Climate Change and Protected Areas

Some critical issues

Virginia Young, Brendan Mackey, Risa Smith, Cyril Kormos, Nigel Dudley, Madhu Rao and Manuel Pulgar-Vidal

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Preface

Over the past decade, the role of natural ecosystems in both mitigating and adapting to climate change has been increasingly recognised, and protected areas identified as critical tools in climate response strategies. The IUCN World Commission on Protected Areas has played no small part in this through a series of publications, workshops and events.

In this short paper, produced in collaboration with the IUCN Climate Crisis Commission, we examine some topical issues of high importance to both protected areas and climate change. The first two sections look at why it is important to link the aims of biodiversity conservation and climate mitigation and adaptation, and what this means in practical terms. The final two chapter examine this with respect to a critical conservation issue: primary forests. Originally produced for the UNFCCC meeting in 2023, the two commissions are releasing them in a longer-lasting form to help further stimulate debate about this important topic.

Photo: Tourist ship below glacier, near Seward, Alaska © Equilibrium Research

1. Connecting the dots: Achieving synergistic action for global biodiversity and climate goals utilising the Kunming-Montreal Global Biodiversity Framework

Virginia Young, Brendan Mackey, Cyril Kormos, Risa Smith, Nigel Dudley, Madhu Rao and Manuel Pulgar-Vidal

Introduction

Calls to integrate climate and biodiversity action have been mounting in the UNFCCC, culminating in a key decision at COP 27 (Decision 1/CP.27 para 1 and Decision 1/ CMA. 4 para. 1) that underlined "*the urgent need to address, in a comprehensive and synergistic manner, the interlinked global crises of climate change and biodiversity loss in the broader context of achieving the United Nations Sustainable Development Goals (SDGs)...*". This decision followed several relevant and important conclusions by IPCC AR 6 WGIII, notably that protection and restoration of natural ecosystems offers high mitigation potential with 'protection offering the highest mitigation value of any action in the AFOLU (Agriculture, Forestry and Other Land Use) sector and that 'high synergies with biodiversity exist in carbon dense ecosystems such as primary forests.' (IPCC, 2022).

The joint IPBES/IPCC workshop in 2021 (Pörtner et al, 2021), which revealed where the strongest synergies between biodiversity protection and climate mitigation lie, has yet to be built on, pointing to the need for either a joint IPBES/IPCC or joint CBD/UNFCCC SBSTA work programme (Young et al., 2023). However, the Kunming-Montreal Global Biodiversity Framework (K-M GBF) also provides a new opportunity to integrate climate and biodiversity action, support the rights and livelihoods of Indigenous peoples, and underpin climate resilient sustainable development.

Indeed, this opportunity was embraced by the recent strong decision taken at UNFCCC COP 28 (1 CMA/.5 para 33, Outcome of the first global stock take) in the United Arab Emirates in 2023 which recognises the importance of aligning climate action in Nature with the K-M GBF "…*the importance of conserving, protecting and restoring nature and ecosystems towards achieving the Paris Agreement temperature goal, including through enhanced efforts towards halting and reversing deforestation and forest degradation by 2030, and other terrestrial and marine ecosystems acting as sinks and reservoirs of greenhouse gases and by conserving biodiversity, while ensuring social and environmental safeguards, in line with the Kunming-Montreal Global Biodiversity Framework*."

Further integration of the Conventions is feasible because an important area of overlap between the CBD, UNFCCC, and SDGs is their dependence on retaining and recovering the ecological integrity of ecosystems, or ecosystem integrity, which is in turn dependent on retaining and recovering biodiversity.

The UNFCCC/Paris Agreement Mandate on Ecosystem Integrity

During formulation of the Paris Agreement there were calls by many Parties to embrace holistic land sector climate solutions (Klein et al, 2017) and ensure the Agreement's operational provisions support rights and protect biodiversity and ecosystem integrity. Ultimately the preamble to the Agreement reflected these calls and thus they are still applicable to all climate actions. Recent IPCC conclusions and UNFCCC COP decisions (UNFCCC, 2019; UNFCCC, 2022) make it an appropriate time to build on the language in the preamble and fully operationalize Article 5 of the Agreement, which calls on parties to "take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases as referred to in Article 4, paragraph 1(d), of the Convention, including forests".

We are at an important inflexion point for increased understanding that biodiversity is the foundation on which successful climate mitigation action in land, forests, and other ecosystems must be built in order to minimize the risk of losing ecosystem carbon to the atmosphere (Rogers et al, 2022). This understanding has brought into sharp focus the relevance of biodiversity and ecosystem integrity for the conservation and enhancement of sinks and reservoirs of all terrestrial, coastal, and marine ecosystems (as per the preamble and in Article 5 of the Paris Agreement, which cross-references Article 4.1(d) of the UNFCCC)

Photo: Natural grasslands, as in this privately protected area in Armenia, hold vast carbon stores
© Equilibrium Research

Moreover, retaining and improving the adaptive capacity of ecosystems**,** including forests, in the face of climate and other anthropogenic pressures depends on maintaining their biodiversity to enable continuation of the foundational ecological and evolutionary processes (Pörtner, et al, 2022).

Article 2 of the UNFCCC explicitly calls for retaining the adaptive capacity of natural ecosystems, stating that we must *"… achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."* Article 7 of the Paris Agreement reinforces this adaptation objective.

IPCC AR6 WGII provided important insights into the potential role of the K-M GBF in helping to retain and improve the adaptive capacity of ecosystems, notably concluding:

"Safeguarding biodiversity and ecosystems is fundamental to climate resilient development, in light of the threats climate changes poses to them and their roles in adaptation and mitigation (very high confidence). Recent analyses, drawing on a range of lines of evidence, suggest that maintaining the resilience of biodiversity and ecosystem services at a global scale depends on effective and equitable conservation of approximately 30-50 per cent of Earth's land, freshwater, and ocean areas, including currently near-natural ecosystems. (SPM.D.4)" And:

"Protecting and restoring ecosystems is essential for maintaining and enhancing the resilience of the biosphere (very high confidence). Degradation and loss of ecosystems is also a cause of greenhouse gas emissions and is at increasing risk of being exacerbated by climate change impacts, including droughts and wildfire (high confidence). Climate resilient development avoids adaptation and mitigation measures that damage ecosystems (high confidence). Documented examples of adverse impacts of land-based measures intended as mitigation, when poorly implemented, include afforestation of grasslands, savannas and peatlands, and risks from bioenergy crops at large scale to water supply, food security and biodiversity (SPM.D.4.2)."

