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Bridging conservation and policy: Evaluating national targets to reduce mangrove loss under the Kunming-Montreal biodiversity framework

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1. Introduction

The Kunming-Montreal Global Biodiversity Framework (GBF) under the Convention on Biological Diversity (CBD) aims to protect 30% of critical biodiversity by 2030, by prioritising high-value ecosystems and halting biodiversity loss (Hughes, 2023). GBF is based on 23 conservation targets, of which Targets 1 and 3 aim to improve the efficiency of protection or create new protected areas, respectively. GBF builds upon the drawbacks of the Aichi Targets by strengthening the clarity and structure of target setting (Katerer, 2023) and enhance enforcement with the introduction of the “30 by 30” commitment of conserving 30% of land and water areas by 2030. GBF's strengths lie in its improved structure and inclusion of social, economic, cultural, and ecosystem services aspects of conservation (Obura, 2023). However, global-level targets may not address gaps in and the needs of local-scale adaptations (Murali et al., 2024). Intergovernmental frameworks, such as the GBF, have the potential to address the global-scale loss of specific ecosystems, like mangroves, through national commitments. However, it is currently unclear if halting mangrove loss can be achieved by 2030 (Dudley, 2024) and whether the global target setting of “30 by 30” is adopted at the national scale for mangroves.

Mangroves represent an ideal focal habitat for evaluating the national capacity to achieve conservation targets of GBF. Mangroves are biodiversity hotspots and provide various ecosystem services such as coastal protection, macroclimate regulation, and cultural values (Friess et al., 2020). Despite 40% of mangroves globally being under some form of protection (Fu et al., 2024), and a large number of countries having some form of mangrove protection legislation (Slobodian et al., 2025), anthropogenic and natural drivers continue to cause global mangrove loss. At the same time, conservation action to curb mangrove deforestation has shown success over the past two decades, exemplified by the reduction in deforestation rates in the 21st century (Friess et al., 2020). Optimising the spatial planning to protect ecosystem service hotspots could safeguard an additional 16.3 billion USD of coastal property, 6.1 million people, 1173.1 Tg C and 50.7 million fisher days per year (Dabalà et al., 2023). However, the current distribution of mangrove protected areas lacks representation of biodiversity and ecosystem services (Sievers et al., 2020) and many protected areas face threats from natural drivers of loss (Heck et al., 2024).

To achieve the targets set by the GBF, 187-190 km² of mangrove loss must be prevented, and ~24,000 km² of mangrove area should be restored (Fu et al., 2024). Studies have shown the potential to increase protected areas to cover key mangrove biodiversity hotspots (Dabalà et al., 2023; Sievers et al., 2020) and compared management types inside and outside of protected areas for their efficiency in managing loss (Heck et al., 2024). It remains unclear whether countries experiencing significant mangrove loss and active loss drivers have incorporated measures to enhance existing protections or expand the extent of protected areas in their National Biodiversity Strategies and Action Plans (NBSAPs)—a critical factor in determining the success of the Global Biodiversity Framework by 2030 (Green et al., 2019). Mangroves are thus a “litmus test” for evaluating GBF success, given disproportionate ecosystem parameters versus deforestation rates (Richards et al., 2020) and capabilities to increase effective protected areas at the national scale.

To understand why mangrove loss persists despite international agreements, we adopt an interdisciplinary approach to investigate whether mangrove areas with high ecosystem values are included in the national

81 targets submitted under the GBF. Here, we spatially overlay ecosystem service hotspots with national GBF
82 Targets 1 & 3 commitments. We hypothesise that to achieve halting mangrove loss by 2030 under the GBF
83 framework, nations would include specific, quantitative targets with short-term (within the GBF timeline,
84 i.e, by 2030) conservation impact, for example, addressing anthropogenic drivers of loss. However, if the
85 active drivers of loss cannot be stopped in the short term, i.e., natural drivers of loss, then the GBF timeline
86 is insufficient to halt mangrove loss. We first identified countries where short- or long-term conservation
87 interventions in currently protected or non-protected areas can halt the loss of mangrove areas with high
88 ecosystem values. We then analysed national targets submitted as NBSAPs under GBF by countries
89 experiencing loss of mangrove areas with high ecosystem values, to understand if their targets align with
90 the potential of managing drivers of mangrove loss in the short or long term.

91 **2. Methods**

92 We used geospatial datasets (Supplementary Table 1) and national target reports submitted by countries
93 under the GBF. We accessed and analysed spatial datasets using Google Earth Engine (GEE), a big data
94 analysis platform using JavaScript for cloud computing of geospatial datasets (Cardille, 2024). The methods
95 are divided into three subsections: estimating the value of mangroves and their losses and classifying the
96 loss of mangroves into long-term or short-term management interventions (Figure 1). The accuracy of our
97 analysis is limited to the accuracy of the original datasets (Supplementary Table 1). We acknowledge that
98 the analysis is limited by data with temporal mismatches. The change data spanned from 2000 to 2016,
99 and the thematic analysis of the text in the national reports was conducted in 2024. The geospatial data is
100 limited by a 30 m pixel size, which may miss small-scale losses and degradation and may not accurately
101 reflect recent changes. Additionally, the national targets do not include subnational governance,
102 community-based or private sector management interventions, which could enhance the management
103 strategies discussed in this study.

