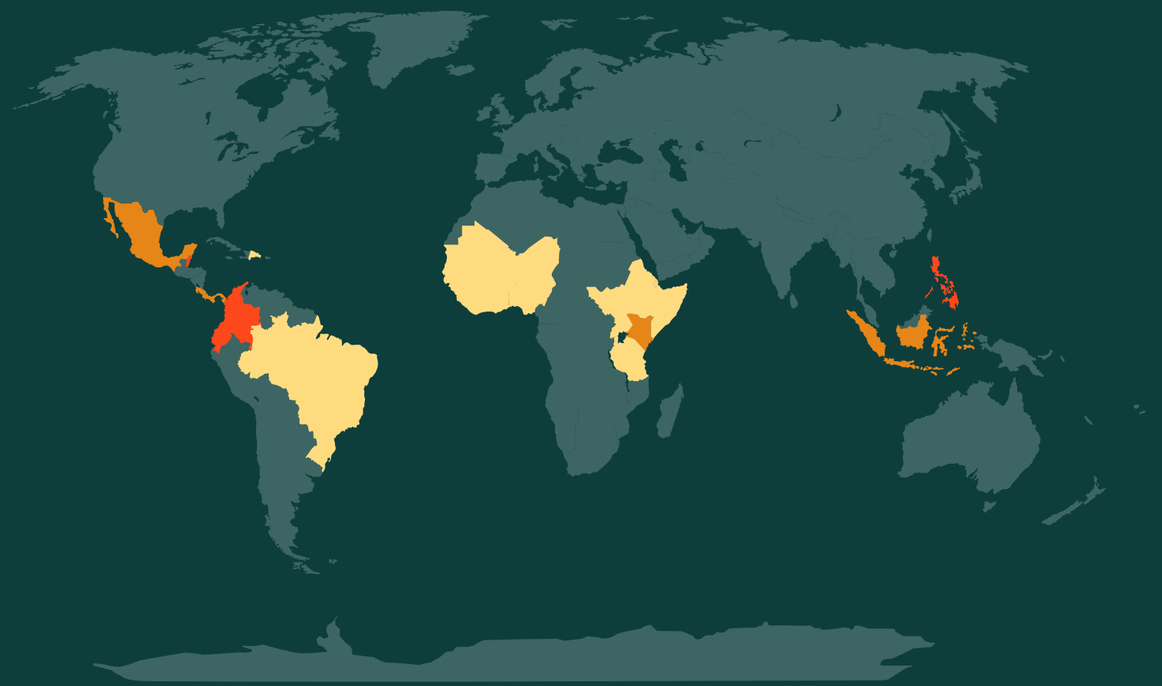


Figure 20. Map of GMA National Chapters at various stages of development

Successes around the world

The activities of these national chapters are impressive, with many having specific and ambitious objectives or timelines, or working to meet or surpass their 2030 goals.

In **Colombia**, for example, teams are working on quantifying and mapping mangrove ecosystem services on Caribbean and Pacific coasts, and on reducing emissions from mangrove degradation and deforestation by 50% by 2030.

The **Indonesia** team plans to enhance their One Map Mangrove using the latest data from Global Mangrove Watch, and to reduce carbon emissions through improved governance of shrimp aquaculture.

Kenya will improve their policy capacity by preparing a report with specific actions for ocean/climate commitments to help the country meet its NDC goals, and support farming communities with livelihood diversification by developing a pilot for restorative aquaculture.

The successes of these activities can become case-studies through which scaling can be simplified in other countries with similar challenges. Updates on the successes and challenges of our national chapters will be shared through the official GMA Newsletter, which you can sign up for here.

Strengthening mangrove restoration in Colombia

J. Alexandra Rodríguez-Rodríguez (INVEMAR)

To reach the national goal of Colombia restoring at least 2,500 hectares of mangrove forests by 2030, the Ministry of Environment and The Marine and Coastal Research Institute (INVEMAR) initiated the project 'Strengthening mangrove restoration in Colombia' with the participation of diverse stakeholders.