Maintaining biodiversity and associated natural processes is therefore key to on-going ecosystem integrity and provides the foundation for effective climate mitigation and adaptation in the biosphere and the provision of all ecosystem services, including carbon retention, on which humanity depends (CBD, 2022).

The CBD Mandate on Ecological Integrity

The protection and recovery of biodiversity and ecological integrity are pillars of the K-M GBF and of central importance to the Convention on Biological Diversity as they underpin every ecosystem service on which humanity relies (CBD, 2022).

While the entire K-M GBF would make a strong contribution to protecting and recovering ecological integrity and thus help protect and recover biosphere carbon reservoirs and maximize the resilience and adaptive capacity of ecosystems (Mackey et al., 2023), several of the K-M GBF goals and targets are critically important for climate mitigation and adaptation and should be reflected in both Nationally Determined Contributions (NDCs) and National Biodiversity Strategy and Action Plans (NBSAPs). Goals A & B and Targets 1,2,3,4 & 8 are particularly relevant and outlined in Attachment A. In particular, Goal A and Targets 1,2 and 12 all mention the importance of ecosystem integrity.

The effectiveness of climate mitigation and adaptation action in land, forests, and other ecosystems would be enhanced if, as a minimum, they were guided by and contributed to the K-M GBF goals and targets. With 30 per cent of terrestrial and marine ecosystems needing to be protected through high quality conservation measures (Target 3) and a further 30 per cent needing to be restored by 2030 (Target 2) in order to recover biodiversity and ecological integrity, it makes sense for these targets to inform climate action in land, forests, and other ecosystems.

Utilizing spatial planning (Target 1) to retain and recover areas of high ecological integrity, buffer and reconnect protected areas, and using new conservation tools such other effective area-based conservation measures (OECMs) (Jonas et al, 2023) and connectivity conservation approaches

(Mackey et al., 2022), would deliver high synergies and lower-risk climate mitigation and adaption outcomes. The success of these approaches is closely linked to working with Indigenous and local communities to support and enhance climate resilient sustainable development, their rights, and cultural aspirations.

The importance of ecosystem integrity for carbon retention

Understanding the importance of biodiversity and ecosystem integrity for climate mitigation requires a deeper appreciation of the functional role of biodiversity in underpinning ecological processes and the provision of all ecosystem services including the ecosystem service of carbon retention. Ecosystem integrity affects the ability of all ecosystems to store carbon over long periods of time (Rogers et al., 2022).

The definition of ecosystem integrity adopted by the UN Statistical Commission in its System of Economic and Environmental Ecosystem Accounts is useful:
"The system's capacity to maintain composition, structure and function over time using processes and elements characteristic for its eco-region and within a natural range of variability. The system has the capacity for self-organisation, regeneration and adaptation by maintaining a diversity of organisms and their interrelationships to allow evolutionary processes for the ecosystem to persist over time at the landscape level. Ecosystem integrity encompasses the continuity and full character of a complex system."

Notably, the IPCC defined ecosystem integrity as "*the ability of ecosystems to maintain key ecological processes, recover from disturbance, and adapt to new conditions*" (IPCC AR6 WG11, SPM footnote 50) (Pörtner et al, 2022).

Photo: The potential of "blue carbon" is increasingly recognised, such as mangroves and sea grass.
© Julika Tribukait, WWF.

Actions that help retain and recover ecosystem integrity, including the protection and recovery of the natural composition, abundance, and structure of biodiversity, contribute to ecosystem integrity and underpin the critically important ecosystem service of carbon retention, reduce the risk of GHG release to the atmosphere, and improve the longevity of carbon storage. Improving ecosystem resilience and resistance to threats that are increasing with climate change will help to conserve and recover carbon reservoirs in the Biosphere and improve their adaptive capacity (Rogers et al., 2022)— both key goals of the UNFCCC and Paris Agreement. Attachment B reveals how to reflect ecological integrity and its relevance for carbon retention in forests.

Conclusion

The ecosystem service of carbon retention, together with every other ecosystem service, is dependent on the protection and restoration of biodiversity. Given the functional roles of biodiversity in ecosystem processes, its protection and restoration is essential for conserving carbon reservoirs in the biosphere and achieving the mitigation goals of Article 4.1(d) of the UNFCCC and Article 5 of the Paris Agreement.

Implementing the GBF goals and targets will also improve the natural adaptive capacity of ecosystems and the services they provide and are thus key to delivering the adaptation goals of Article 2 of the UNFCCC and Article 7 of the Paris Agreement.

Recommendations

1. Recognize that ensuring the integrity of all ecosystems including forests and oceans, through improved protection, restoration, and conservation management is essential for achieving the goals of the CBD, UNFCCC, and the Paris Agreement—providing immediate and cost-effective benefits for biodiversity, climate mitigation, adaptation, and the SDGs.
2. Prioritise protection and conservation management of high integrity carbon dense ecosystems like primary forests because their carbon stocks and biodiversity are irrecoverable by 2050, followed and supported by restoration action that improves ecological integrity at a landscape scale.
3. Utilise the K-M GBF to increase connections between key instruments and mechanisms such as the NBSAPs of the CBD and the NDCs of the Paris Agreement.
4. Adopt spatial planning approaches as called for in Target 1 of the K-M GBF, in which to nest all of the GBF targets aimed at reducing biodiversity loss and improving ecological integrity.
5. Recognise that the K-M GBF provides important tools for facilitating climate mitigation and adaptation. Ensuring ecological "connectivity" at a landscape scale (Target 3 of the K-M GBF) will facilitate adaptation and improve ecological integrity and by buffering and reconnecting existing natural areas play an important role in enhancing and/or retaining ecological functions and services, including carbon retention.
6. Reflect key principles of the K-M GBF that encourage holistic action, support the rights and livelihoods of indigenous and local communities, and work with communities to deliver protection and restoration objectives essential for achieving long-term climate and biodiversity outcomes and climate resilient sustainable development.