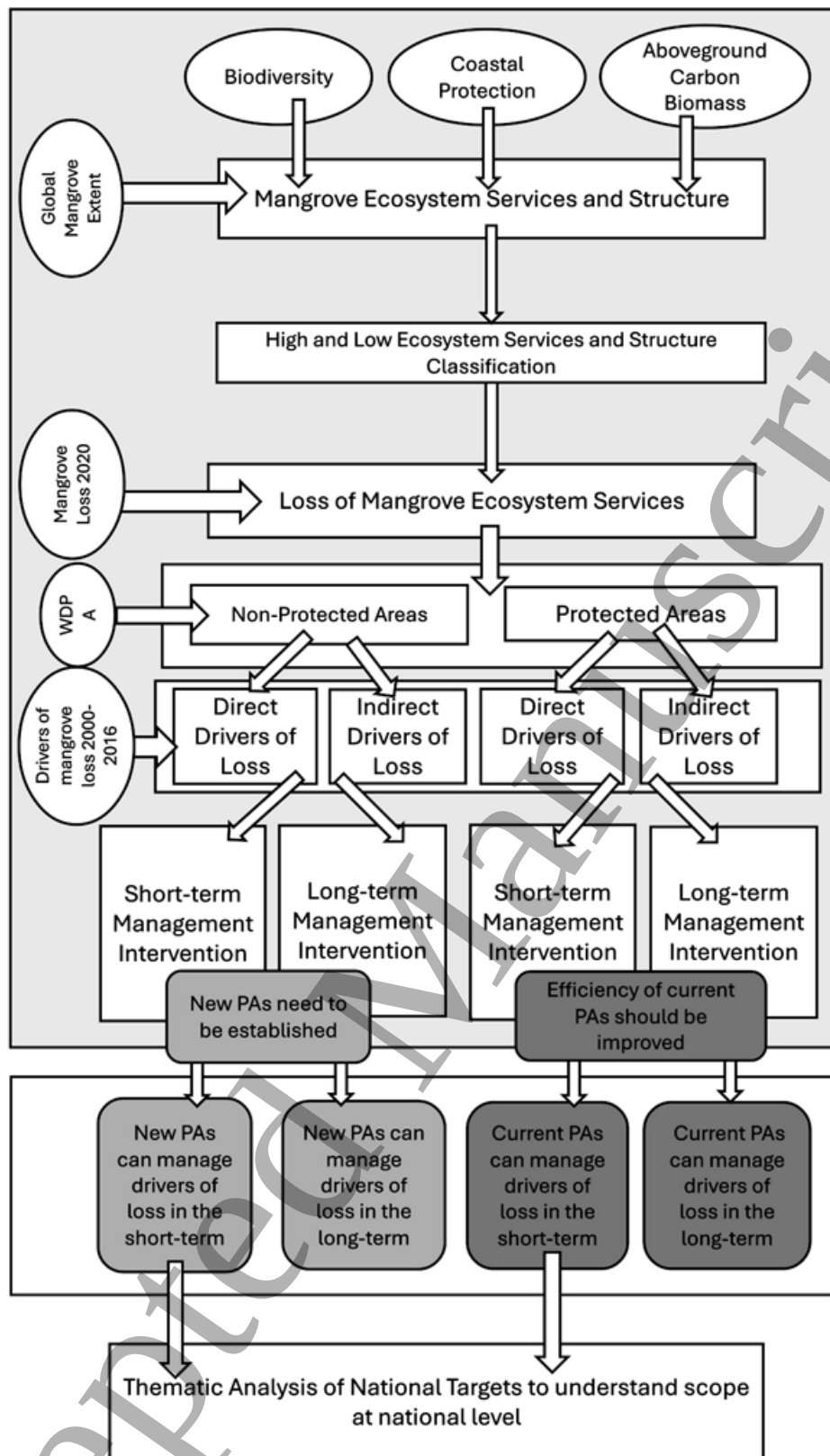


Figure 1: Methodology used to analyse whether countries can meet their targets of halting mangrove loss under the Kunming-Montreal Global Biodiversity Framework. Circles indicate datasets, squares indicate the process flow of the data, and light and dark grey boxes indicate management intervention classes.

2.1 Mangrove Loss

Net mangrove loss was identified using Global Intertidal Wetland Change (GIWC) Version 1 (1999-2019) by Murray et al. (2022), which gave the maximum period for analysis with similar accuracy to other mangrove extent datasets (e.g., Global Mangrove Watch, 1999-2016 (Bunting et al., 2018)). United Nations- Food and Agriculture Organisation sub-aggregated mangrove loss at the district level using the Global Administrative Unit Layers (GAUL).

2.1.1 Drivers of mangrove loss

District-level mangrove loss data were subcategorised into mangrove loss drivers based on Goldberg et al. (2020). However, we did not categorise the mangrove loss drivers into anthropogenic or natural drivers as Goldberg et al. (2020) did. The drivers of mangrove loss are complex and can result from multiple interacting or multiplicative processes at various spatial scales. It is common to categorise commodities, settlements, and non-productive conversion as anthropogenic drivers, while erosion and extreme weather events are natural drivers (Asner et al., 2005; Heck et al., 2024). However, working with such categories at a global scale is challenging due to synergistic causes, some of which might originate kilometres away from the impact site. Moreover, erosion fits neither the anthropogenic nor the natural category as it is impacted by both (e.g., climate change and storms (Ward et al., 2016), land use change (Jones et al., 2019), coastal infrastructures (Xie et al., 2022)). As a result, erosion and extreme weather events were termed “indirect drivers of loss”, whereas commodities, non-productive conversion and settlement are “direct drivers of loss” (*sensu* Murray et al., 2022). Additionally, we mapped the co-occurrence of direct and indirect drivers to estimate the impact of “co-occurring” drivers (e.g., cyclones and commodities). To do so, if a district was impacted by one or more direct or indirect drivers, we labelled it as a co-occurring driver; however, if a district was impacted only by direct or indirect drivers, co-occurring drivers were not reported from those areas. We also acknowledge the limitations of this study in projecting post-2030 outcomes, as global climate change may exacerbate the drivers of mangrove loss.

2.1.2 Short versus long-term management interventions

We interpreted direct and indirect drivers of loss as those that can be managed in the short term versus those requiring long-term interventions to evaluate whether mangrove loss can be halted within the 2030 timeline of GBF. Direct drivers of losses would require direct intervention, which, when effective, can halt mangrove loss in the short term. For example, a well-enforced mangrove protected area can reduce deforestation due to commodities or settlements and non-productive conversions (de Almeida et al., 2016; Heck et al., 2024; López-Angarita et al., 2018). Establishing protected status takes time, but it could be considered a shorter-term action compared to managing losses from erosion or extreme weather events. The impact of indirect drivers of loss can cause long-term impacts on forest structure and health (Asbridge et al., 2018; Mandal & Hosaka, 2020; Mondal et al., 2022) or are defined by preexisting conditions and the presence of other drivers of loss (Bhargava & Friess, 2022). Forest recovery from such drivers can take decades, even with protection (Milbrandt et al., 2012). Thus, managing mangrove loss due to erosion or extreme weather events requires long-term interventions, including restoration, nature-based protection, or adaptive management to build ecosystem resilience against natural drivers of loss (Reed et al., 2025).

2.2 Loss of mangrove areas with high ecosystem value

To evaluate the loss of mangrove areas with high ecosystem value, we utilised datasets on biodiversity, aboveground biomass, and coastal protection, which were available at a global scale.

We estimated biodiversity using species range map polygons from the International Union for the Conservation of Nature (IUCN) Red List of Endangered Species and BirdLife International data (BirdLife International and Handbook of the Birds of the World, 2024; IUCN, 2024) for mammals, reptiles, amphibians, and birds whose distribution falls within the extent of mangroves from the Global Mangrove Watch Dataset (Bunting et al., 2018). We summed species distribution to estimate species richness values per cell at 30 m resolution, aggregated at the district level. We aggregated carbon biomass values from Simard et al. (2019) at the district level to estimate mangrove aboveground biomass. To estimate a biophysical value for the coastal protection service of mangroves, we used Chaplin-Kramer et al. (2023)'s evaluation, as they provided relatively high-resolution (i.e., 300m) aggregates of the contribution of natural habitats (e.g., mangroves and coral reefs in the tropics) to reducing a coastal risk index every 2 km worldwide. To assign an appropriate value of coastal risk reduction to each of the mangrove districts, we estimated the mean of all the data point values that overlapped with the mangrove district's boundaries.