By 2021 the project had begun the restoration process of more than 330 hectares through sociological diagnostics, rehabilitation of more than 8,264m of channels, and planting 48,000 mangroves. More than 4,100 temporary jobs were created, and 320 community leaders and government members took part in capacity building training. With the lessons learned from this national project, Colombia is planning to scale up mangrove restoration in the coming years.

Image: Sediment platforms in Ciénaga Grande de Santa Marta. The technique helps to provide proper water levels to mangrove seedlings
Photo: J. Alexandra Rodríguez-Rodríguez

5

Meet our members

GLOBAL MANGROVE ALLIANCE

The Global Mangrove Alliance has over 30 members in total, and that number is growing! Read on to learn how our members contribute to mangrove conservation. All members of the Global Mangrove Alliance enjoy opportunities to contribute to, and benefit from, the collaborative spirit with which the Alliance is organized and run. Learn more on how you can join the Alliance.

GLOBAL MANGROVE ALLIANCE

AIDA

AIDA is a pioneer regional organization that for more than 20 year s has been working to uphold the right to a healthy environment in Latin America and the Caribbean. Our unique approach using international law, scientific arguments, and regional collaboration has yielded significant environmental victories across the hemisphere. Our work has focused on strengthening legal protections for coastal wetlands and the life they support in Colombia, Panama, Costa Rica, Guatemala, Mexico and the Dominican Republic.

www.aida-americas.org

Audubon

Audubon Americas has set a Strategic Goal of restoring or improving the management of 1 million hectares of coastal bird habitat by 2026 through its Coastal Resilience Strategy. As a key habitat for shorebirds and provider of numerous ecosystem services, mangroves are a main focus of this ambition. Our Strategy will quantify and articulate their economic value in terms of reducing climate risk, protecting public health, and mainstreaming nature-based and green infrastructure solutions into planning, policy, and implementation instruments.

www.audubon.org

BEDS

The BEDS (**Bangladesh Environment and Development Society**) is a leading community-based organization committed to maintaining ecological balance and create harmony between humans and nature. BEDS has been successfully implementing many mangrove conservation activities such as a women-led mangrove nursery under our Integrated Mangrove Aquaculture (IMA) activities, mangrove biodiversity education, and promotion of sustainable mangrove-based livelihoods.

www.bedsbd.org

blue ventures
beyond conservation

Blue Ventures is a marine conservation organization that puts people first and prioritizes community engagement. They support coastal fishers in remote and rural communities to rebuild fisheries, restore ocean life and build lasting pathways to prosperity in more than a dozen countries. Their work began two decades ago in Madagascar's remote coastal communities and is growing globally. Blue Ventures recognizes the importance of mangroves in supporting healthy fisheries and has engaged with the Global Mangrove Alliance to promote best practices in community-led conservation.

www.blueventures.org

GLOBAL MANGROVE ALLIANCE

Conservation International protects nature for the benefit of humanity. Through science, policy, fieldwork and finance, we spotlight and secure the most important places in nature for the climate, for biodiversity and for people. Mangrove forests are one of Conservation International's priority ecosystems and are a key component of our blue carbon work. Through projects and partnerships on-the-ground, Conservation International works to protect nature around the world. We co-founded the Global Mangrove Alliance alongside four partner organizations.

www.conservation.org

Fauna & Flora International (FFI) supports local stakeholders to conserve threatened species and ecosystems worldwide. Our marine programme, established in 2010, currently spans 17 countries across five regions. FFI views mangrove protection and restoration as an integral part of our global efforts to reverse biodiversity loss and combat climate change. Across our marine project portfolio, we are working with in-country partners to ensure that mangroves receive the attention they deserve, with a particular focus on Tanzania, Honduras and Cambodia.