Attachment A: Role of the Kunming-Montreal Global Biodiversity Framework

Strong and focused implementation of the Kunming-Montreal Global Biodiversity Framework is the best way to strengthen nature's contribution to the coupled climate and biodiversity crises. Goals and targets of particular importance for climate mitigation and adaption include:

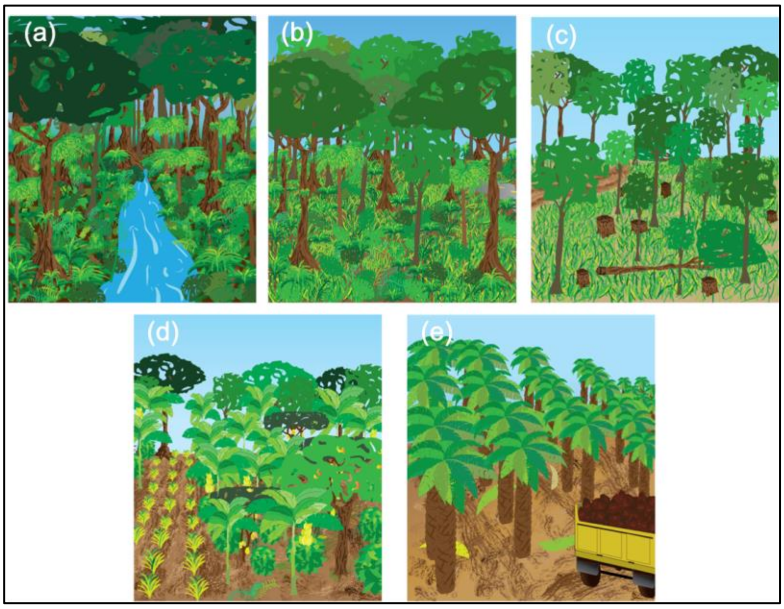
- **Goal A** – "The integrity, connectivity and resilience of all ecosystems are maintained, enhanced, or restored, substantially increasing the area of natural ecosystems by 2050…The genetic diversity within populations of wild and domesticated species is maintained, safeguarding their adaptive potential."

- **Goal B** – "Biodiversity is sustainably used and managed and nature's contribution to people, including ecosystem functions and services are valued, maintained and enhanced, with those currently in decline being restored, supporting the achievement of sustainable development for the benefit of present and future generations by 2050."

- **Target 1** – "Ensure that all areas are under participatory integrated biodiversity inclusive spatial planning and/or effective management processes addressing land and sea use change, to bring the loss of areas of high biodiversity importance, including ecosystems of high ecological integrity, close to zero by 2030, while respecting the rights of indigenous peoples and local communities."
- **Target 2** – "Ensure that by 2030 at least 30 per cent of areas of degraded terrestrial, inland water, and coastal and marine ecosystems are under effective restoration in order to enhance biodiversity and ecosystem functions and services, ecological integrity and connectivity."
- **Target 3** – "Ensure and enable that by 2030 at least 30 per cent of terrestrial, inland water, and of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures, recognizing indigenous and traditional territories, where applicable, and integrated into wider landscapes, seascapes and the ocean while ensuring that any sustainable use, where appropriate in such areas, is fully consistent with conservation outcomes, recognizing and respecting the rights of indigenous peoples and local communities, including over their traditional territories."
- **Target 4** – "Ensure urgent management actions to halt human induced extinction…to maintain genetic diversity (and) adaptive potential…"
- **Target 8** – "Minimize the impact of climate change and ocean acidification on biodiversity and increase its resilience through mitigation, adaptation and disaster risk reduction including through nature based solutions and/or ecosystem based approaches, while minimizing negative and fostering positive impacts of climate action on biodiversity."

Attachment B: The significance of ecosystem integrity for carbon storage in Forests

Not all forests are equal in terms of their level of ecosystem integrity, carbon storage value, and how they are impacted by climate and other risks. The figure illustrate these differences for five categories of forests: (a) primary forest; (b) secondary forest; (c) production forest; (d) agro-forestry; and (3) commercial plantation. Higher integrity results in forests having more dense carbon stocks and greater stability, resilience and adaptive capacity in the face of escalating external pressures. The first table provides an overview of how these forest types differ in terms of their ecosystem integrity and the second table provides further details on the three key factors (structure, processes, stability).



Forest type	Definition	Relative level of ecosystem integrity
(a) Primary Forest	Naturally regenerated forest of native tree species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed	High levels for all three factors
(b) Secondary Forest	Natural forests recovering from prior human land use impacts. Canopies dominated by pioneer and secondary growth tree species	Moderate depending on time since disturbance
(c) Production Forest	The consequence of conventional forest management for commodity production (e.g., timber, pulp). Forest predominantly composed of trees established through natural regeneration, but management favours commercially valuable canopy tree species	Low to moderate depending on intensity of logging regimes and biodiversity loss
(d) Agro-forestry	Some level of natural tree species is maintained with subsistence food or commercial crops grown (e.g., shade coffee). Swidden subsistence farming commonly used by traditional communities. Utilizes a mix of natural and assisted regeneration	Low to moderate given sufficient management inputs
(e) Commercial plantations	Forest predominantly composed of trees established through planting and/or seeding and intensely managed for commodity production (timber, pulp, plant oil)	Low