We aggregated the layers of coastal protection, aboveground biomass and biodiversity globally at the district level. Next, we normalised to fit a Gaussian curve, and any value greater than the global mean was labelled as "mangrove areas with high ecosystem values". Finally, we combined coastal protection, aboveground biomass and biodiversity for each pixel to generate a 3 * 3 ecosystem value distribution matrix.

2.3 Protected Areas and Non-Protected Areas and Management Intervention Classification

We extracted data on mangrove loss, drivers of loss, ecosystem value, and the type of protection (or lack of protection) using the World Database of Protected Areas (WDPA). WDPA has false negatives—i.e., non-protected areas in the dataset could have de facto but not "de jure" protection. Thus, analysing national targets was useful for enhancing our analysis.

Overlaying protected area status with ecosystem value matrix produced the following categories: (1) Non-protected areas experiencing direct drivers of mangrove loss: the potential to reduce mangrove loss in the short term by increasing protected area (2) Non-protected areas experiencing indirect drivers of mangrove loss: the potential to reduce mangrove loss in the long term by increasing protected areas; (3) Protected areas experiencing direct drivers of mangrove loss: potential to reduce mangrove loss in the short term by improving management; and (4) Protected areas experiencing indirect drivers of mangrove loss: potential to reduce mangrove loss in the long term by improving management.

2.4 National Target Review

We evaluated the national targets submitted by countries experiencing loss of mangrove areas with high ecosystem values to understand if they align with the management interventions identified in Section 2.3. We analysed the National Targets 1 and 3 submitted through the CBD's Online Reporting Tool by 2024. These targets focus on halting habitat loss and achieving the conservation of 30% of terrestrial, inland water, coastal, and marine areas by 2030 ('30 by 30'), respectively.¹ Text under Targets 1 and 3 was tabulated for each country, and thematic analysis (Braun & Clarke, 2022) was performed manually to extract themes using an inductive (grounded) coding framework (Sarker et al., 2000). Supplementary Table

¹ <https://ort.cbd.int/national-targets>

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2 covers themes, codes, and definitions. Two researchers coding a 30% subset of the dataset performed inter-code validation; themes were finalised when a >90% agreement was reached (Miles et al., 2013).

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3. Results

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3.1 Identification of countries that can reduce the loss of mangrove areas with high ecosystem values through short or long-term management interventions

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Approximately 78% (64%-93% with 95% CI and 85.4% accuracy, as detailed in Supplementary Table 1) of mangrove areas with high biodiversity, biomass, and coastal protection are experiencing loss, primarily outside protected areas. Among the 120 countries with mangroves, 30 (25%) experienced a loss of mangrove areas with high ecosystem values between 2000 and 2016. Losses in non-protected areas were driven by direct (24.23% [5.7-42.8%, 95% CI, 81.5% accuracy]) and indirect (44.85% [26.3-63.4%, 95% CI, 81.5% accuracy]) drivers of loss, with 12.71% [0-31.3%, 95% CI, 81.5% accuracy] from co-occurring drivers (Supplementary Figure A). Here, co-occurring drivers refer to both direct and indirect drivers that occur together, for example, deforestation due to commodity production and cyclones occurring in the same place.

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Of the 30 countries and territories, only Gabon, Panama, and New Caledonia experienced losses solely in protected areas, 10 had losses only in non-protected areas, and 18 countries faced losses in both (Figures 2 and 3). Eight countries were affected by direct, 10 by indirect, and 12 by co-occurring drivers (Figures 2, 3). Co-occurring drivers were the primary cause of losses in both protected and non-protected areas.

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Regionally, only Africa (Cameroon, Mozambique, and Tanzania) can halt mangrove loss in the short term by expanding protected areas. In contrast, countries such as Guinea, India, and the USA can address a few drivers in the short term or manage all drivers in the long term by increasing protected areas. Gabon and New Caledonia can potentially manage all loss drivers in the short term through improved protected area management alone. Most African countries can halt losses in the short term, while only Vietnam, among nine Asian countries, can do the same. In the long term, many countries will need to increase protection to overcome the drivers of losses; improving current protection in the short term will not be sufficient (Figure 4).

