Maximizing Climate-Biodiversity Synergistic Outcomes: Prioritizing ecosystem integrity in SDG 13

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Abstract

There has long been an understanding that the climate and biodiversity crises are closely linked, and therefore that the policy response to these crises must be similarly synergistic. Indeed, the UN General Assembly called for mutually reinforcing action between the CBD and UNFCCC as early as 1997 (A/RES/S-19/2 19 September 1997). The Kyoto Protocol then recognized sustainable forest management, afforestation and reforestation as mitigation activities in 1998, and the Paris Agreement took another step forward in 2015, recognizing the importance of biodiversity and ecosystem integrity in its preamble, and promoting new forest mitigation activities in Article 5.2 on REDD+ (reducing emissions from deforestation and forest degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries). Numerous CBD and UNFCCC COP (and IPCC and IPBES) decisions have followed recognizing the climate – biodiversity nexus, as well as several declarations, including the Glasgow Leaders' Declaration on Forests and Land Use from COP 27 in 2021 and the COP 28 Joint Statement on Climate, Nature and People in 2023.

However, many of these decisions have not been fully implemented, and the UNFCCC and the CBD have not yet synchronized their efforts to maximize climate and biodiversity benefits by prioritizing ecosystem integrity, retention and ecological restoration of carbon dense reservoirs. This has hampered our ability to achieve SDG 13 and related goals, and has resulted in missed opportunities for increasing climate finance for biodiversity to help resolve both crises, and in particular for supporting the community and Indigenous actors who are critical to its conservation, and who are often in urgent need of development assistance.

Fortunately, advances in big data analytics, biological data portals, Earth systems data from passive (multi-spectral) and active (radar, Lidar) ground, satellite and drone-based sensors, are transforming our capacity to monitor and assess forest condition, the impacts of forest management and climate change, and identify priority areas for conservation and restoration to maximize climate-biodiversity outcomes and minimize investment risks.

Climate Biodiversity Linkages

Forest ecosystems provide vital solutions for the climate crisis as they remove carbon from the atmosphere and accumulate it in living trees, dead wood and soils. However, not all forests are equal: the climate and biodiversity benefits forests provide vary greatly according to their ecosystem condition. Forests in better ecosystem condition contain more biodiversity and store more carbon per hectare. Crucially, they also store carbon with a lower risk of loss than carbon in a degraded forest or a plantation. In other words, ecosystem condition and ecosystem services are closely correlated: the higher the ecosystem condition, the higher both the quality and quantity of ecosystem services, including biodiversity and carbon retention, the forest provides.

Despite the capacity of forests in good ecosystem condition to maximize biodiversity and climate mitigation and adaptation benefits, and many other vital ecosystem services, little consideration has been given to differentiating between the condition or integrity of forests in UN policy, and to date there is no agreed framework for assessing, mapping, and reporting on forest condition. However, increasing utilization of 'ecosystem integrity' (i.e., the ecological integrity of ecosystems) in international policy now provides the basis and impetus for revising implementation frameworks and applying new high resolution Earth systems data and related analytics to allow decisionmakers to minimize risks to investments and maximize forest ecosystem service benefits.

This brief summarizes the concept of ecosystem integrity, identifies how to better integrate ecosystem integrity into UN policy frameworks, and explains how technological innovation can help catalyze this change through providing high resolution and timely information services and decision support tools.

What is Forest Ecosystem Integrity?

Ecosystem integrity describes an ecosystem's ability to achieve and maintain its 'optimum operating state' given prevailing environmental conditions1. A high level of ecosystem integrity means that an ecosystem is entirely self-organizing and self-regenerating, i.e., it is not reliant on human management. A forest ecosystem's integrity can be assessed via three factors[1,2].

Species Composition e.g., the extent to which a forest (a) contains its native biodiversity, including dominant canopy tree species, plant and animal species, and species assemblages found only in mature forests, and (b) is free of invasive weeds and feral animals.