Primary forest

- Naturally regenerated forest of native tree species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed
- Likely to have never been commercially logged or intensely managed
- At a landscape level, can comprise early successional (seral) stage following natural disturbances
- More likely to contain full complement of evolved natural biodiversity
- Often the customary territories of Indigenous Peoples

Dissipative structures	*• Ecosystem processes*	*• Stability and risk profiles*	*• Ecosystem integrity level*
• Canopy trees dominated by large, old trees • In wet tropics, closed canopies • Dense soil organic stocks • Typically significant quantities of dead biomass	• Fully self-generating (autopoiesis) • In temperate and boreal forests, includes seral stages following natural disturbances • Tight nutrient cycling with minimal leakage and/or erosion • Clean water supply	• Highly resistant and/or resilient to extreme weather events • In boreal and temperate biomes, fire-adapted plant species • Rich biodiversity provides functional and phenotypic adaptive capacity	• High levels for all three factors

Secondary forest

- Natural forests recovering from prior human land use impacts
- Canopies dominated by pioneer and secondary growth tree species
- If not subsequently disturbed by human land use, can continue to develop additional primary forest attributes over time

• Dissipative structures	*• Ecosystem processes*	*• Stability and risk profiles*	*Ecosystem integrity level*
• In wet tropics, canopy closure can occur within 1–2 decades • Aboveground living significantly less than primary forests • Some dead biomass may remain	• Fully self-regenerating so long as primary propagules/seed stock are available • Soil carbon and nutrients stocks can be depleted due to past erosion and biomass removal	• In temperate and boreal forests, increased exposure to wildfire and drought impacts due to more open canopy and drier forest interior • Reduced biodiversity impairs some key processes (e.g., pollination, top-down tropic control)	• Moderate depending on time since disturbance

Production forest

- The consequence of conventional forest management for commodity production (e.g., timber, pulp)
- Forest predominantly composed of trees established through natural regeneration, but management favors commercially valuable canopy tree species

• Dissipative structures	*• Ecosystem processes*	*• Stability and risk profiles*	*Ecosystem integrity level*
• Logging regimes maintain a predominantly even-aged, younger age structure (~20–60 years) • Simplified vertical vegetation structure	• Canopy tree species natural regenerated but some level of assisted regeneration common • Ongoing soil loss	• More flammable forest conditions • Greater exposure to invasive species	• Low to moderate depending on intensity of logging regimes and biodiversity loss

Agro-forestry (commercial, subsistence)

- Some level of natural tree species is maintained with subsistence food or commercial crops grown (e.g., shade coffee).
- Swidden subsistence farming commonly used by traditional communities
- Utilizes a mix of natural and assisted regeneration

Dissipative structures	*Ecosystem processes*	*Stability and risk profiles*	*Ecosystem integrity level*
• A curated canopy of trees, often remnant from primary forest or planted from local stock • Little if any understory • Ground cover are food crops	• In tradition swidden system, closed nutrient cycle through use of natural regeneration • Canopy trees buffer food crops from extreme weather and help maintain soil moisture	• Intensive small-scale management and modest level of biodiversity provides assisted resilience and adaptive capacity	• Low to moderate given sufficient management inputs

Source: Rogers et al., 2022

2. Role of Protected Areas in Climate Change Mitigation and Biodiversity Conservation

Risa Smith, Virginia Young and Madhu Rao

Key messages

1. Widespread consensus has emerged that biodiversity loss and climate change are twin crises that must be addressed together to achieve success in either one.
2. Protected and Conserved Areas are the most effective tool to address both biodiversity loss and climate change within a timeframe that reflects the required urgency.
3. New protected areas, the expansion of existing protected areas and support for OECMs can target places where carbon richness and high biodiversity overlap to create 'carbon stabilization' areas.

Broad Policy Consensus

There is general consensus that biodiversity loss and climate change are twin crises requiring integrated, comprehensive and holistic approaches. As aptly articulated by António Guterres, Secretary-General of the United Nations, the twin global challenges of climate change and biodiversity loss have to be tackled in a more coordinated manner: "climate change threatens to undermine all efforts to conserve and sustainably manage biodiversity and [that] nature itself offers some of the most effective solutions to avert the worst impacts of a warming planet". The creation of new Protected areas, the expansion of existing ones, protecting and establishing conservation corridors that connect protected areas, and better protected area management are the first and most effective policy tools to address these global crises. UNFCCC COP 27 underlined: *"…the urgent need to address in a comprehensive and synergistic manner, the interlinked global crises of climate change and biodiversity loss in the broader context of achieving the Sustainable Development Goals, as well as the vital importance of protecting, conserving, restoring and sustainably using nature and ecosystems for effective and sustainable climate action*" (CMA 4 para 1*)*.

Likewise, The United Nations Convention on Biological Diversity (CBD) recognized the importance of the climate change/biodiversity nexus (Campbell et al., 2009), including in the Kunming Declaration from COP15 Part 1 and the Kunming-Montreal Global Biodiversity Framework (target 8) (CBD, 2022). A nature-positive world, as promoted by the 95 country signatories to the *Leaders Pledge for Nature*, embodies this collective understanding of the interdependence of biodiversity loss, ecosystem integrity, climate change impacts and human well-being (Leaders' pledge for nature, 2020).

Status of Biodiversity and Climate Change Targets

Some significant successes have been achieved in protecting natural ecosystems and biodiversity. From 2010 to 2023 terrestrial protected areas have increased from about 10 per cent of the land and inland waters to over 16.05 per cent, and marine protected areas have increased from 3 to 8.17 per cent.

If Other Effective Conservation Measures (OECMs) are included, the total terrestrial and inland waters protected stands at 17.23 per cent and marine protected areas at 8.28 per cent (UNEP-WCMC, 2023). Forty-two per cent of the area now within protected areas has been added since 2010. In spite of these successes, most indicators of ecosystems and biodiversity are showing rapid decline, with 75 per cent of the land surface significantly altered, 66 per cent of the ocean area experiencing increasing cumulative impacts, over 85 per cent of wetland area having been lost, and 25 per cent of assessed animal and plant species threatened (SCBD, 2022). As well, the tropics lost 10 per cent more primary rainforest in 2022 than in 2021, the year after the Glasgow Leaders' Declaration on Forests and Land Use to halt and reverse forest loss by the end of the decade (Weisse et al., 2023). Climate change is now one of the top five drivers of biodiversity loss globally (SCBD, 2022).