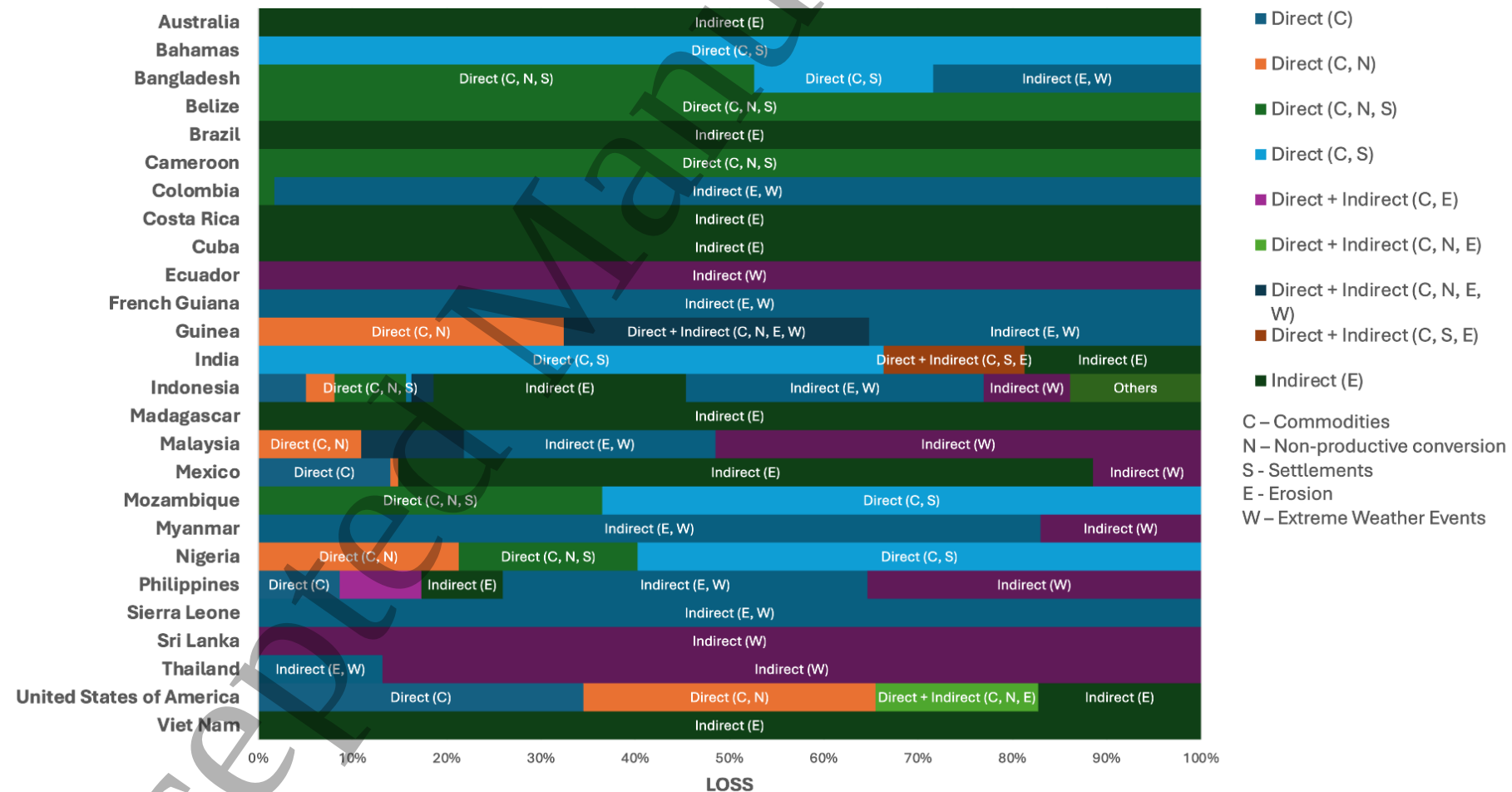


Figure 2: Drivers of loss of mangrove areas with high ecosystem values in non-protected mangrove areas between 2000 and 2016 by countries. Direct drivers were commodities (C), non-productive conversion (N), and settlements (S), and indirect drivers were erosion (E) and extreme weather events (W).

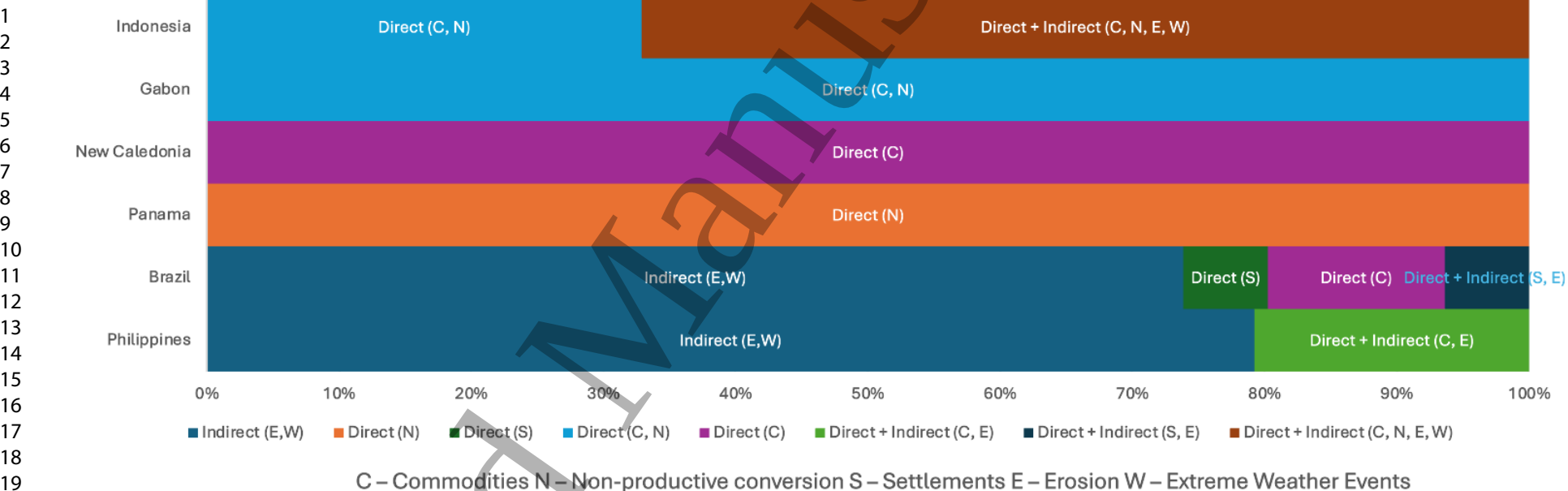


Figure 3: Drivers of loss of mangrove areas with high ecosystem values in protected mangrove areas between 2000 and 2016. Direct drivers were commodities (C), non-productive conversion (N), and settlements (S), and indirect drivers were erosion (E) and extreme weather events (W).