www.fauna-flora.org

The Gallifrey Foundation published the Blue Carbon – Mind the Gap study in 2020, leading to the creation of the collaborative project Fair Carbon. The Fair Carbon project brings together leading conservation NGOs and other stakeholders to simplify the creation of natural carbon projects. The accreditation process is complex and contains many barriers to entry. We provide open-access resources to increase understanding of the value of nature-based offsets, the importance of ethical approaches, and to build transparency in the Voluntary Carbon Market.

www.gallifrey.foundation

Griffith University and the **Global Wetlands Project** are proud to partner with the Global Mangrove Alliance to provide scientific support to the mangrove conservation community. We specialize analyzing global trends and stressors of mangroves, assessing mangrove biodiversity and characterising ecosystem services including nutrient pollution and climate mitigation.

www.globalwetlandsproject.org

GLOBAL MANGROVE ALLIANCE

The Gulf of California Marine Program (GCMP) is dedicated to finding solutions to Mexico's environmental issues. We have visited many mangrove sites for ecological monitoring, blue carbon analysis, and community outreach to help protect this valuable ecosystem. In 2020, GCMP hosted a webinar for World Mangrove Day with the Global Mangrove Alliance to discuss remote sensing techniques that can be used for measuring the carbon stock and site's health. We also contributed to the 2021 edition of this report on remote sensing.

www.gocmarineprogram.org

INVEMAR is responsible for carrying out basic and applied scientific research on marine and coastal ecosystems in Colombia, generating and disseminating knowledge for decision-making. INVEMAR identifies the value of mangroves working with them on baseline, monitoring, restoration and management, recognizing traditional knowledge, and sharing experiences with GMA community. INVEMAR leads efforts for inclusion of mangroves in Colombia's NDC, and technical support for 'Vida Manglar' Certification as a first blue carbon project selling credits. We also recently completed a mangrove national map with 10m spatial resolution.

www.invemar.org.co

IUCN is a membership Union composed of both government and civil society organizations with a wide array of resources and experts. IUCN is the global authority on the status of the natural world and the measures needed to safeguard it. As part of IUCN's mandate to promote the protection, conservation, sustainable management, and restoration of coastal and mangrove ecosystems, IUCN hosts the IUCN SSC Mangrove Specialist Group, implements numerous mangrove initiatives from national to global levels, and works to scale up collective mangrove ambition through the Global Mangrove Alliance.

www.iucn.org

The Leibniz Centre for Tropical Marine Research, ZMT Bremen, Germany, aims at providing scientific knowledge as a fundament for sustainably managing tropical coastal ecosystems, including mangroves. Trans-, multi- and interdisciplinary approaches of ecology, biogeochemistry, geology, economics, social sciences, and integrative modelling, provide solutions for protection, sustainable resource-use, successful rehabilitation and ecosystem design of coastal ecosystems. ZMT is represented in the IUCN-SSC Mangrove Specialist Group and involved in the Advisory Team of the World Mangrove Centre in Indonesia.

www.leibniz-zmt.de

GLOBAL MANGROVE ALLIANCE

Mangrove Action Project (MAP), a US-based non-profit, is a team of dedicated, passionate, and experienced mangrove experts and conservationists collaborating with individuals and organizations at all levels to conserve and restore our world's mangrove forests. MAP's work includes teaching "best practices" on how to restore degraded or unhealthy mangrove ecosystems while encouraging the conservation of existing mangroves and promoting multiple generations to take an active interest in mangrove forests.

www.mangroveactionproject.org

Shenzhen Mangrove Wetlands Conservation Foundation (MCF) was founded in July 2012. It is the first local non-governmental public foundation focusing on environmental protection in China. MCF conducts research and demonstration projects with topics such as restoration, sustainable use, community-based conservation, etc. MCF advocates cooperation between China and Southeast Asian countries through financial support and knowledge sharing regarding mangrove conservation and restoration. It also assists the Chinese government with the establishment of the International Mangrove Center in China to promote global cooperation on mangrove conservation.