Since the Paris Agreement in 2015, greenhouse gas (GHG) emissions increased every year, except for a small decline from 2019 to 2020 due to the COVID-19 pandemic. As well, the concentration of CO_2 in the atmosphere continued to grow (UNEP, 2022) and atmospheric concentrations of CO_2 reached an all-time high in September 2022 of 419 parts per million (ppm), from 280 ppm in the mid-1700s. Natural carbon sinks on land and in the ocean absorbed about half of the CO_2 emitted each year between 2011 to 2020. The other half accumulated in the atmosphere (NOAA, 2022).

All pathways to attaining the Paris Agreement target of limiting average global temperature increases to well under 2°C above pre-industrial levels require protecting the global carbon sinks and reservoirs in natural ecosystems, in addition to rapid and drastic declines in GHG emissions. One fundamental and well-recognized tool is the protection of carbon-rich ecosystems such as primary forests, peatlands, grasslands, coastal blue carbon and marine biota (Macreadie et al., 2021), as well as the restoration of lost and damaged terrestrial, freshwater, coastal and marine ecosystems. These ecosystems are often referred to as 'carbon-rich' because they sequester and store more carbon than other ecosystems.

Supporting Evidence

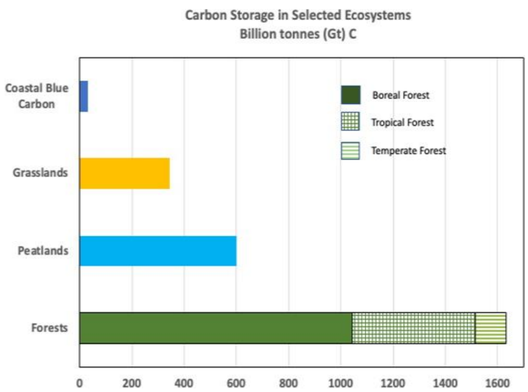
The science agencies supporting the UN Rio Conventions all identified the important role of protected areas in realizing the synergies between the two conventions. The sixth assessment report (AR6) of the Intergovernmental Panel on Climate Change (IPCC) acknowledged area-based conservation, protection and restoration of ecosystems as effective strategies to reduce the vulnerability of biodiversity and humans to climate change (Pörtner et al., 2022). It also concluded that actions to protect ecosystems with a high biodiversity value, such as forests, and particularly primary forests, coastal vegetated wetlands, peatlands, savannas and grasslands offer the highest total and per area mitigation value of any action in the Agriculture, Forestry and Other Land Uses (AFOLU) sector. And at the lowest cost.

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystems Services (IPBES), in its *Global Assessment Report* recognizes the increasing impacts of climate change on biodiversity and the unlikelihood of reaching the Sustainable Development Goals or the Paris Agreement without addressing the relationship between nature and people. A joint IPBES-IPCC workshop on *Biodiversity and Climate Change* has also demonstrated the interdependence of biodiversity and climate change and the need to explore solutions that address both crises (Nabuurs et al., 2022) Recent analyses, drawing on multiple lines of evidence, suggest that maintaining the resilience of biodiversity and ecosystem services at a global scale depends on effective and equitable conservation of approximately 30 to 50 per cent of Earth's land, freshwater and oceans (Woodley et al, 2019).

Role of Protected Areas

The purpose of protected areas has evolved over time. The original concept of protecting scenic landscapes, culturally important areas and areas where people can connect to nature, was supplanted by the concept of maintaining populations of iconic and threatened species. As threats from climate change have intensified, there has been an increasing understanding of the value of protected areas in protecting carbon sinks and stores, as well as other ecosystem services. The *Protected and Conserved Areas Joint Statement on Climate Change and Biodiversity Crises*, signed at the UNFCCC COP26, recognizes this expanded role for protected areas. It encourages "better conservation and restoration of nature, especially of carbon-rich ecosystems, and better connectivity of these spaces to become the heart and anchors of nature recovery networks globally" (Protected area agencies, 2022).

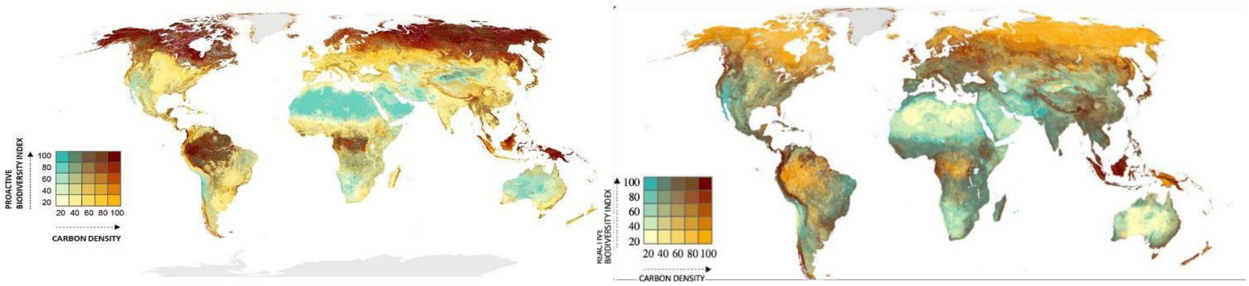
Protecting existing carbon-rich ecosystems, such as primary forests, peatlands, grasslands, mangroves, seagrass beds and salt marshes has multiple benefits for biodiversity and people. Emissions benefits are achieved quickly (*i.e*. within a time-frame compatible with the urgency of the climate and biodiversity crises) and the cost per tonne of CO_2 is low (Cook-Patton et al., 2021).