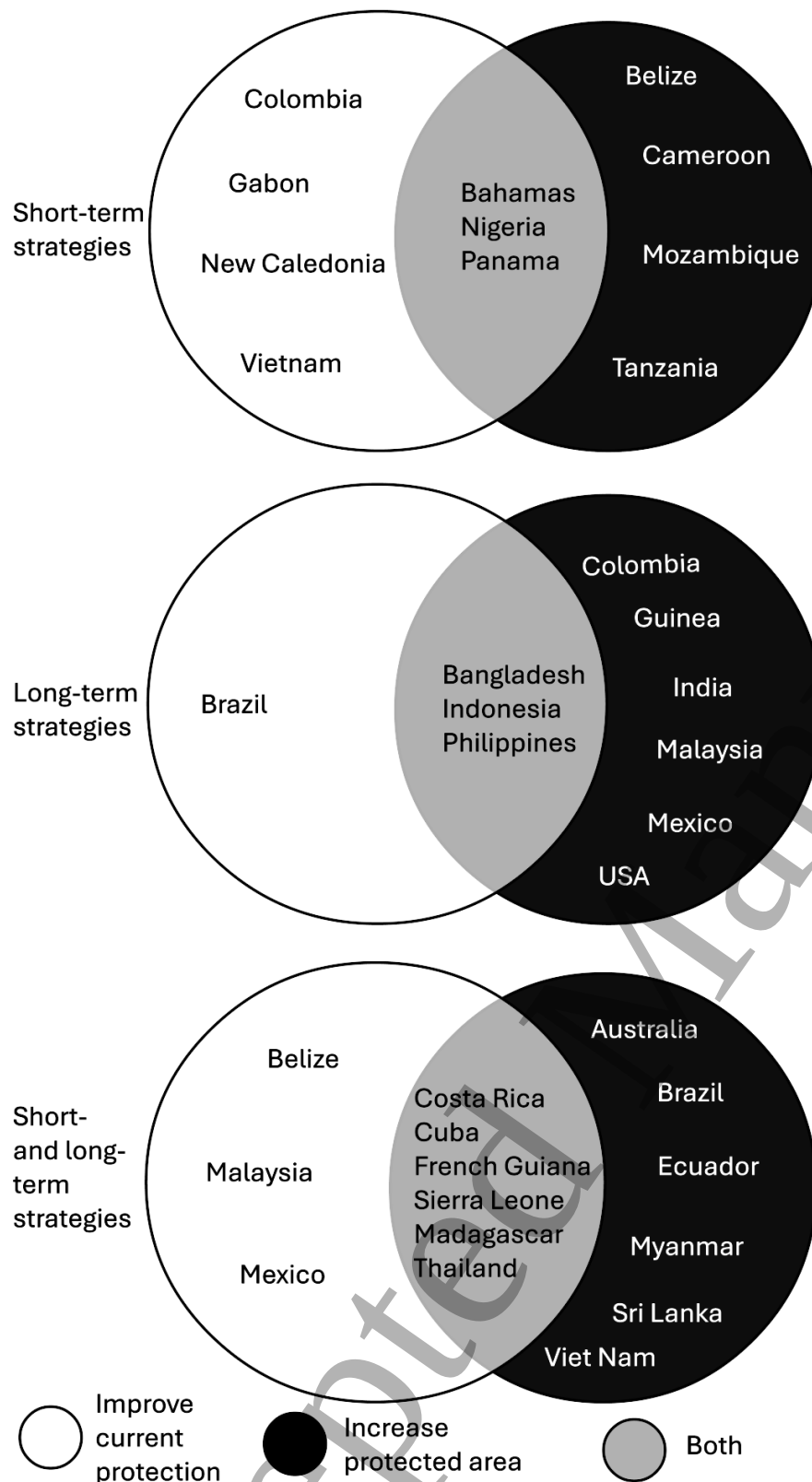


Figure 4: Conservation and management interventions to reduce/ halt mangrove loss by improving the management of currently protected areas, increasing protection, or both using short-term, long-term or both short- and long-term timelines. The countries in the white and black circles refer to those that can improve current protection or increase protected areas, respectively. The ones in the grey area refer to those countries that can use both to increase protected areas and improve current protection.

3.2 Do National Targets align with the distribution of drivers of loss in the short versus long term?

Of the 30 countries² identified with the loss of mangrove areas of high ecosystem value, 11 countries included in their national targets, and the management interventions that could address the active drivers of loss in the short or long term (Figures 5 and 6). Additionally, of the 11 countries³ that could halt all drivers of mangrove loss in the short term; seven countries incorporated this goal into their national targets (Supplementary Table 3, Figure 5).

Nine of the 15 countries identified as reducing some or all drivers of loss in the short term by expanding protected areas included this goal in their targets. Similarly, out of the 10 countries that could mitigate drivers of loss through improved management in the short term, 9 included them in their national targets. Cameroon, Colombia, Gabon, Panama, and Tanzania are the only countries that can manage all or part of the drivers of mangrove loss in the short term, i.e., by the GBF timeline, and have included it as a target.

² Out of the thirty countries, three (French Guiana, New Caledonia, and the United States of America) are not parties to the GBF. Additionally, no (or limited) data was available for six countries at the CBD's Online Reporting Tool (ORL: <https://ort.cbd.int/national-targets>). Thus, there is evidence from twenty-four out of thirty countries supporting this result. The national targets (or equivalent) presented in this database are taken from the NBSAPs received since COP-10, fifth national reports or separate submissions

³ ³ Bahamas*, Belize*, Cameroon, Colombia, Gabon, Mozambique, New Caledonia#, Nigeria, Panama, Tanzania, Viet Nam. * Data Unavailable, # Not a party to GBF