www.mcf.org.cn

The IUCN Mangrove Specialist Group (MSG) comprises about 60 members from academia, government, and NGOs engaged in mangrove research, conservation, and restoration in different geographic regions. Apart from promoting mangrove conservation through research, advocacy, and frontline work, the MSG also participates in the Global Mangrove Alliance through contributions to its Science team.

www.zsl.org/iucn-ssc-mangrove-specialist-group

The Pew Charitable Trusts' Protecting Coastal Wetlands and Coral Reefs project supports the inclusion of comprehensive and measurable coastal wetlands protections in updated Nationally Determined Contributions to the Paris Agreement. We have partnered with local organizations, research institutions, and governments in Belize, Costa Rica, and Seychelles to fill country-specific research, policy, and finance gaps for mangrove and seagrass conservation. Building on this initial success, Pew is expanding its efforts in the Caribbean, Latin America, and Western Indian Ocean regions.

www.pewtrusts.org

Rare is an international non-profit organization specializing in social change for the environment. With a behavior-based approach, Rare empowers individuals and communities to better manage and protect nature on which we all depend.

www.rare.org

The Smithsonian Institution is the world's largest museum, education, and research complex. Researchers from across the institution have been conducting long-term mangrove fertilization experiments, supporting mangrove management plans at the regional scale, understanding the effects of climate variables on mangrove ecosystems, conducting blue carbon assessments, and mapping mangroves at high resolution. Within the GMA, Smithsonian researchers have been active members of the implementation and national chapter working groups to facilitate science-based decision making within mangrove management and restoration efforts.

www.si.edu

Restore America's Estuaries (RAE) is an alliance of ten coastal conservation organizations located around the United States. We support restoration and conservation efforts through grantmaking, outreach and education, advocacy, and convening the community of practice. RAE has been instrumental in developing blue carbon methodologies for the offset market and supporting federal policy in the US that promotes and funds conservation and restoration of blue carbon ecosystems.

www.estuaries.org

The Nature Conservancy (TNC) is the world's largest conservation organization and a co-founder of the Global Mangrove Alliance. Our work impacts 76 countries, from international to local levels through interventions like global policy influence and fieldwork in partnership with local communities. TNC puts people and equity at the forefront of our conservation projects. Our mangrove work on the ground has been successful through community-led conservation, gender equity initiatives, blue carbon projects, sustainable livelihoods, and providing the latest science though the Global Mangrove Watch platform.

www.nature.org

GLOBAL MANGROVE ALLIANCE

United Way Mumbai (UWM) is part of a 130+ year old international network spread across 41 countries. Over the past 20 years, UWM has been working in urban and rural communities across India to identify and implement the most impactful solutions to community problems. Considering the fast-depleting mangrove cover around Mumbai city, UWM launched Mission Mangroves in June 2015. The mission is to rejuvenate the mangrove cover through public-private partnership and sensitize the citizens of Mumbai towards the importance of Mangroves – the shore-keepers.

www.unitedwaymumbai.org

Wetlands International works at global, regional, and national levels towards safeguarding and restoring mangroves as an essential ecosystem for resilient and productive coastal landscapes. We are a founding member of the Global Mangrove Alliance and work together with international and local partners who have a wealth of knowledge and expertise on mangroves. With an eye towards promoting "ecological mangrove restoration", together with our partners, we enable policy and mindset shifts towards effective conservation and restoration by translating knowledge into action on the ground.

www.wetlands.org

WWF works to protect, conserve, and restore mangroves in more than 20 countries. We work with governments, communities, and other local partners to strengthen mangrove protection and effective management, as well as restore lost and degraded mangroves using best practices, while maximizing benefits to people and nature. Our work is informed by science and research, inclusive of local knowledge and context, and is underpinned by international, national-level, and sub-national policy engagement. WWF is a co-founder of the Global Mangrove Alliance.