Estimates of global carbon storage in selected ecosystems. Sources for estimates are: Coastal blue carbon (mangroves, salt marshes and seagrass beds) (Macreadie et al 2021); Grasslands (Lorenz and Lal 2018); Peatlands (Strack et al. 2022); Forests (Woods Hole Climate Research Center et al 2020).

Much of the carbon in these ecosystems has accumulated over centuries or longer: if released by human activities it is essentially irreplaceable in a timeframe that can meet the urgent need to reduce greenhouse gas emissions. About 23 per cent of this irrecoverable carbon is found within protected areas, with about half of it concentrated in just 3.3 per cent of the planet's lands (Goldstein et al., 2020; Noon et al., 2021). Globally, forests contain the most stored carbon, partly because of their widespread extent. Mangroves, salt marshes and seagrass beds contain more stored carbon on an area basis than most forests, although their limited geographic extent makes them less important on a global scale.

While areas rich in biodiversity and high in carbon do not always overlap, it is always the case that carbon retention in ecosystems is dependent of ecological integrity, which in turn is underpinned by an ecosystem's natural biodiversity. In both cases protection offers high mitigation and biodiversity value. Where they do overlap, there is potential to significantly improve the protection of species rich ecosystems. In one global analysis, Soto-Navarro *et al* (2020) found an overlap of 38 per cent between carbon richness and a biodiversity index that prioritizes areas of high biodiversity (measured as high species richness, range-size rarity), high local intactness and high habitat condition, with 12 per cent of the overlap area falling within existing protected areas. The same authors found only a 5 per cent overlap between carbon richness and a biodiversity index that prioritizes high local biodiversity, low average habitat condition and high threats to biodiversity, but 21 per cent of the overlap area fell within existing protected areas. There is potential for increasing protected areas where the overlap is high and protection is low.



The map on the left depicts the area of overlap between areas of high local biodiversity (high species richness, range- size rarity), high local intactness and high average habitat condition with carbon-richness. The map on the right depicts the area of overlap between areas of high local biodiversity, low average habitat condition and high threats with carbon richness. The dark brown areas depict the areas of highest overlap. Reprinted with permission.

Protected areas have been estimated to store about 15.2 per cent of terrestrial carbon stocks and to sequester about 20 per cent of the carbon sequestered by all land ecosystems (Melillo et al., 2016). A similar analysis has not been made for Marine Protected Areas (MPAs), although they are believed to be significant, considering that the oceans have absorbed 20-25 per cent of atmospheric carbon dioxide since 2008 (La Quére et al., 2018).

Analyses at the regional or national level provide the detail important for planning protected areas that can provide biodiversity protection and serve as ‘carbon stabilization areas’. A study by Graham *et al (*2021), in southeast Asia, demonstrated that carbon emissions in protected areas are 2.5 times lower than outside protected areas. Biodiversity hotspots (measured as species richness) overlapped with carbon-rich hotspots in 38 per cent of the mapped area (Graham et al., 2021). Similarly, the 364 refuges in the U.S. National Wildlife Refuge System store 16.6 Gt of carbon, with higher carbon per unit area inside refuges than outside (Zhu et al., 2022).

Protected and Conserved Areas, as well as the conservation corridors that connect them (Soto-Navarro et al., 2020): i) provide the ecosystem integrity on which the long-term persistence of ecosystems depends; ii) enhance the resilience of natural ecosystems to change, and especially the disturbances resulting from climate change; and iii) reduce the vulnerability of ecosystems to multiple pressures across a landscape, including providing a buffer against global tipping points. They are thus a critically important strategy for retaining carbon in biosphere carbon reservoirs and supporting resilient, long lived carbon recovery in natural ecosystems.

Nationally Determined Contributions (NDCs) to the Paris Agreement and Protected Areas

In the first iteration of Nationally Determined Contributions (NDCs) to the Paris Agreement, 67 countries (37 per cent of the NDCs examined) explicitly mentioned terrestrial protected areas or other conserved areas as part of their contribution to reduce greenhouse gas emissions, although few offered specific numbers on how much GHG reduction would be achieved by protected areas (Hehmeyer et al., 2019). A similar analysis on the updated NDCs remains to be done, but the role of nature in GHG emissions is receiving increasing prominence in discussions at UNFCCC, so we can presume that protected areas will also be more prominent in updated NDCs.

Unlike in the terrestrial realm, few countries included MPAs in their NDCs to the Paris Agreement, although the potential for MPAs to provide both mitigation and adaptation benefits is well-documented. Oceans play a significant role in buffering climate change - by absorbing more than 90 per cent of the temperature increases caused by global warming and 50 per cent of all the carbon emissions since the Industrial Revolution (Sabine et al., 2004; NASA, 2022).

However, this is not sustainable given the cost to marine ecosystems such as deoxygenation (Laffoley and Baxter, 2019), ocean acidification and ocean temperature increases (Northrop et al., 2021; Laffoley and Baxter, 2016). It has been estimated that between 0.02 to 0.65 billion tonnes (Gt) of CO_2e/year of GHG emissions could be sequestered and stored by increasing the protection and restoration of coastal ecosystems (mangroves, salt marshes and seagrasses) (Northrop et al., 2019). MPAs created and managed using climate information can enhance marine ecosystem resilience by:

- Enhancing connectivity between populations, species and ecosystems, including protecting species that migrate or travel over large distances.
- Providing climate refugia or safe havens for vulnerable species and ecosystems and protecting populations of species important for food security.
- Improving the adaptive capacity of species, given the evidence that species and genetic diversity are often greater in marine reserves compared to harvested areas.
- Recognizing and supporting Other Effective Area-based Conservation Measures (OECMS) to protect key habitats, provide connectivity and enhance the resilience of coastal and marine ecosystem.