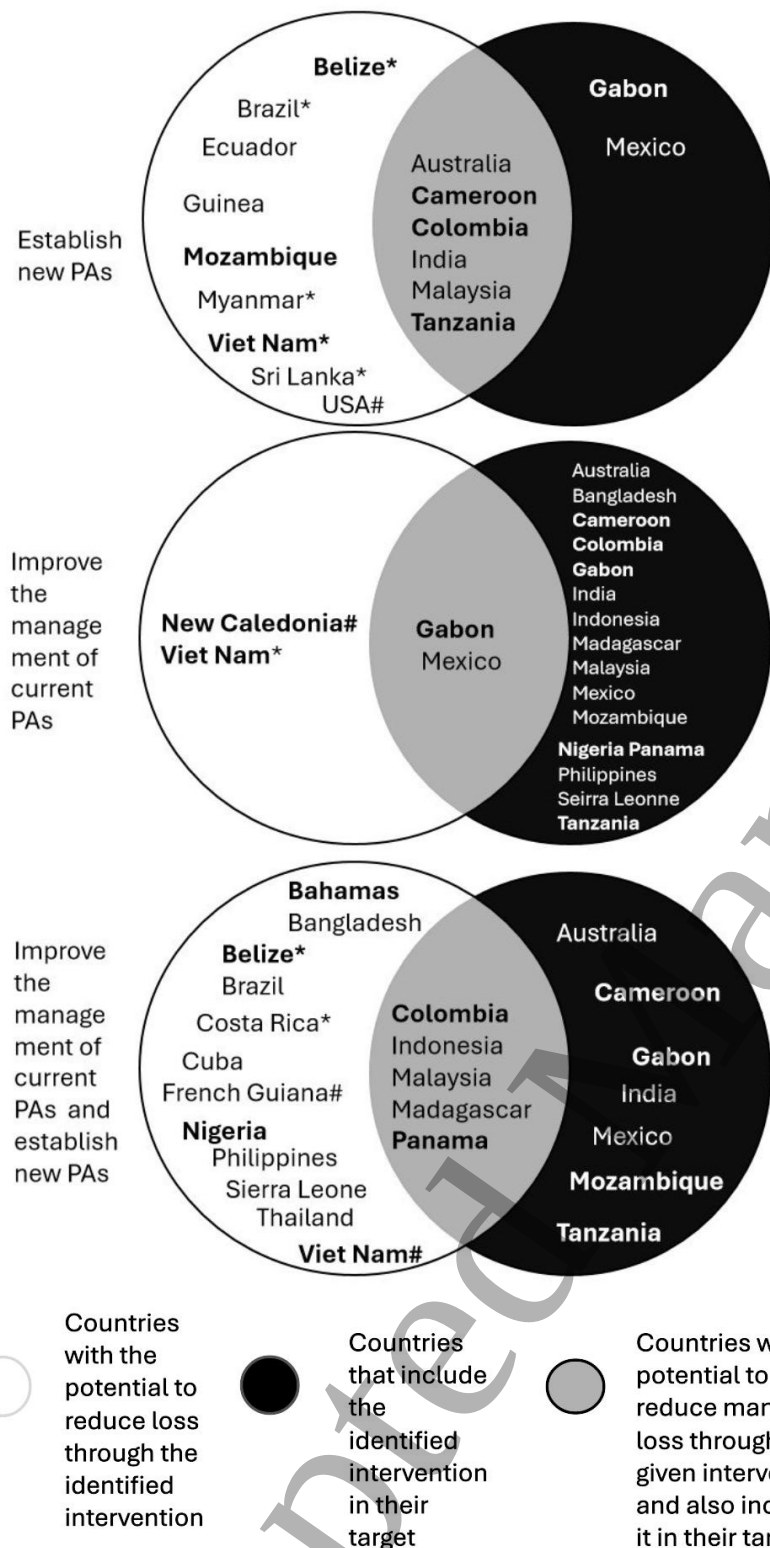


Figure 5: Overlap between Identified Conservation Potential and National GBF Targets for Mangrove Loss Reduction. This Venn diagram illustrates the alignment between the potential for countries to reduce mangrove loss using specific conservation actions (such as Target 1: Spatial Planning, or Target 3: Area Conservation) and their stated commitments within their National Biodiversity Strategies and Action Plans (NBSAPs). The White Area represents countries identified as having high potential to reduce mangrove loss through an identified intervention, while the Black Area shows countries that included the specific conservation intervention in their national targets. The Grey Overlap highlights the subset of countries that

★ Countries that include the identified short-term intervention in their NBSAP targets

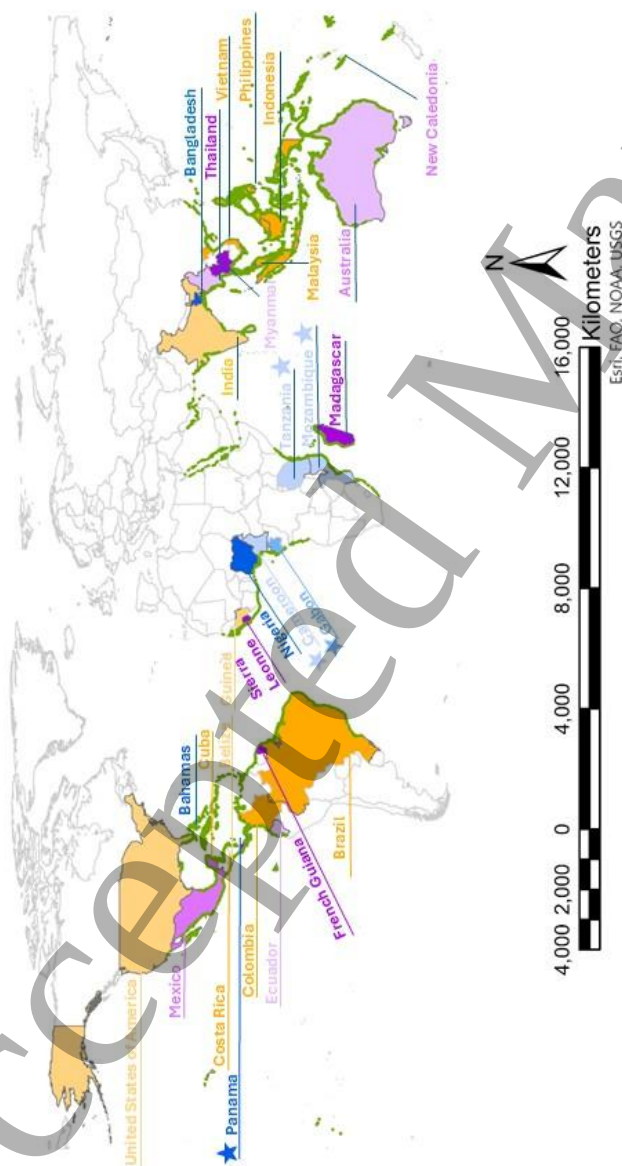


Figure 6: Countries that have the potential to reduce mangrove loss by either improving management, increasing protection or both and those that include these interventions as their NBSAPs national targets. Country names with a star indicate those that can manage a given driver of threat in the short term.

Fifteen countries set targets to increase mangrove protected areas by 3–40%, ranging from 3–5% in Vietnam to 40% in Tanzania. Costa Rica, Cuba, Thailand, and Vietnam only targeted protected area expansion, while Bangladesh, Nigeria, the Philippines, and Sierra Leone focused solely on improving management. Nine countries did not set targets for either expansion or improved management of coastal ecosystems (Supplementary Table 3, Figure 5).

Countries that adopted Target 1 (halting habitat loss) emphasised enhancing the management of current protected areas to achieve zero loss, improve biodiversity, and strengthen ecosystem value. Key strategies included spatial planning, improved data and mapping, participatory approaches, and increased connectivity. Costa Rica focused on controlling threats, while Bangladesh set multi-year targets for biodiversity-inclusive spatial planning.

Unlike Target 1, Target 3, which focused on conserving 30% of land and water areas by 2030, was addressed by all countries. Madagascar and Ecuador reported having achieved Target 3 and are now prioritising Target 1. Themes included connectivity, genetic diversity, OECMs, community rights, and participation. However, the target lacked clarity on specific ecosystem priorities, often using the generic term "coastal ecosystems." Only Indonesia mentioned mangrove-specific targets managed by local authorities. Among the developed countries with mangroves, Australia, the only GBF party, focused on accessible environmental information and 30% protection targets for coastal ecosystems. Target 3 also emphasised community rights and inclusion through holistic and participatory approaches. Colombia prioritised ranger and officer security, while Madagascar focused on enhancing stakeholder resources and capacity. Although less common, some countries addressed gender-equitable planning (Supplementary Table 3).

India, Indonesia, Madagascar, and Panama addressed all targets: expanding protected areas, improving management, reducing loss and its drivers, community representation and inclusion, and biodiversity or ecosystem service representation (Figure 7). Moreover, India prioritised coastal ecosystems, Indonesia lacked quantitative targets, Madagascar focused on community inclusion, and Panama emphasised improved data and high-tech GIS resources (Supplementary Table 3).