Structure refers to the height, density and age of the forest canopy, and the number of layers and density of the understory. Older forests have more developed and complex structures, with denser biomass and larger carbon stocks. Mature canopy structure is particularly influential in modifying the micro-environmental conditions needed for many other species.

Processes: the stability and self-regenerating capacity of forests is dependent on the complex networks of species that support critical ecosystem functions including nutrient cycling, plant pollination and seed dispersal, and food webs that maintain the dynamic balance between predators and prey, herbivores and vegetation.

A critical property of ecosystem integrity is the stability mature forests show in the face of external pressures and stresses. There are three kinds of stability:

> **Resistance** – or constancy – which means the ecosystem is not disrupted and does not change in response to an external perturbation. Forest resistance is the result of 'negative feedbacks' (e.g., dense canopies that maintain a moist, fire-resistant understory) and 'buffers' (e.g., water held within the soil that supports plant growth during droughts).
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> **Resilience** – the ability of an ecosystem to bounce back to a similar condition following disruption, at short time scales (months to years). The resulting ecosystem state can be somewhat altered (called 'ecological resilience') but when viewed over an appropriate time span, a resilient forest is able to maintain its 'identity' in terms of composition, structure and function.
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> **Persistence** – refers to the ability of an ecosystem to persist at the landscape, if not at the same location, over longer timescales.

Forest resistance and resilience are the result of an ecosystem's natural adaptive capacity resulting from its biodiversity which includes genetic diversity and species diversity. Genetic diversity is the raw material from which species can evolve new traits that are better suited to prevailing climatic conditions. Having a large pool of species in a forest landscape increases the chances that there will be species that are best able to cope or even thrive with changing environmental trends and extreme events. Many species have a flexible genetic makeup (called phenotypic plasticity) enabling them to modify their shape or functioning in response to environmental drivers.

Practical Implications of Ecosystem Integrity

Ecosystem integrity provides the basis for assessing the condition of an ecosystem and the quality of its ecosystem services. For example, primary forests, which have the highest level of ecosystem integrity, protect more species, store more carbon and yield the cleanest water relative to logged forests and plantations. The U.N.'s System of Environmental-Economic Accounting (SEEA-EA) is an important recent policy development as it utilizes a natural reference level of high ecological integrity to assess the quality of and risks to ecosystem services. This enables assessment of the economic benefits of retaining and recovering high integrity ecosystems, including of critical ecosystem services like carbon retention. Ecosystem integrity also provides critical information to decisionmakers on the likelihood that a forest will be impacted by natural or human disturbance and the risk of loss and damage to the ecosystem services it provides. For example, a forest with a high-level of integrity has a lower risk of losing carbon to the atmosphere than a forest in poor ecological condition (Figure 1, see next page).

Breakthroughs in monitoring, evaluating and mapping forest ecosystem integrity

Fortunately, advances in big data analytics, biological data portals, Earth systems data from passive (multi-spectral) and active (radar, Lidar) ground, satellite and drone-based sensors, are transforming our capacity to monitor and assess forest condition, the impacts of forest management and climate change, as well as identify priority areas for conservation and restoration to maximize climate-biodiversity outcomes and minimize investment risks. Timely and high-resolution data can now be readily obtained globally and modelled to monitor changes in forest structure, map areas of deforestation and forest degradation, and undertake analyses that can attribute identified changes to natural or human disturbances, including

Figure 1. Comparison of ecosystem integrity between five main forest types based on the foundational elements of: (1) dissipative structures; (2) ecosystem processes; and (3) stability and risk profiles

Forest type	Definition	Relative level of ecosystem integrity
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
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
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
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

from fires and logging, and how these impact on ecosystem carbon stocks. Drawing upon global and national digital biological data repositories, species distribution modelling using machine learning methods can be applied to provide the ecological context needed to interpret the significant of the forest structural monitoring to assess the impacts on biodiversity. Examples of biological digital databases are the Global Biodiversity Information Facility (https://www.gbif.org/) and the Atlas of Living Australia (https://www.ala.org.au/), while EcoCommons (https://www.ecocommons.org.au/) showcases how web platforms provide advanced ecological modelling capacities and seamless access to Earth system data.