Photo: Intact forest, Nahanni National Park, northern Canada. © Equilibrium Research

3. Primary Forests, Ecosystem Integrity, and Climate Change

Cyril Kormos, Brendan Mackey, Risa Smith, Virginia Young and Madhu Rao

A Rapidly Accelerating Climate Crisis

The global impacts from the 1.1°C of global warming we are currently experiencing are already devastating, including fire disasters, widespread flooding, droughts, and massive coral die-offs. Allowing global warming to increase beyond 1.5°C of warming will result in far greater impacts, and risks of irreversible loss and damage.

Unfortunately, the response to global warming to date has been far from sufficient. The Global Stocktake report (UNFCCC SBSTTA, 2023) concluded that much more ambitious targets are needed in NDCs to reduce global GHG emissions by 43 per cent by 2030, and by 60 per cent by 2035 compared with 2019 levels, and to reach net zero CO_2 emissions by 2050 globally. The report concluded that based on current NDCs, the gap to emissions levels consistent with limiting warming to 1.5 °C in 2030 is estimated to be 20.3–23.9 Gt CO_2 eq. In the meantime, our remaining global atmospheric carbon budget is around 400 GtCO_2e or only about seven years of emissions at current emissions levels.

Achieving these targets means that we must now phase out fossil fuels and generate urgent and drastic emissions reductions across all sectors. (IPCC, 2022; UNEP, 2022)

Primary Forests and Climate Change

The world's forests store massive amounts of carbon: at least 862 GtC, (Pan et al., 2011) which is more carbon than in known oil and coal reserves combined, and more than is currently in the atmosphere. Releasing about 110 GtC through deforestation and degradation this century, or roughly 8 per cent of this global forest carbon stock, is enough to exhaust our global carbon budget, and push us over the 1.5°C threshold.

Unfortunately, we are releasing significant amounts of forest carbon every year. Between 2010 and 2019 the Agriculture, Forests and Land Use sector has been responsible for about a quarter of gross anthropogenic greenhouse gas emissions (IPCC, 2022) and annual emissions from deforestation and degradation are about 8.1 Gt CO_2. Nonetheless, it has been estimated that over 2001-2019, global forests were a net carbon sink of −7.6 Gt CO2e per year, reflecting the net balance between gross carbon removals of −15.6 Gt CO2e per year, and gross emissions from deforestation and other disturbances of 8.1 Gt CO2e (Harris et al, 2021). Ending emissions from deforestation and degradation would therefore provide a potential 8.1 Gt CO_2 net mitigation benefit per year, which if coupled with deep cuts in fossil fuel emissions would put the world community on track to limit warming in line with the Paris Agreement target of 1.5 °C. Forests are therefore an appropriate and important focus of global mitigation efforts.

However, not all forests have equal value in terms of climate mitigation: primary forests are disproportionately important, and their protection should be the top priority for mitigation efforts for several reasons.

- **Primary forests are exceptionally carbon dense.** Primary forests store significantly more carbon per hectare than degraded forests or plantations. A tropical forest that has been logged once stores about 35 per cent less carbon than a tropical primary forest; the difference is even greater in temperate forests where a logged forest may store 70 per cent less than primary forest. (Keith et al., 2009; Mackey, 2014; Mackey, 2020; Mayer, 2020).

- **Primary forests represent a globally significant carbon stock.** There is more than enough carbon in primary tropical forests alone (~150 GtC) to push us beyond 1.5°C of warming if emitted this century, without counting the massive primary forest carbon stocks in boreal and temperate forests [Mackey et al. 2020]. Although there is a misperception that old forests release as much carbon as they absorb, in fact primary forests, and in particular the largest, oldest trees in primary forests, continue to sequester carbon at globally significant rates. (Luyssaert et al., 2008; Lewis et al., 2009; Stephenson et al, 2014).

- **Primary forests are more stable, and therefore their carbon stocks are at much lower risk of loss from natural disturbance.** Primary forests are more resistant to natural disturbance than degraded forests of plantations, and more resilient when disturbance occurs. This increased stability means that they are better able to resist pressures such as droughts, fire, insect outbreaks, disease etc., and also better able to bounce back from these pressures, which in turn means that their carbon stocks are at lower risk of being lost (Rogers et al., 2022; Kormos et al., 2017).

- **Primary forest carbon is irrecoverable on any timeframe that is meaningful to preventing catastrophic climate change.** Industrial extractive activity, including commercial logging with best practices, is not sustainable in primary forests, and the time it takes for a forest to recover its carbon and biodiversity after industrial disturbance far exceeds climate mitigation targets for staying below 1.5°C of warming and meeting the Kunming-Montreal Global Biodiversity Framework targets (Goldstein et al, 2020, IPCC, 2022).

- **The ecosystem integrity of primary forests allows them to persist over the very long term.** A primary forest can regenerate itself for many thousands of years – even millions of years in some cases. This means that the carbon stocks in primary forests are also the longest-lived of any forest. Longevity is critical: carbon must be stored for a century or more to have a climate impact. Short term carbon fluxes over decades will not prevent dangerous warming.

Thus, primary forests store the most carbon per hectare and enormous carbon stocks globally (while continuing to draw down even more carbon dioxide), their carbon stocks are at lower risk of being emitted than degraded forests or plantations, they store carbon for the longest period of time, and their carbon is irrecoverable. Protecting these ecosystems from conversion or degradation is therefore of the highest priority.

It also follows that the next highest priority for forests from a mitigation standpoint over the next few decades (i.e. to mid-century) is to allow a degraded forest to mature (a process often referred to as “proforestation”) (Moomaw et al., 2019; Mo et al., 2023). Ecological restoration of degraded forests generates far more carbon and biodiversity benefits than planting trees over the next few critical decades and allows degraded forests to begin to recover their ecosystem integrity. It is by far the highest priority mitigation action after protection primary forests and other high ecosystem integrity carbon reservoirs.