www.worldwildlife.org

ZSL is an international conservation charity working to create a world where wildlife thrives. Our scientists and conservationists have globally renowned expertise in mangrove ecology and their rehabilitation. Working primarily in the Philippines, we lead community-based mangrove rehabilitation projects, build capacity through the production of technical manuals, and lead trainings and drive policy for the long-term protection and recovery of mangroves, including through the reversion of disused fishponds. We are active members of the GMA through providing technical expertise and sharing success stories.

www.zsl.org

The Wildlife Conservation Society (WCS) brings together experts in field-based applied science, policy, and finance to design and implement innovative ocean solutions globally. Over 350 of our marine specialists operate across 27 countries, prioritizing areas of the highest biodiversity and facing the greatest threats. Our work conserving and restoring mangrove ecosystems builds upon this broader strategy, engaging scientists and local stakeholders to produce equitable conservation outcomes for the communities and ecosystems that rely on mangroves for their array of services.

www.wcs.org

WRI is a global nonprofit organization that works with leaders in government, business and civil society to research, design, and carry out practical solutions that simultaneously improve people's lives and ensure nature can thrive. WRI works on mangrove condition assessments, ecosystem services valuation and restoration, supports ocean accounting initiatives, bolsters blue carbon agenda, and informs coastal zone management. Ocean Watch provides users with an understanding of how land-based pressures threaten coastal ecology and highlights where integrated management is needed.