The Policy Context

The Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC) emerged together from the Rio Summit in 1992 as a joint response to global environmental crises. However, integration of CBD and UNFCCC objectives progressed slowly until 2015 when the Paris Agreement (PA) recognized the importance of biodiversity and ecosystem integrity in its preamble, and included new forest mitigation activities in Article 5.2 on REDD+. However, Article 5 of the PA has not been applied systematically to maximize carbon and biodiversity benefits, i.e. by emphasizing the need to retain high ecosystem integrity carbon dense reservoirs and promote long term ecological restoration in carbon dense ecosystems. A fundamentally important element of both the PA and UNFCCC has therefore been missed, as has the opportunity to build stronger connections to the CBD.

Nonetheless, integration of climate and biodiversity policy has progressed since 2015. The CBD passed several key decisions on ecosystem integrity and primary forests at COP 14, and the Kunming Montreal Global Biodiversity Framework (KMGBF) was agreed in 2022, recognizing ecosystem integrity as a core principle in Goal A, and Targets 1 and 2. UNFCCC decisions 1/CP.25 and 1/CP.26 in 2020 and 2021 respectively emphasized ecosystem integrity and integrated climate-biodiversity solutions, and in 2023, the UNFCCC's decision on the Global Stocktake at COP 28 (CMA 5 para 33), stated:

> 33. *Further emphasizes 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*

The Intergovernmental Panel on Climate Change (IPCC) and Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES) have also promoted protecting and restoring ecosystem integrity. A joint IPBES-IPCC report in 2021 noted the importance of ecosystem integrity, and the IPCC's 6th Assessment Report (Working Group III, Climate Change Mitigation) stated in 2022 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."

In addition, the Glasgow Leaders' Declaration on Forests and Land Use from COP 27 in 2021 commits signatories to "halt and reverse forest loss and land degradation by 2030" and the COP 28 Joint Statement on Climate, Nature and People in 2023 also reinforced the importance of ecosystem integrity, and of primary forests and other primary ecosystems, to address the climate and biodiversity crises in an integrated manner.

However, key gaps in the UN policy system persist. One is that the CBD's KMGBF has not yet agreed on a decision (Target 8) on climate and biodiversity: it is critical that the CBD passes a strong decision on climate and biodiversity at COP 16. Another is that the United Nations Framework on Forests has not adopted a focus on ecosystem integrity and primary forests. Perhaps most critically, neither SDG 13 nor SDG 15 have recognized the fundamental importance of ecological integrity, a gap recognized in the 2018 High Level Political Forum Review of SDGs implementation, which stated:

> "The monitoring framework of SDG 15 does not capture essential elements related to quality that are crucial for more meaningful results, pointing to the need for additional indicators in areas such as forest intactness, management effectiveness of protected areas, and meaningful integration of biodiversity into other processes."

Conclusions

Given their high level of ecosystem integrity and superior ecosystem service benefits, protecting primary forests, and other primary, carbon-dense ecosystems are the highest priority for meeting international climate and biodiversity objectives and achieving the SDGs. Ecological restoration of degraded ecosystems so that they begin to recover ecosystem integrity is the second highest priority. We are rapidly running out of time to address the climate and biodiversity crises: it is critically important that SDGs 13 and 15 fully reflect the crucial importance of protecting and restoring ecosystem integrity as the most effective pathway to maximizing ecosystem services, and in particular climate and biodiversity benefits. Recent advances in spatial data analytics, Earth systems data, digital biological data repositories, and ready access to high performance computing are quickly transforming our capacity to monitor, evaluate and map forest conditions, and translate the results into relevant information for decision makers.

References

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