Climate-Biodiversity Synergies: biodiversity underpins forest mitigation

Primary forests have superior mitigation benefits precisely because they have not been disturbed by industrial activity and still have high ecosystem integrity, i.e., they still have all of their biodiversity, healthy species populations, and their original vegetation structure. Their biodiversity is what enables them to adapt over time to maximize biomass and ensure their ability to resist and bounce back from natural disturbance. **Thus, ecosystem integrity fundamentally underpins a forest's ability to provide superior mitigation benefits: it is essential to a primary forest's ability to maximize carbon stocks, as well as to the stability and longevity of those carbon stocks.**

Primary forests not only maximize mitigation benefits, they also protect the most species of any terrestrial ecosystem and far more species than degraded forests. Estimates of forest biodiversity vary, but many studies suggest that tropical forests alone may hold two thirds of Earth's terrestrial species. Studies also show that primary forests protect many more species than degraded forests of the same type, and that many primary forest species do not survive in degraded forests (Barlow et al., 2007; Gibson et al, 2011). We cannot solve the biodiversity crisis without primary forests.

Primary Forests are critically important in many additional respects. They are very often the lands of Indigenous Peoples, and essential to the ability of Indigenous communities to maintain their traditional cultures and livelihoods. Many primary forests have survived precisely because they are the traditional lands of Indigenous Peoples and remain under their customary guardianship.

Primary forests also provide critically important freshwater benefits. Water flowing from watersheds covered by primary forest is clean and free of excess sediments (Furniss et al., 2010). Forests also help regulate regional rainfall through globally scaled teleconnections: for example, deforestation in the Amazon can impact rainfall patterns as far away as California (Sheil, 2020).

An Ecosystem Integrity Mandate

The good news is that both the Convention on Biological Diversity and the United Nations Framework Convention on Climate Change increasingly recognize the importance of primary forests and ecosystem integrity and the key linkages between climate and biodiversity.

- The joint IPBES-IPCC report in 2021 (Pörtner et al., 2021) and U.N. Framework Convention on Climate Change decisions 1/CP.25 and 1/CP.26 in 2020 and 2021 all emphasize the fundamental importance of ecosystem integrity and integrated climate-biodiversity solutions to resolving the climate crisis.

- The Glasgow Declaration on Forests and Land Use, signed by over 140 countries in 2021 commits signatories to "*halt and reverse forest loss and land degradation by 2030*" and affirms the importance of Indigenous and locally led forest stewardship.

- The IPCC's 6th Assessment Report (Working Group III, Mitigation) notes that "avoiding the conversion of carbon-rich primary peatlands, coastal wetlands and forests is particularly important as most carbon lost from those ecosystems are irrecoverable through restoration by the 2050 timeline of achieving net zero carbon emissions" and that "the protection of high biodiversity ecosystems such as primary forests deliver high synergies with GHG abatement.

- The Kunming-Montreal Global Biodiversity Framework recognizes the importance of ecosystem integrity in Goal A and Targets 1, 2 and 12.

- In addition, the International Union for Conservation of Nature has also adopted a policy recognizing the irreplaceability of primary forests and intact forest landscapes (IUCN, 2020) and the Global Environment Facility created a new Integrated Program on the Amazon, Congo and Critical Forest Biomes (GEF, 2022), with a strong primary forest focus.

Conclusions and Recommendations

Despite the fact that primary forests are irreplaceable, essential to resolving both the climate and the biodiversity crises and provide many other critical social and ecosystem service values, degradation, fragmentation, and loss of primary forests continues at very high rates (Morales-Hidalgo et al., 2015; Haddad et al., 2015). As recognized in the Glasgow Leaders' Declaration on Forests and Land Use (goal 6), protecting primary forests will require deep changes in national and international forest policies, and in the way funding for forest stewardship is mobilized and allocated. In particular, far more resources must be allocated to Indigenous Peoples, local communities, and protected areas, as these are the only forest management approaches with proven capacity to protect primary forests and their many essential ecosystem services. In addition, currently under 3 per cent of climate finance is directed to forests of any condition, let alone to primary forest protections (Climate Policy Initiative, 2021), even though ecosystems could provide thirty per cent or more of the mitigation needed to avoid catastrophic warming. On the other hand, we spend trillions of dollars annually subsidizing extractive industries and industrial agriculture, with devastating impacts on forests and their biodiversity – and trillions more attempting to mitigate climate change, pandemics and other crises resulting from environmental destruction. We therefore recommend that:

- Nature-Based Solutions standards should clearly emphasize the crucial importance of primary forests (and other primary forest ecosystems) and prioritize their protection.

- Climate and biodiversity finance, including reallocation of destructive subsidies called for under the Kunming-Montreal Global Biodiversity Framework and elsewhere, should prioritize primary forest protection as a matter of urgency.

- Carbon accounting must be adjusted so that it can differentiate between stable, long-lived carbon dense ecosystems with high ecosystem integrity, and degraded ecosystems and tree plantations with low ecosystem integrity. A ton of carbon stored in a primary forest is in no way equivalent to a ton of carbon stored in a plantation because a plantation is far more vulnerable and, in many cases, unlikely to persist more than a few decades. Further adoption of the UNSEEA-EA standard would facilitate new accounting methodologies recognizing the superior biodiversity and mitigation and adaptation value of primary forests and ecological restoration of degraded forests.

Author biographies

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Cyril Kormos is the founder and executive director of Wild Heritage, a project of the Earth Island Institute. His organization is focused on primary forest protection globally. He is also a trustee of Wild Europe and serves as a member of the IUCN Primary Forest Task Team. He became a National Geographic Explorer in 2018.

Nigel Dudley is a consultant with Equilibrium Research and currently co-editor of WCPA publications. In 1993, he was one of three authors of *Some Like it Hot*, a synthesis for WWF of the projected impacts of climate change on biodiversity, and in 2009 was lead author of *Natural Solutions*, a multi-organisation report on the role protected areas play in climate adaptation and mitigation.

Madhu Rao is chair of the IUCN World Commission on Protected Areas, coordinating work by all the regional chairs and specialist groups and representing the Commission on the IUCN Council. She also works with the Wildlife Conservation Society throughout southeast Asia and is an associate professor at the University of Singapore.

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