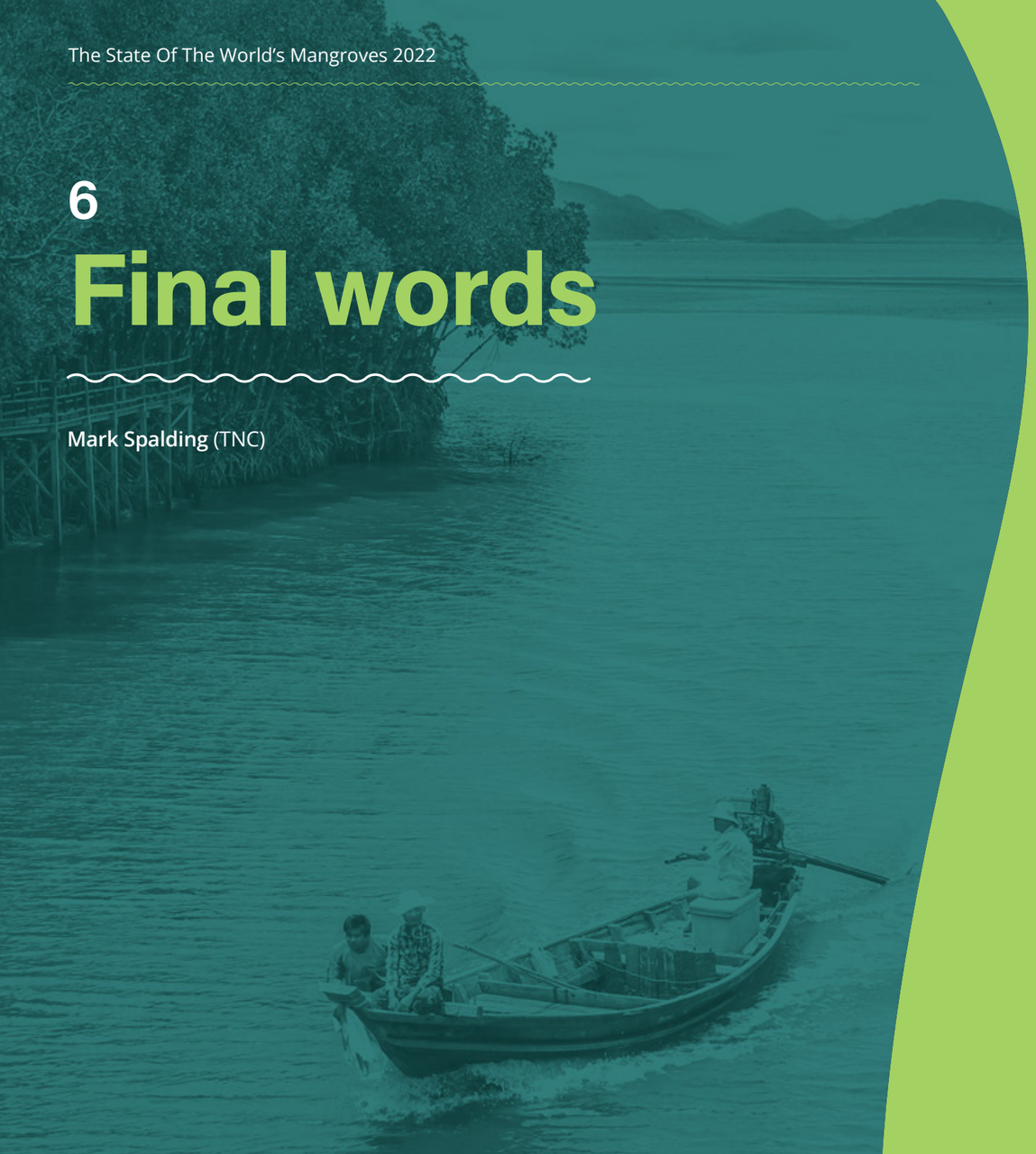
www.wri.org

An American crocodile near the mangroves in Cuba © Lorenzo Ragazzi, TNC Photo Contest 2018

6

Final words

Mark Spalding (TNC)



In the first edition of this report, the surge in interest, knowledge and action around mangroves seemed unparalleled, and the State of the World's Mangroves appeared to be a marker. It presented a 'line in the mud' against which we might track changes: reality on the ground, progress in policy, and advances in science.

It turns out that the pace of change on all fronts is much faster than most of us expected. A little over a year later we are reporting on a Global Mangrove Alliance that has doubled its reach and established national chapters in eight countries.

The GMA has crystalized its determination to make a difference with three ambitious goals to halt loss, restore half and double protection by 2030.

It has also continued to support ground-breaking science. The new global maps bring our understanding of change almost up-to-date, filling gaps and improving accuracy. They reassure us that the direction of travel is positive and rates of loss over the last decade are low, and probably still falling. New models of carbon and fisheries help to cement the facts of the importance of these ecosystems.

Members of the GMA are active across the policy world, ensuring that these fabulous and critical ecosystems are receiving the attention they deserve across multiple agendas and agreements. At the same time our boots are dirty: GMA members and partners are active in local settings in countries around the world.

Mangrove restoration is one of the most important points of focus in this report. Across the goals set by the GMA and others, it is only restoration which will enable us to claw back some of the losses of the past.

It is restoration which will really help to move the needle towards climate mitigation and adaptation. It is also one of the more challenging targets.

Restoration doesn't always work, and stories of failed restoration sit heavily on the minds of communities, governments, and funders. But in this work, we can see the multiple strands of action that are needed to reassure, to verify, to prioritize and to support restoration. We need this combination of hard science, real experience and honest reporting to drive the surge in mangrove restoration that is so needed.

The world of a mangrove forest is an intricate composite of land and sea, where insects compete with crustaceans and fish with birds. The tight interlocking of roots and branches builds a complex cohesive ecosystem where endless variation generates rich productivity and a great overspill of benefits. The solutions to safeguarding mangroves, or indeed to building a secure future for our planet, will be similarly complex. Simple or top-down resolutions cannot account for the needs and the challenges of local settings or the nuances of the ecology itself which are so place-based.

The complexity of the work and partnerships described here gives some hope that we can build such solutions. We are beginning to generate synergies between science and governance, policymakers and communities, indigenous peoples and industry. Much more is needed, but patterns, rather than a pathway, are emerging.

There is still lots to do, but there is space for hope.

www.mangrovealliance.org