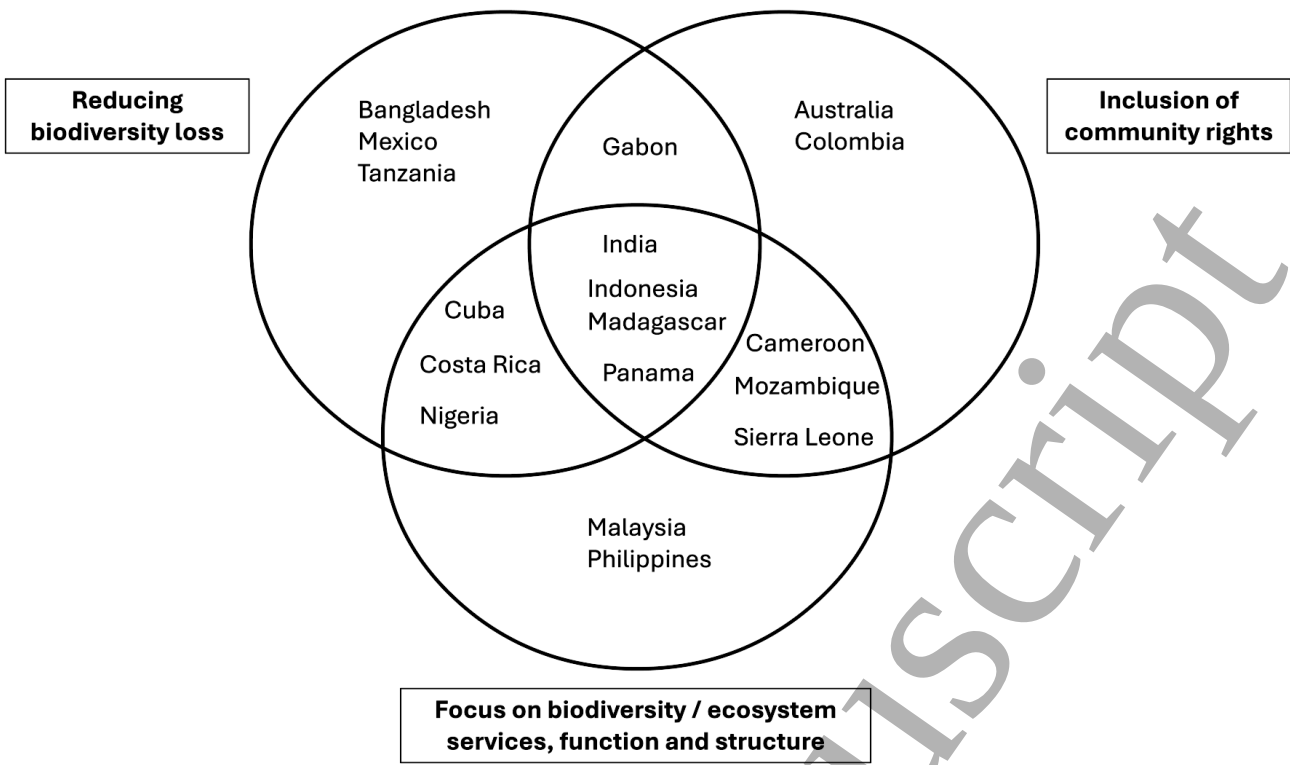


Figure 7: The key themes identified in the national Targets 1 and 3 and their common occurrences. The countries in the centre encompass all three themes: reducing biodiversity loss, the inclusion of community rights, and a focus on biodiversity/ecosystem services, function, and structure.

4. Discussion

4.1 Countries that can reduce the loss of mangrove areas with high ecosystem values through short or long-term management interventions

While Target 3 aims for "near-zero" loss, achieving this requires targeted interventions to address both direct and indirect causes (Hughes, 2023). Short-term management can help 11 countries reduce losses of mangrove areas with high ecosystem values, but long-term strategies are essential to achieve near-zero losses. Correlating drivers of loss and management strategies showed that some countries could halt losses by focusing on either strategy. In contrast, countries like Malaysia, Indonesia, and the USA can combine strategies to achieve zero loss. These policies may be most effective when localised and will depend on the area's protection status (Sudtongkong & Webb, 2008).

Sub-Saharan Africa outperformed globally in reducing losses in the short term and would contribute the most to halting mangrove loss under the GBF structure. Outside of Africa, only Bangladesh, Panama, and the Bahamas can reduce losses in the short term. These countries are more conducive to community management due to their social, political, and cultural factors (Slobodian et al., 2025). Central American and African countries that can reduce mangrove loss using short-term strategies can improve implementation and monitoring going forward (Ajonina, 2022; Chamberland-Fontaine et al., 2022; Murillo-Sandoval et al., 2025). Among the countries with holistic targets, only Panama could halt mangrove loss in the short term. However, current management policies in Panama suffer from competing government agendas and policy implementation gaps, which cannot overcome high rates of mangrove loss, urban expansion and coastal development (Chamberland-Fontaine et al., 2022). Mangrove conservation at scale

can be more successful when incorporating bottom-up, community-based management approaches (Begum et al., 2021; Di Franco et al., 2020). Stricter protection by national governments and IUCN categories alone may not necessarily result in successful conservation outcomes (Heck et al., 2024). For instance, Cameroon achieved conservation success with mangrove community-based management (Ajonina, 2022), meanwhile, Bangladesh and Indonesia are struggling to maintain one of the largest mangrove extents due to bureaucratic hurdles (Khan & Giessen, 2021; Mursyid et al., 2021). Focusing solely on short-term strategies for Target 3 to increase mangrove protection areas may be insufficient. Climate-smart restoration under GBF (Target 2) could also be combined with Targets 1 and 3 to enhance mangrove ecosystem conservation (Fu et al., 2024).

4.2 Gaps in alignment of national targets and potential management strategies to reduce mangrove loss

Global mangrove deforestation rates have declined due to increased protection, improved monitoring, and better data quality (Friess et al., 2020). Intergovernmental agreements, such as the GBF, offer the potential for further reductions in mangrove loss by providing incentives or frameworks to participating countries. However, we show that countries have not fully utilised strategies to halt drivers of loss. Therefore, achieving the GBF's short-term goal of halting mangrove loss by 2030 appears unlikely. Addressing indirect loss drivers is crucial for effective intervention planning. For example, although Asian countries have set national targets in line with GBF Targets 1 and 3, expanding protection by 2030 may not stop mangrove loss, especially with active indirect loss drivers and the low extent of protected area networks (Farhadinia et al., 2022). Countries such as Bangladesh, Brazil, and Mexico have already protected over 80% of their mangrove areas, necessitating considerable effort for further expansion (Leal et al., 2024). Consequently, short-term reduction in mangrove loss may be challenging without targeted strategies.

The review of national targets in meeting mangrove conservation goals showed a lack of clarity on specific measures to improve efficiency, increase protection or reduce drivers of losses. It is also unclear whether the targets meant mangroves when referring to coastal ecosystems. This ambiguity aligns with critiques of the GBF and prior Aichi Targets for lacking clear guidance on achieving, measuring, and reporting progress (Katerer, 2023; Xu et al., 2023). The lack of clarity gives the benefit of contextualising the targets to location situations and flexibility of implementation to the local governments (Harrop & Pritchard, 2011). The Aichi Targets fell short due to vague metrics and transparency issues (Green et al., 2019). While the GBF has incorporated measurable targets (e.g., 30% by 2030), national targets can also include national-level quantitative targets, assessments and monitoring. Additionally, the disconnect between Targets 1 and 3 and ground realities, such as the need for clarification on land tenure, a lack of capacity and human resources, and funding, should be addressed in the targets. Achieving the GBF targets will depend on financial support, monitoring, and cross-country coordination (Eckert et al., 2023). Low- and middle-income countries, suffering from funding gaps (Spring & Spring, 2024), it may find it challenging to implement and improve targets without international support, although recent global commitments aim to raise USD 30 billion by 2030 (CBD, 2025).

4.3 Management interventions specific to drivers of loss

There is mixed evidence on the effectiveness of protected areas in managing biodiversity and ecosystem service losses in mangrove forests (Medeiros et al., 2023; Osorio-Olvera et al., 2024; Yusuf et al., 2017). Where mangrove protection is effective, a reduction in loss and recovery of mangrove cover is observed (Lima et al., 2021; Osorio-Olvera et al., 2024). Distance from roads (Osorio-Olvera et al., 2024), the

promotion of monoculture of natural or exotic species (Jia et al., 2016), and a lack of local community participation (Macamo et al., 2016) are other factors that have impacted the effectiveness of mangrove protection. Even if increased protection is added as a target, ecosystem mapping and actions to curb local drivers of losses can aid in reducing mangrove loss (Hagger et al., 2022).

While some national targets aim to reduce the impacts from direct drivers of loss, none address indirect drivers, such as erosion and extreme weather events, which are more challenging to manage. Over 50% of protected and unprotected mangroves are affected by erosion, extreme weather, or a combination of these factors, alongside direct drivers. Therefore, long-term strategies to enhancing mangrove resilience against indirect drivers, which are crucial for effective protected area management. Such strategies could be incorporated into NBSAPs through Targets 2, 8, and 11 via a cross-sectoral, integrated approach to ecosystem management. Direct interventions, such as permeable dams (Winterwerp et al., 2020) and targeted mangrove restoration (Handayani et al., 2021; L. T. M. Nguyen et al., 2020), can help mitigate erosion, with partial success. Nature-based solutions and ecosystem-based adaptations could aid in reducing the impacts of indirect drivers (Lovelock et al., 2024). Mangrove forests are naturally disturbance-adapted, though human intervention often aids recovery post-cyclone (Amaral et al., 2022).

4.4. Policy Implications

The establishment and management of protected areas vary by regional, national, and local governance structures (Gnansounou et al., 2022; Gopal & Chauhan, 2016; Kamau et al., 2024). Regardless of governance type, legitimacy, fairness, and stakeholder inclusion are vital for success (Golebie et al., 2021). Including local and Indigenous community values and land rights beyond the instrumental focus of the GBF ensures just planning (Murali et al., 2024), especially after the adoption of Target 22 on land-use change and land tenure in the traditional territories of Indigenous Peoples and local communities (WCMC, 2025). Several countries have adopted this inclusive approach, while others, such as India and Indonesia, focus on holistic strategies that combine protection, efficiency, and co-management. Countries lacking alignment between GBF targets and mangrove loss drivers should include ecosystem-specific measurable targets in addition to including community rights and biodiversity hotspots in future iterations of NBSAPs. At the national level, ecosystem-based monitoring—such as greenhouse gas inventories, biodiversity mapping, and ecosystem service assessments—can help identify priority areas while generating data to support transparent reporting under international frameworks, including the Nationally Determined Contributions (NDCs) and the CBD. Focusing on ecosystem functions, services and structures for area-based management and targeting specific drivers of losses (Arifanti et al., 2022; Camacho et al., 2020) could improve the application of GBF.

Internationally binding agreements are essential, but national strategies require measurable metrics, monitoring, and clear progress indicators (Hodgetts et al., 2018; Katerer, 2023). Integrating various policies, such as coastal zone management, co-management, Other Effective Area-based Conservation Measures (OECMs), Payment for Ecosystem Services (PES), Sustainable Development Goals (SDGs), NDCs and transboundary management, offers comprehensive benefits (Alves-Pinto et al., 2021; Carter et al., 2015; Damastuti et al., 2022). Mangrove restoration initiatives can be strategically positioned to access existing climate adaptation finance streams, such as the Green Climate Fund (GCF), Adaptation Fund, or regional mechanisms like the ASEAN Catalytic Green Finance Facility, by framing them as ecosystem-based adaptation measures that reduce coastal vulnerability, enhance livelihoods, and contribute to NDC targets

(NDC Partnership, n.d.; Slobodian et al., 2025). Meanwhile, a permanent arrangement for providing biodiversity finance (\$200 billion per year) and future-proofing funds beyond 2030 was agreed upon at the resumed COP16 in Rome (Chandrashekhar et al., 2025). However, blue carbon finance was absent from national targets (Fu et al., 2024). Additionally, the climate change mitigation benefits from mangroves can also be coupled to increase avenues of funding (Macreadie et al., 2021).. Meeting the "30 by 30" target alone is insufficient; meaningful engagement and cross-sectoral collaboration are important for conserving mangrove biodiversity (Zabala et al., 2024).

5. Conclusions

Several countries can reduce mangrove loss by establishing new protected areas and improving current protection measures. However, the national targets submitted to the GBF do not currently align with this scope of reducing mangrove loss. Thus, the GBF targets for mangroves will be challenging to meet by 2030. While certain countries may successfully mitigate local drivers of mangrove loss, there is a risk of threat leakage, where destructive activities shift to other regions or ecosystems, within and between countries. Long-term planning and investment can help address this issue, as can a commitment to improving current management practices and aligning them with the UNFCCC agreements, climate adaptation, and resilience frameworks. Additional work should be undertaken to strengthen the connection between national targets and subnational policies. GBF could mandate ecosystem service planning with quantitative, measurable, and ecosystem-specific targets to measure impact. Countries can also utilise climate-smart spatial planning and available climate finance mechanisms to support their mangrove conservation initiatives. GBF signatories should adopt mangrove-specific ecosystem service hotspots for target setting and enhance real-time monitoring. Such approaches will often require sustained political will, international cooperation, and financial support to preserve mangrove forests and their ecosystem services.

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